Grades 5 to 8 Science

A Foundation for Implementation

Manitoba
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GRADES 5 TO 8 SCIENCE

A Foundation for Implementation

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CONTENTS

INTRODUCTION

Background

Grades 5 to 8 Science: A Foundation for Implementation was produced by Manitoba Education and Training in collaboration with a development team composed of Manitoba educators. This resource for teachers and administrators provides support for implementing *Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes* (2000). This framework identifies general and specific student learning outcomes for science, and integrates the four foundation skill areas of literacy and communication, problem solving, human relations, and technology.

Contents

Grades 5 to 8 Science: A Foundation for Implementation contains the following sections:

- **Introduction**—The introduction describes the background, contents, and purpose of this document.
- **Scientific Literacy**—This section presents a vision for scientific literacy and describes how the general and specific student learning outcomes help to define that vision. A chart showing the division of specific learning outcomes into clusters for each grade is provided.
- **Scientific and Technological Skills and Attitudes**—This section describes the two processes for science education, Scientific Inquiry and Design Process (Technological Problem Solving). These processes comprise the Cluster 0: Overall Skills and Attitudes included in this document.
- **Planning for Instruction and Assessment**—This section describes the importance of creating a plan for instruction and assessment to develop a balanced science program and to ensure student progress and achievement. It also provides suggested approaches for planning and assessment.
- **Suggestions for Instruction, Assessment, and Learning Resources: Grades 5 to 8**—This four-column section contains the prescribed student learning outcomes, suggestions for instruction, suggestions for assessment, and suggested learning resources. It is organized by grade and is further divided into clusters or thematic units. Each grade is accompanied by blackline masters to support and enhance learning.
- **Appendices**—The three appendices provide additional information related to general student learning outcomes, cluster titles, and pets in the classroom.
- **References**—The reference list identifies the works used in the development of this document.

Purpose

Grades 5 to 8 Science: A Foundation for Implementation provides theoretical content about science instruction. It also provides educators with practical suggestions for planning instruction and assessment to support and monitor student progress and achievement of the student learning outcomes.

Notes

SCIENTIFIC LITERACY

The Foundations for Scientific Literacy

Grades 5 to 8 Science: A Foundation for Implementation is designed in accordance with the vision for scientific literacy articulated in the *Common Framework of Science Learning Outcomes K to 12: Pan-Canadian Protocol for Collaboration on School Curriculum* (1997) (hereafter referred to as the *Pan-Canadian Science Framework).*

The *Pan-Canadian Science Framework*

> is guided by the vision that all Canadian students, regardless of gender or cultural background, will have an opportunity to develop scientific literacy. Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities, to become lifelong learners, and to maintain a sense of wonder about the world around them.
>
> Diverse learning experiences based on the [Pan-Canadian] framework will provide students with many opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment that will affect their personal lives, their careers, and their future. (p. 4)

To develop scientific literacy, science learning experiences must incorporate the essential aspects of science and its related applications. These essential aspects, the foundations for scientific literacy, have been adapted from the *Pan-Canadian Science Framework* to address the needs of Manitoba students. Manitoba science curricula are built upon the following five foundations for scientific literacy:

A. Nature of Science and Technology

B. Science, Technology, Society, and Environment (STSE)

C. Scientific and Technological Skills and Attitudes

D. Essential Science Knowledge

E. Unifying Concepts

For more background on each of these foundation areas, consult *Grades 5 to 8 Science*: *Manitoba Curriculum Framework of Outcomes* (2000) (hereafter referred to as *5-8 Science: Manitoba Framework*).

Manitoba's vision for scientific literacy, as reflected in the five foundation areas, represents a paradigm shift in science education also evident across North America and Western Europe. The chart on the following page highlights some areas in which there are changing emphases.

CHANGING EMPHASES*

The *National Science Education Standards* envision change throughout the system. The science content standards [or student learning outcomes] encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Knowing scientific facts and information	Understanding scientific concepts and developing abilities of inquiry
Studying subject matter disciplines (physical, life, earth sciences) for their own sake	Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
Separating science knowledge and science process	Integrating all aspects of science content
Covering many science topics	Studying a few fundamental science concepts
Implementing inquiry as a set of processes	Implementing inquiry as instructional strategies, abilities, and ideas to be learned

CHANGING EMPHASES TO PROMOTE INQUIRY *

LESS EMPHASIS ON	MORE EMPHASIS ON
Activities that demonstrate and verify science content	Activities that investigate and analyze science questions
Investigations confined to one class period	Investigations over extended periods of time
Process skills out of context	Process skills in context
Emphasis on individual process skills such as observation or inference	Using multiple process skills—manipulation, cognitive, procedural
Getting an answer	Using evidence and strategies for developing or revising an explanation
Science as exploration and experiment	Science as argument and explanation
Providing answers to questions about science content	Communicating science explanations
Individuals and groups of students analyzing and synthesizing data without defending a conclusion	Groups of students often analyzing and synthesizing data after defending conclusions
Doing few investigations in order to leave time to cover large amounts of content	Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
Concluding inquiries with the result of the experiment	Applying the results of experiments to scientific arguments and explanations
Management of materials and equipment	Management of ideas and information
Private communication of student ideas and conclusions to teacher	Public communication of student ideas and work to classmates

Achieving Scientific Literacy through Student Learning Outcomes

General student learning outcomes (GLOs) for Manitoba, based on the five foundation areas, define overall expectations for scientific literacy from Kindergarten to Senior 4. Appendix A: General Learning Outcomes includes a complete list of GLOs, excerpted from *5-8 Science: Manitoba Framework*. Specific student learning outcomes (SLOs) that further define expectations for student achievement at each grade are also included in this document.

Specific student learning outcomes for Grades 5 to 8 science are arranged in clusters. Clusters 1 to 4 are thematic groupings that generally correspond to disciplinary distinctions within science, including life science, physical science, and Earth and space science. Specific student learning outcomes included in Cluster 0 address the overall science skills and attitudes students are expected to achieve. For a full listing of Cluster 0 student learning outcomes, consult *5-8 Science: Manitoba Framework* grade-by-grade presentation, or the Overall Skills and Attitudes Chart for Grades 5 to 8 science included with that document.

Cluster Titles

Grades / Clusters	Grade 5	Grade 6	Grade 7	Grade 8
Cluster 0	Overall Skills and Attitudes (to be integrated into Clusters 1 to 4)			
Cluster 1	Maintaining a Healthy Body	Diversity of Living Things	Interactions within Ecosystems	Cells and Systems
Cluster 2	Properties of and Changes in Substances	Flight	Particle Theory of Matter	Optics
Cluster 3	Forces and Simple Machines	Electricity	Forces and Structures	Fluids
Cluster 4	Weather	Exploring the Solar System	Earth's Crust	Water Systems

See Appendix B for a Cluster Titles chart for Kindergarten to Grade 4 and Senior 1.

Notes

SCIENTIFIC AND TECHNOLOGICAL SKILLS AND ATTITUDES

Science education, with scientific literacy as its goal, must engage students in scientific inquiry, technological problem solving (design process), and decision making. These skills, behaviours, and attitudes are essential for the development of scientific understanding and the application of science and technology to new situations. Cluster 0 from *5-8 Science: Manitoba Framework* identifies student learning outcomes related to scientific inquiry and the design process (technological problem solving), as well as those that apply to both processes. For some educators, this way of conceptualizing science will be new. Yet, the increasing importance of technology in daily life and the need for critical problem-solving skills underscore the importance of integrating basic science concepts with skills and attitudes related to scientific inquiry and the design process.

The following figure, adapted from Alberta Learning, illustrates some differences and similarities between scientific inquiry and the design process in purpose, procedure, and product. As teachers plan for the integration of student learning outcomes from Cluster 0: Overall Skills and Attitudes they will become more familiar with these two distinct processes as well as the overlapping skills involved.

Processes for Science Education*

	Scientific Inquiry	**Design Process (Technological Problem Solving)**
Purpose	satisfying curiosity about events and phenomena in the natural world	coping with everyday life practices, and human needs
Procedure	What do we know? What do we want to know?	How can we do it? Will it work?
Product	knowledge about events and phenomena in the natural world	an effective and efficient way to accomplish a task or meet a need

	Scientific Question	**Technological Design Problem**
Example	Why does my coffee cool so quickly? *An answer:* Heat energy is transferred by conduction, convection, and radiation.	How can I keep my coffee hot? *An answer:* One solution is to develop a styrofoam cup that will keep liquids warm for a long time.

*__Processes for Science Education:__ Adapted with the permission of the Minister of Learning, Province of Alberta, 1999.

The specific student learning outcomes in Cluster 0 are identified as applying to scientific inquiry, the design process, or both (see example). The scientific inquiry elements are included in black type on a white box on the left. The design process elements are identified by the use of white type on a black box on the right. Learning outcomes related to both processes are located in a horizontal box below the left and right hand boxes. All specific student learning outcomes appear in a numbered and lettered sequence (e.g., 1a, 1b, 1c, 2a, 2b, etc.).

<table>
<tr><th></th><th colspan="2">GRADE 6</th></tr>
<tr><th></th><th>SCIENTIFIC INQUIRY</th><th>DESIGN PROCESS</th></tr>
<tr><td rowspan="2">1. Initiating</td><td>6-0-1a Formulate specific questions that lead to investigations.
Include: rephrase questions to a testable form; focus research questions.
GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6)</td><td>6-0-1c Identify practical problems to solve.
Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?...
GLO: C3</td></tr>
<tr><td>6-0-1b Identify various methods for finding the answer to a specific question and select one to implement.
Examples: generating experimental data; accessing information from a variety of sources...
GLO: C2
(ELA Grade 6, 3.2.2; Math: SP-I.2.6, SP-II.1.6)</td><td>6-0-1d ⊂ Identify various methods to solve a practical problem, and select and justify one to implement.
Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...
GLO: C3
(Math: SP-I.2.6, SP-II.1.6)</td></tr>
<tr><td>2. Researching</td><td colspan="2">6-0-2a ⊂ Access information using a variety of sources.
Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...
GLO: C6
(ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

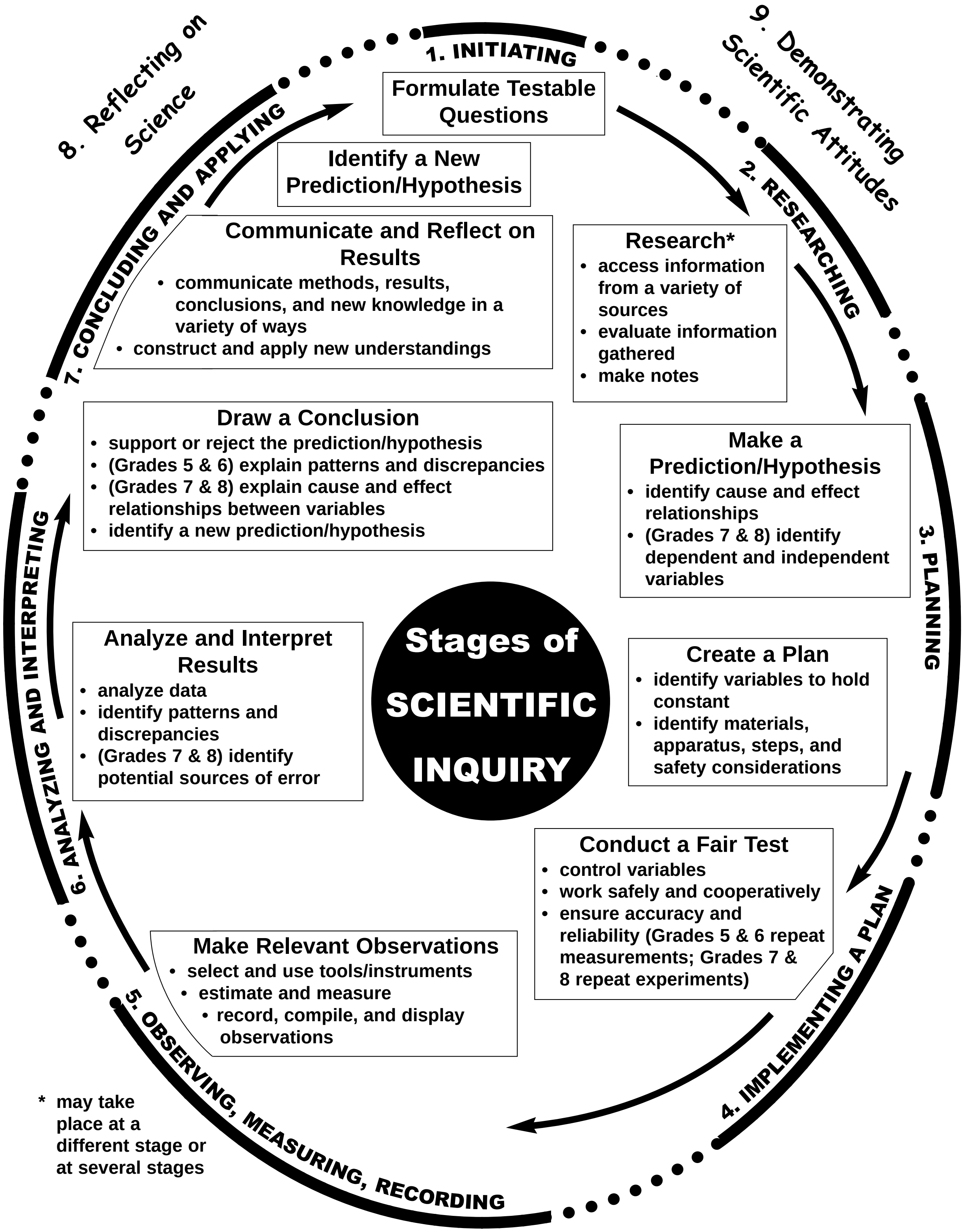
6-0-2b ⊂ Review information to determine its usefulness, using predetermined criteria.
GLO: C6, C8
(ELA Grade 6, 3.2.3)

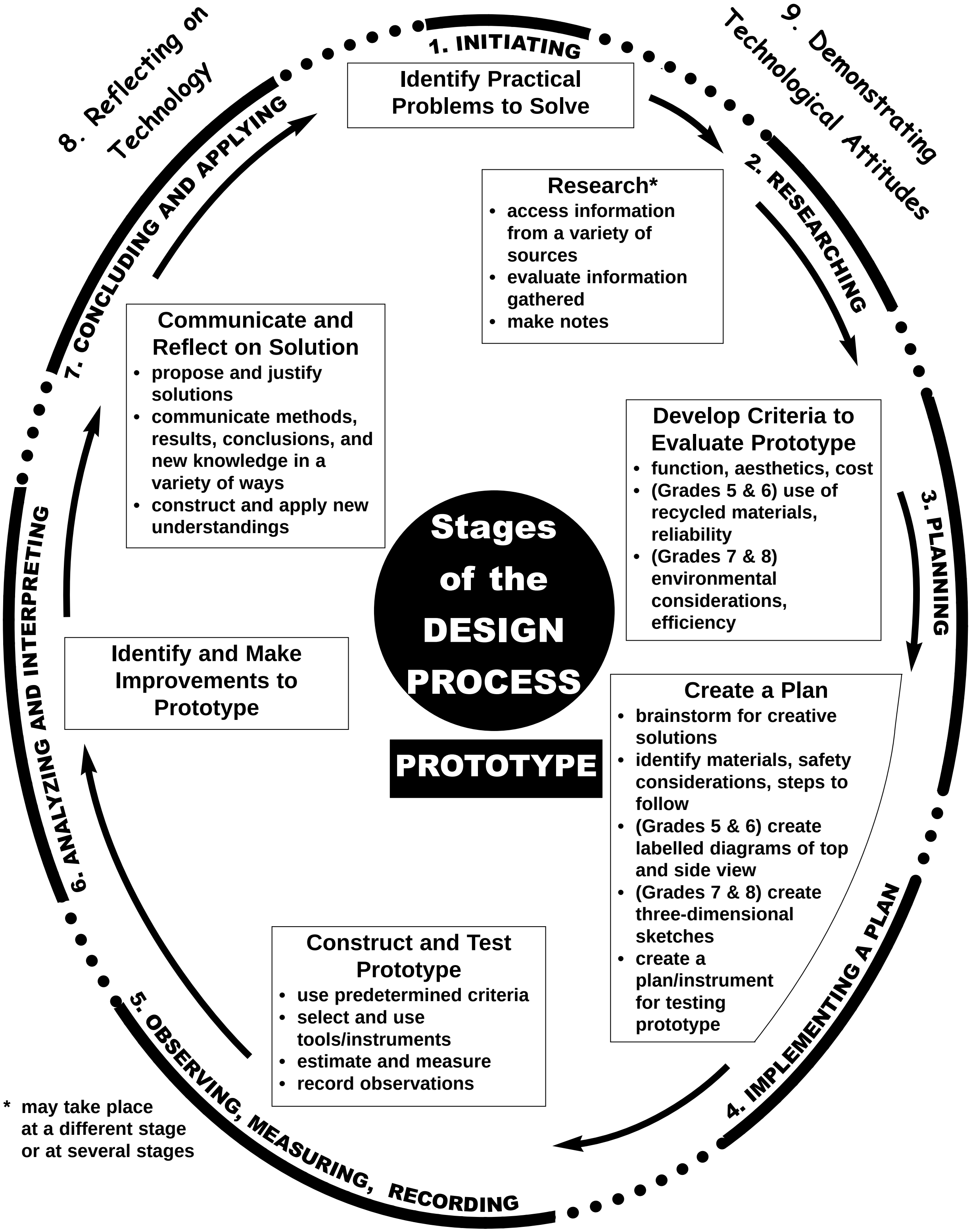
6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately.
GLO: C6
(ELA Grade 6, 3.3.2)</td></tr>
</table>

The specific student learning outcomes are further organized into the following nine categories:

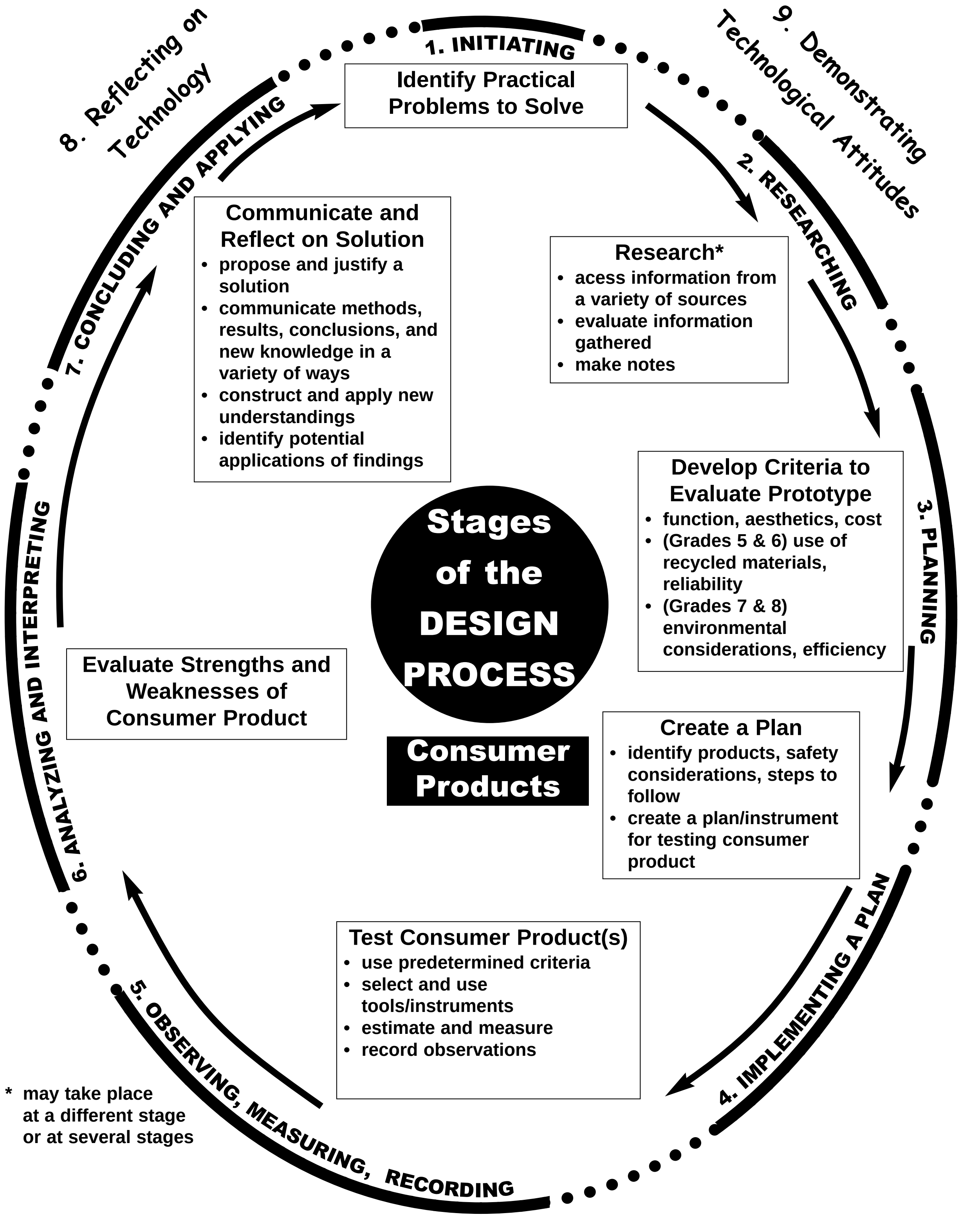
1. Initiating
2. Researching
3. Planning
4. Implementing a Plan
5. Observing, Measuring, Recording
6. Analyzing and Interpreting
7. Concluding and Applying
8. Reflecting on Science and Technology
9. Demonstrating Scientific and Technological Attitudes and Habits of Mind

The three graphics on the following pages illustrate the stages of scientific inquiry and the design process. Detailed descriptions of each process follow the graphics.


1. INITIATING
Formulate Testable Questions
2. RESEARCHING
Research*
• access information from a variety of sources
• evaluate information gathered
• make notes
3. PLANNING
Make a Prediction/Hypothesis
• identify cause and effect relationships
• (Grades 7 & 8) identify dependent and independent variables
Create a Plan
• identify variables to hold constant
• identify materials, apparatus, steps, and safety considerations
4. IMPLEMENTING A PLAN
Conduct a Fair Test
• control variables
• work safely and cooperatively
• ensure accuracy and reliability (Grades 5 & 6 repeat measurements; Grades 7 & 8 repeat experiments)
5. OBSERVING, MEASURING, RECORDING
Make Relevant Observations
• select and use tools/instruments
• estimate and measure
• record, compile, and display observations
6. ANALYZING AND INTERPRETING
Analyze and Interpret Results
• analyze data
• identify patterns and discrepancies
• (Grades 7 & 8) identify potential sources of error
7. CONCLUDING AND APPLYING
Draw a Conclusion
• support or reject the prediction/hypothesis
• (Grades 5 & 6) explain patterns and discrepancies
• (Grades 7 & 8) explain cause and effect relationships between variables
• identify a new prediction/hypothesis
Communicate and Reflect on Results
• communicate methods, results, conclusions, and new knowledge in a variety of ways
• construct and apply new understandings
Identify a New Prediction/Hypothesis
8. Reflecting on Science
9. Demonstrating Scientific Attitudes
Stages of SCIENTIFIC INQUIRY
* may take place at a different stage or at several stages



* may take place at a different stage or at several stages


Stages of the DESIGN PROCESS
Consumer Products
1. INITIATING
Identify Practical Problems to Solve
2. RESEARCHING
Research*
• acess information from a variety of sources
• evaluate information gathered
• make notes
3. PLANNING
Develop Criteria to Evaluate Prototype
• function, aesthetics, cost
• (Grades 5 & 6) use of recycled materials, reliability
• (Grades 7 & 8) environmental considerations, efficiency
Create a Plan
• identify products, safety considerations, steps to follow
• create a plan/instrument for testing consumer product
4. IMPLEMENTING A PLAN
5. OBSERVING, MEASURING, RECORDING
Test Consumer Product(s)
• use predetermined criteria
• select and use tools/instruments
• estimate and measure
• record observations
6. ANALYZING AND INTERPRETING
Evaluate Strengths and Weaknesses of Consumer Product
7. CONCLUDING AND APPLYING
Communicate and Reflect on Solution
• propose and justify a solution
• communicate methods, results, conclusions, and new knowledge in a variety of ways
• construct and apply new understandings
• identify potential applications of findings
8. Reflecting on Technology
9. Demonstrating Technological Attitudes
* may take place at a different stage or at several stages

Scientific Inquiry

As indicated in the graphic on page 9, scientific inquiry generally proceeds according to a sequence of stages, although there will be differences in the order and number of stages the students undertake. With repetition and experience, students will become aware of the logical underpinnings of scientific inquiry and develop familiarity and fluency with the requisite skills and attitudes.

While all grades follow the general stages of scientific inquiry, there are significant differences in expectations of students across the grades. For example, in Grades 5 and 6, students formulate a prediction/hypothesis that identifies a cause and effect relationship. In Grades 7 and 8, students begin to replace the terms *cause* and *effect* with *independent* and *dependent variables*. From Grades 5 to 8, students are also working with increasing independence to plan fair tests, including identifying variables to hold constant and identifying potential sources of error.

The Stages of Scientific Inquiry

The stages of the scientific inquiry are discussed below. Note that these stages are general guidelines only and every scientific inquiry may not address all the stages, or the stages may not be addressed in the exact order provided here. “Experiment Report” blackline masters have been provided at all grades for student use.

- **Formulate Testable Questions**

  Scientific inquiry begins with a student’s ability to formulate testable questions. A general question such as “*What do plants need in order to grow?*” needs to be rephrased into a focused and testable question. Students may need to perform some background research to focus the question on one variable. A good testable question includes a cause and an effect. For example, “*Does the amount of light a geranium plant receives affect how well it grows?*” includes the “cause” (the amount of light) and the corresponding “effect” (how well the plant grows). Note: This sample question focuses on one type of plant as it is not possible to test all plant types in one experiment.

  In Grades 5 and 6, a considerable amount of teacher guidance and class discussion may be required for a class to develop a testable question. By Grades 7 and 8, students should be able to develop testable questions more independently. A good testable question will enhance students’ ability to make predictions, create a plan, conduct a fair test, and make relevant observations and conclusions.

- **Research**

  The research portion of scientific inquiry may take place at various stages during scientific inquiry. It is important that students refer to a variety of sources, evaluate the information’s usefulness (Grades 5 and 6), and evaluate the reliability of information gathered (Grades 7 and 8).

  English language arts, General Learning Outcome 3: *Manage Ideas and Information,* provides teachers with strategies to assist students in developing research skills and to assess those skills. This component of the scientific inquiry process provides an opportunity to integrate science and English language arts for instruction and assessment.

- **Make a Prediction/Hypothesis**

  In the Middle Years, no distinction between prediction and hypothesis is required—the two are used interchangeably. In Grades 5 and 6, prediction is more commonly used, while in Grades 7 and 8, hypothesis is used. In some cases, a distinction between the two terms is made in learning resources and it is up to the teacher to decide whether to highlight this information.

  In Grades 5 and 6, students should state the cause and effect relationship in their prediction/hypothesis. For example, students may predict that a plant that receives more light will grow more than a plant that receives less light.

  In Grades 7 and 8, students are making similar types of predictions/hypotheses. However, rather than referring to cause and effect, students identify independent (manipulated) and dependent (responding) variables. For example, the independent variable is the amount of light and the dependent variable is the recorded growth.

- **Create a Plan**

  In Grades 5 and 6, students create a written plan that includes the apparatus, materials needed, safety considerations, and steps to follow. The plan should identify variables that could affect the experiment and should be controlled to ensure a fair test. For example, the plants that are being compared should be of the same type and given the same care. Several plants should be used. A considerable amount of initial teacher guidance will be necessary. The teacher may choose to develop the plan as a class undertaking.

  In Grades 7 and 8, students create a written plan that includes the apparatus, materials needed, safety considerations, and steps to follow. The plan should identify which variables need to be controlled. Students are expected to develop the plan and identify the variables more independently than in Grades 5 and 6.

- **Conduct a Fair Test**

  In the Middle Years, students conduct fair tests in which the variables are controlled. In Grades 5 and 6, students repeat measurements to ensure accuracy. In Grades 7 and 8, students repeat measurements as well as experiments (conduct several trials) to increase accuracy and reliability. This stage of conducting a fair test presents teachers with opportunities to introduce different aspects of science safety and laboratory procedures. Students should also assume various roles in order to achieve group goals.

- **Make Relevant Observations**

  In Grades 5 and 6, students are expected to make observations that are relevant to the specific question, select and use appropriate tools (with teacher guidance), estimate and measure using SI units, and record and organize observations in a variety of formats, such as graphs, point-form notes, diagrams, sentences, charts, lists, and spreadsheets (with teacher guidance, as needed).

  In Grades 7 and 8, students are expected to make observations that are relevant to the specific question, choose and use appropriate tools, estimate and measure using SI units (making conversions when necessary), and compile and display observations and data using an appropriate format, including point-form notes, diagrams, sentences, charts, lists, spreadsheets, graphs, and frequency tallies (with teacher guidance, as needed).

- **Analyze and Interpret Results**

  In Grades 5 and 6, students analyze collected data and observations and identify patterns and discrepancies in data. Classroom data may be compiled for analysis, providing students an opportunity to identify discrepancies. For example: *"Nine out of 10 plants showed better growth in sunlight."* Discussion should take place on possible causes of this discrepancy. This provides the opportunity to discuss the nature of science and to lay the groundwork for expectations in Grades 7 and 8 related to identifying potential sources of error. However, students should come to recognize that the overall trend indicates that plants grew better in the sunlight (even though one plant did not).

  In Grades 7 and 8, students analyze collected data and observations, identify patterns and discrepancies in data, and infer and explain their relationships. Students should also be able to identify any potential sources of errors. For example, one plant that was in the sunlight may have been exposed to another factor such as spider mites or disease, resulting in poor growth.

- **Draw a Conclusion**

  In Grades 5 and 6, students are expected to draw conclusions that explain investigation results. Teachers and students should recognize the limitations of their results. For instance, in the sample plant experiment, teachers and students should note that the results from this experiment can only be applied to the one type of plant tested, although generalizations for all plants may be proposed. The conclusion should explain patterns in data and support or reject the prediction/hypothesis. For example: *"We can conclude that the amount of sunlight that a geranium plant receives affects how well it grows. In our trials, the plants that received 10 hours of sunlight grew an average of 15 cm more than the plants that only received four hours of sunlight. The plants that received the extra light also appeared more healthy (more leaves, greener, thicker stems)."*

  In Grades 7 and 8, students also draw conclusions that explain investigation results, as well as the cause and effect relationship between the independent variable and the dependent variable. For example: *"Our experiment shows that increased sunlight causes superior growth in plants. In our experiment, all variables, other than the amount of sunlight, were kept constant. In the 32 days that we ran the experiment, the plants that received 10 hours of sunlight a day grew an average of 15 cm. The plants that only received four hours of sunlight a day grew an average of 3 cm. Our results support our prediction/hypothesis."* Students are also expected to identify a new prediction/hypothesis. This should emphasize to students that even though they may have a sound conclusion, the process of scientific inquiry can continue. For example, students may predict from their findings that a plant will continue to grow at twice the rate if they double the amount of time the plant is exposed to light.

- **Communicate and Reflect on Results**

  At all grades, students should be encouraged to present their results in a variety of ways, such as written reports, oral presentations, and multimedia presentations. Students should also be encouraged to apply their new understandings or look for links to daily life. For example, they may suggest, based on what they have learned in this inquiry, that greenhouse operators should increase the amount of light to which they expose their plants in order to improve yields. Further, students may want to propose an investigation into the cost-effectiveness of a tomato hothouse owner running his or her lights for extended periods of time. Would the increase in yields cover the cost of running the lights?

Additional Information

Materials/Equipment Required

In the Middle Years, the materials and equipment required for scientific inquiry become more specialized. While the specialized equipment required in Grades 5 and 6 is limited (e.g., a balance and thermometer in Grade 5), requirements for science equipment in Grades 7 and 8 increases. Grade 7 students work with equipment such as microscopes, thermometers, scientific glassware, and heating sources. Grade 8 students work with similar equipment and additional tools such as mirrors and lenses. Teachers must identify both general equipment requirements as indicated by the learning outcomes, and specific material and equipment requirements determined by the choices they make with regard to learning experiences for their students (these needs will differ from teacher to teacher). Cluster 0: Overall Skills and Attitudes provides some guidance on equipment requirements.

Safety Considerations

While the primary responsibility for safety in science belongs to teachers and other school personnel, Middle Years students must become aware of the importance of safety measures (in relation to themselves, others, and the environment) and become skilled in safety procedures. This awareness and these skills are critical components of the scientific culture of students who will become responsible citizens of the future.

Many science classes in Grades 5 and 6 (and possibly many in Grades 7 and 8) are conducted within the regular classroom setting and not a formal science lab. In this instance it is critical for practices to be in place to ensure the ongoing safety of students. Safe storage of equipment, materials, and chemicals is essential, as is effective clean-up. This is especially important if students will be eating lunch in the classroom.

In Grades 7 and 8, the complexity of experiments and the associated materials and equipment required increases substantially. There is, therefore, a heightened need for teachers and students to use safe science practices, and the new curriculum reflects a focus on student safety and a shift in expectations from previous curricula. For example, hot plates can be used as a safer source of heat that still allows students to meet the expectations set out in the learning outcomes. Similarly, while mercury thermometers may still be used in the classroom, they are not required by the curriculum and should eventually be replaced by alternative types of thermometers. Some schools and school divisions/districts have voluntarily chosen to remove mercury thermometers from classrooms because of the danger associated with breakage and the subsequent release of mercury and the challenges that are posed by clean-up. In addition, the use of bodily fluids or tissues is no longer allowed in the classroom. This means that learning activities outlined in previous curricula should be replaced with safer alternatives. For example, students should not be making wet mounts using cheek cells or taking blood samples for testing. Refer to *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* for important safety information for teachers and students at all grades (available from the Manitoba Text Book Bureau, stock number 85293). Another valuable resource is *Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum* (available through the Science Teachers Association of Ontario).

Assessment

Students' application of the steps of the scientific inquiry process involves the acquisition of knowledge, skills, and behaviours. Like other areas of the curriculum, scientific inquiry skills and attitudes should be assessed in relation to student learning outcomes. (See page 27 for a discussion on planning for assessment.) Teachers need to identify and become familiar with Cluster 0, grade-level learning outcomes that focus on skills specific to scientific inquiry. These skills are difficult to assess in a paper and pencil testing format. They are best assessed through observation, interviews, and tasks that involve students in actively exploring, investigating, and experimenting.

Design Process

As indicated in the graphics on pages 10-11, the design process consists of a series of sequenced stages. Through these stages, Middle Years students continue to develop the skills and attitudes of the design process that lead to a broader understanding of technological problem solving.

While all grades follow the general stages of the design process, there are significant differences in expectations of students across the grades. For example, students in Grades 5 and 6 develop criteria that include function, aesthetics, cost, reliability, and use of recycled materials, while students in Grades 7 and 8 also include efficiency and environmental considerations. Similarly, in creating a written plan, students in Grades 5 and 6 include sketches of top and side views, while students in Grades 7 and 8 include three-dimensional sketches.

At the Middle Years level the design process is separated into two approaches:

1. planning, constructing, and evaluating a prototype
2. comparing and evaluating the design of consumer products

The Stages of the Design Process for Constructing a Prototype

The stages of the design process are discussed in detail below. Note that these stages are general guidelines only and every design task may not address all the stages, or the stages may not be addressed in the exact order provided here. "Design Project Report" blackline masters have been provided at each grade for student use.

- **Identify a Practical Problem to Solve**—Identifying a practical problem initiates the design process. For example, the practical problem for learning outcome 6-4-13, *Use the design process to construct a prototype that tells the time of day or measures a time span,* could be presented in the following manner:

  "Design and construct a prototype that tells the time of day or measures a time span for a group of wilderness campers on a survival excursion. The campers will not carry any watches or clocks and need to arrive at a particular destination for pick-up at a specified time interval."

  Middle Years students should be involved in the problem identification. The problem should be framed within a context. This might involve a real-world problem or a scenario linked to another discipline, such as social studies or a literature selection. It is critical that the design challenge presented to students is problem focused as opposed to product focused. For example, "construct a boat" is a product-focused challenge, while "construct a floating device to transport a load of three blocks across a span of water one metre wide" is problem focused. The problem must also be open-ended to encourage optimum solutions.

- **Research**—Gathering information is an integral part of the design process. Information is gathered a number of ways, using a variety of resources. It occurs at various stages of the design process. The design process also draws on knowledge and skills developed through the scientific inquiry process. Effective questioning by the teacher can assist students in activating and integrating their prior knowledge and experiences. Students need to evaluate the gathered information to determine its usefulness. Researched information is organized and recorded in an appropriate format. Students need to recognize both the need to access information throughout the design process and the different resources available. Human, print, and electronic resources should be made accessible to students.

  English language arts, General Learning Outcome 3: *Manage Ideas and Information* provides teachers with strategies to assist students in developing research skills as well as assessing those skills. This component of the design process provides an opportunity to integrate English language arts and science for instruction and assessment.

- **Develop Criteria to Evaluate a Prototype**—Criteria must be specific enough to limit the scope of impractical solutions and ensure success, but also open-ended enough to allow originality and creativity. It is also important that the criteria are testable.

  Criteria should be generated with student input. They should also be framed in the context of the science learning within the cluster. The teacher may need to specify certain criteria related to the learning outcome and available materials, whereas students will often identify "real-life" type of criteria. In developing criteria, students should address function, cost, and aesthetics. In Grades 5 and 6, reliability and the use of recycled products (where appropriate) are included. Students in Grades 7 and 8 need to address environmental considerations and efficiency (where appropriate).

  To ensure that each of the specified criteria is testable, students need to provide descriptors. These might include:

  — Aesthetics: For some prototype solutions aesthetics is an important factor. The criterion of being "visually appealing" can be included, but further descriptors (e.g., colour, scale, finishing) facilitate evaluation.

  — Cost: The inclusion of cost heightens student awareness to issues of product production and cost-effectiveness. This criterion can be included by assigning a monetary value to materials or processes involved in the construction of the prototype.

  — Criteria addressing the function, reliability, and/or efficiency of the prototype must be clearly specified to ensure consistency in testing. These criteria often have a strong overlap with the scientific inquiry process as the concept of a "fair test" is applied.

  — Criteria that include the use of recycled materials or environmental considerations focus student awareness on sustainability and the potential environmental impacts of design solutions on the environment. This links with the Science, Technology, Society and Environment (STSE) component of the curriculum.

- **Create a Plan**—At this stage, the group of students generates several ideas and selects the best possible solution to the proposed problem. It is important that the teacher assists in activating students' creative thinking skills of fluency, flexibility, elaboration, and originality. This will encourage optimum solutions to the problem. The group then identifies appropriate materials, safety considerations, and a logical sequence of steps to follow. Students record their plan including labelled diagrams of the top and side views of the prototype in Grades 5 and 6, and three-dimensional sketches in Grades 7 and 8. It is important that students are aware of the value of the labelled sketch. It provides a visualization of the prototype to guide the construction and serves as a draft blueprint. The constructed prototype can be (and likely will be) altered from the initial sketch and an explanation of the need for changes is an important aspect of student learning.

  In creating a plan for the design and construction of the prototype, it is useful to have students include a plan/instrument to test the prototype according to the criteria identified and following a fair test approach.

- **Construct a Prototype**—Constructing the designed prototype gives students opportunities to apply their understanding of the properties of materials and their uses. It encourages students to identify information needs and access the required information through research. It provides the opportunity to apply the science knowledge and skills that have been acquired through that particular science cluster in a practical context.

  For example, the design problem associated with specific learning outcome 7-3-12: *Use the design process to construct a structure that will withstand the application of an external force*, requires students to apply the following knowledge and skills acquired in Cluster 3: Forces and Structures.

  — identifying internal and external forces and the stress they apply to structures

  — identifying the centre of gravity and its effect on stability

  — determining the efficiency of the structure as it relates to mass

  — investigating the effect of a force in terms of its magnitude, direction, plane, and point of application

  — determining methods to increase the strength and stability of a structure

  It is important for students to have had experience with key concepts and skills prior to the design project. The construction stage may involve the generation and revision of ideas and the identification of the need for further research. This could result in a solution that differs from the original plan.

- **Test a Prototype**—Students test the prototype against the predetermined evaluation criteria. They select and use appropriate tools and instruments in order to conduct a fair and consistent test. Students will use accurate estimates and measurements and record their observations and results. Students often needed to be reminded that their prototype needs to address *all* the criteria identified.

- **Identify and Make Improvements—**Based on the performance test of the prototype using the predetermined criteria, students analyze the performance information and identify modifications to improve the performance of their prototype and ensure that it meets all criteria. They revise the design sketch to reflect modifications and make the improvements to the prototype.

- **Communicate and Reflect on Solution**—The design process concludes with the communication and justification of a solution to the problem that has been tested with respect to the evaluation criteria and that reflects improvements based on students' analyses. "In writing, speaking, and representing, students construct meaning in order to communicate with others" (*Grades 5 to 8 English Language Arts: A Foundation for Implementation*, p. 9). Through photo essays, videos, design sketchbooks, flow charts, oral presentations, illustrated reports, demonstrations, or multimedia presentations, students communicate the products and procedures of their design process. They include the methods used, the results, and new knowledge. Students identify the strengths and weakness of their original design, and their application of new understanding is explained in the improvements made to the prototype. New problems may also be identified, leading to the need for new product development.

Additional Information

Materials/Equipment Required

Materials for a design task include recycled and everyday materials as well as tools and equipment. The use of recycled materials addresses the Science, Technology, Society and the Environment (STSE) component of the curriculum. Supplemental items such as tape, glue, scissors, etc. will need to be provided.

It is important that students become familiar with the characteristics and properties of the materials they are using. Hands-on experiences involving these materials and their structural qualities should precede a design task. For certain design tasks the types of materials can be limited. This encourages students to gain experience in the use and properties of specific materials, and be creative in their application to a task.

At times, some tools and equipment will be required for constructing a prototype. Instruction on the use of tools and equipment should precede use to ensure student safety.

Safety Considerations

The use of tools and equipment raises safety concerns. The tools and storage containers used for the technology component of the curriculum should be specifically designed to maximize user safety. Low-temperature glue guns, safety goggles, mitre boxes, and bench hooks are examples of "safer" items. If a construction part of a design task is to be done at home, parents/guardians should be alerted to provide supervision.

There are several methods to ensure safety in the classroom during the construction stage of the design process:

- Teach tool use. Demonstrate and have students practise safe use of the tools prior to beginning the task.
- Generate safety rules for the classroom, with the students developing the criteria whenever possible.
- Organize
  - — the students (groupings, supervision, responsibilities)
  - — the materials (storage, responsibilities)
  - — the tools and equipment (storage, work area, student/teacher tools, supervision)
  - — the design process display area
- Arrange the classroom for access to resources and equipment with safety in mind.

Assessment

Learning outcomes for the design process, like other areas of the curriculum, should be assessed for the acquisition of knowledge, skills, and behaviours. (See page 4 for a general discussion of assessment.) Teachers need to identify, and become familiar with, the grade-specific student learning outcomes in Cluster 0 that relate to the design process. A variety of assessment practices can be applied to the performance of a design task such as teacher observation, questioning, and student learning logs or notebooks. “Design Project Report: Assessment” and “Constructing a Prototype: Observation Checklist” blackline masters have been provided as assessment tools. It is important that the focus of assessment be on the demonstration of learning that has occurred throughout the design process. Similarly, the solution should not be evaluated on whether it worked, but rather on the degree of its effectiveness in addressing the original problem.

Because of the sequential and recursive nature of the design process, student self-assessment and peer evaluation should be ongoing. The design process also provides opportunities for formative assessment so that the teacher can plan the next stage of instruction and learning. For example, if during the design task associated with learning outcome 7-3-12, *Use the design process to construct a structure that will withstand the application of an external force*, the teacher observes that the students are encountering difficulties due to limited understanding of the structural shapes, a mini-lesson or background learning activity may be inserted into the learning experience.

In the evaluation stage of the design process, assessment should focus on the positive aspects of the solution. Through the use of probing and open-ended questions, the teacher can elicit further thinking on making improvements to enhance the solution as well as student understanding of the science knowledge connected to the design task. This will also provide indicators as to the student’s level of achievement related to the learning outcomes. Design notebooks, demonstrations, oral presentation using visuals, and multimedia presentations can provide records of student learning at each stage of the design process and assist in the assessment of student learning.

The Stages of the Design Process for Evaluating Consumer Products

The stages of the design process as applied to evaluating consumer products are discussed in detail below. Note that these stages are general guidelines and every design task may not address all the stages, or the stages may not be addressed in the exact order provided here.

- **Identify a Practical Problem to Solve**—Identifying a practical problem initiates the design process. For example, the practical problem for learning outcome 5-1-05, *Evaluate prepared food products using the design process*, could be presented in the following manner:

  “In planning daily menus over a weekly period, working parents would like to include some prepared foods for supper. They want to ensure that the prepared food contributes to a balanced, nutritional meal and is reasonably priced. Which prepared foods should be considered?”

  Middle Years students should be involved in the problem identification. The problem should be framed within a context. This might involve a real-world problem or a scenario linked to another discipline such as social studies or literature. It is important that the problem is open-ended to encourage optimum solutions.

- **Research**—Gathering information is an integral part of the design process. Information is gathered in a number of ways, using a variety of resources. It occurs at various stages of the design process. The design process also draws on knowledge and skills developed through the scientific process. For example, information on consumer products may be accessed electronically through a company's website, email address, or a 1-800 number provided on the package. Students need to evaluate the information gathered to determine its accuracy and usefulness. Researched information is organized and recorded in an appropriate format. Students need to recognize both the need to access information throughout the design process and the different resources available. Human, print, and electronic resources should be made accessible to the students.

  English language arts, General Learning Outcome 3: *Manage Ideas and Information,* provides teachers with strategies to assist students in research and note-taking. This component of the design process provides an opportunity to integrate science and English language arts for instruction and assessment.

- **Develop Criteria to Evaluate a Consumer Product**—Evaluation criteria should be generated with student input. They should also be framed in the context of the science learning within the cluster. The teacher may need to specify criteria related to the learning outcome. Criteria must be testable. For consumer products some features of the design may not be readily accessible which might affect the selection of criteria. It may be important to rank the criteria in order of importance to the solution of the problem, especially when comparing consumer products.

  In developing criteria, the students should include function, cost, and aesthetics. Students in Grades 5 and 6 consider reliability and the use of recycled products (where appropriate), while in Grades 7 and 8 students address environmental considerations and efficiency (where appropriate).

  In evaluating consumer products, it is important to compare similar products. This assists students in evaluating a product using predetermined criteria, and in investigating different ways in which products are designed. The use of comparison heightens student awareness of the importance of the design component and their critical analysis of consumer products.

  To ensure that each of the specified criteria is testable, students need to provide descriptors. These might include:

  — Aesthetics: For some prototype solutions aesthetics is an important factor. The criterion of being "visually appealing" can be included, but further descriptors (e.g., colour, packaging features) facilitate evaluation.

  — Cost: The inclusion of cost assists students in analyzing the value of a consumer product.

  — Criteria addressing the function, reliability, and/or efficiency of the prototype must be clearly specified to ensure consistency in testing.

  — Criteria that include the use of recycled materials or environmental considerations focus student awareness on sustainability and the potential impacts of design solutions on the environment. This links with the Science, Technology, Society and Environment (STSE) component of the science curriculum.

- **Create a Plan—**The group identifies appropriate materials, safety considerations, and a logical sequence of steps to follow to evaluate consumer products.

  In creating a plan for the evaluation of consumer products, the teacher needs to decide whether:

  — each group will evaluate one product and then compare the effectiveness of each in solving the problem through class sharing and discussion

  or

  — each group will compare more than one product and determine the effectiveness of each in solving the problem

  It is useful to have students include a plan for testing the consumer product. This might involve developing a testing instrument with the concept of a fair test in mind.

- **Test Consumer Products**—Students test the consumer products against the predetermined evaluation criteria. They select and use appropriate tools and instruments to conduct a fair and consistent test. Students use accurate estimates and measurements and record their observations and results.

- **Evaluate Strengths and Weaknesses of Consumer Products**—From the test of the consumer product using the predetermined criteria, students identify and record its strengths and weaknesses. When comparing two or more consumer products, students may need to rank each one on each specified criterion or use a list of prioritized criteria to determine the better product. The comparison of consumer products enables students to analyze specific features that need improvements to meet the criteria.

- **Communicate and Reflect on Results**—The design process concludes with the proposal and justification of a solution to the problem that has been tested with respect to the evaluation criteria, and that reflects improvements based on students' analyses. "In writing, speaking, and representing, students construct meaning in order to communicate with others" (*Grades 5 to 8 English Language Arts: A Foundation for Implementation*, p. 9). Through oral presentations, illustrated reports, demonstrations, or multimedia presentations, students communicate the products and procedures of their design process. They include the methods used, the results, the conclusions, and new knowledge. Students identify the strengths and weakness of the consumer products. Through product comparison they apply their new understanding in recognizing the design features that best address the solution to the initial problem. New problems may also be identified, leading to the need for analysis of other products, or new product development.

Additional Information

Safety Considerations

The use of consumer products in the design process can raise different types of safety concerns. In a classroom environment health and hygiene need to be addressed, particularly if the design task involves food. To ensure safety when using consumer products, the teacher should

- select a school facility that minimizes risks, such as the gym or outdoors to test sports equipment, and the school lunchroom to test prepared food products
- address hygiene and health issues such as allergies
- check the product to be tested for defects or features that may cause injury

PLANNING FOR INSTRUCTION AND ASSESSMENT

Introduction

To implement the Manitoba science curriculum and to ensure that students successfully master the learning outcomes, teachers must have a plan for instruction and assessment. Planning needs to take place at both the school and the classroom levels. As a community of learners, the school provides opportunities for staff and students to learn together. Communication among the teachers at various grades promotes the discussion of grade level learning outcomes, student progress related to those outcomes, and strategies for the continued success of all students. Without this communication, teachers are repeatedly starting over with each new class of students. School-based planning helps teachers to see the big picture: the role of science in the whole school and in the community. Using classroom-based assessments and any other testing/assessment tools that are available, teachers are able to see general strengths and weaknesses of both individual students and the programming.

Student learning outcomes assist teachers and other educators to

- plan learning activities that support student achievement
- establish goals for learning, instruction, and assessment
- monitor student progress in achieving learning outcomes
- communicate with students, parents, and guardians about student progress
- develop a science plan for a school

Diversity in the Classroom

Students come from a variety of backgrounds and have distinct learning requirements, learning and thinking approaches, and prior knowledge and experiences. Their depth of prior knowledge varies, reflecting their experiences inside and outside the classroom. Some entry-level knowledge held by students may be limited or incorrect, impeding new learning. For new learning to occur, it is important for teachers to activate prior knowledge, correct misconceptions, and encourage students to relate new information to prior experiences.

Manitoba's cultural diversity provides opportunities for embracing a wealth of culturally significant references and learning resources in the Middle Years science classroom. Students from various backgrounds bring socially constructed meanings, references, and values to science learning experiences, as well as their unique learning approaches. As noted in the *Senior Years Science Teachers' Handbook (SYSTH)*, "To be effective, the classroom must reflect, accommodate, and embrace the cultural diversity of its students" (1997, p. 7.13).

Toward this end, *Grades 5 to 8 Science: A Foundation for Implementation* acknowledges and supports cultural diversity. Included in this document are a range of instructional strategies and conceptual links to appropriate communities and their resources (e.g., Aboriginal communities, agricultural communities). Teachers are encouraged to utilize the community and the surrounding natural habitats as these relate to particular science learning outcomes, as they afford opportunities to enrich the learning experience. The careful selection of learning resources that acknowledge cultural, racial, and gender differences will allow students to affirm and strengthen their unique social, cultural, and individual identities. A meaningful learning environment for all requires that teachers be sensitive to the role that diversity plays in the Middle Years science classroom.

Planning a Balanced Science Program

Developing a balanced, integrated science program is a dynamic process. The program is shaped by the teaching style and resources of each teacher, by the interests and abilities of the students, and by the needs of the community.

Planning a balanced science program needs to take into account

- that specific learning outcomes stated are end-of-year learning outcomes. Students may achieve the learning outcomes at any time during the year.
- that learning is recursive and cumulative; many of the learning outcomes need to be addressed in different ways throughout the school year. Students need practice in many meaningful contexts to consolidate new knowledge, skills, and strategies.
- that planning is continuous, informed by ongoing classroom assessment
- that a variety of instructional approaches, classroom management techniques, assessment practices, tools, strategies, and problem-solving activities are essential
- that student grouping patterns should be varied: individual, pairs, small groups, large groups, whole class, heterogeneous, homogeneous, student-directed, teacher-directed
- that students have various learning approaches and multiple intelligences
- that students learn at various rates, necessitating pre-teaching, review, additional practice for some students, and/or challenging extension activities for others

Teachers strive for balance in their classrooms. The following diagram illustrates options to consider in planning instructional and assessment activities.

Planning to Ensure Balance*

explicit instruction	and	indirect instruction
interactive learning	and	independent learning
vicarious experiences	and	concrete experiences
teacher choices	and	student choices
teacher assessment	and	self/peer assessment
teacher talk	and	student talk

* **Planning to Ensure Balance:** Adapted from Manitoba Education and Training, *Kindergarten to Grade 4 English Language Arts: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1997, p. 29.

Questions to Guide Results-Based Planning

1. *What do we want students to know and be able to do?*
   This question can be answered by reading the student learning outcome to determine the knowledge, skills, and strategies that it includes.

2. *What do students already know?*
   This question can be answered by having students work through learning activities that demonstrate their prior knowledge related to particular learning outcomes. Using strategies such as KWL Charts, word cycles, and concept maps would also help to provide information on prior knowledge.

3. *What instructional methods, materials, and strategies will help students develop these competencies?*
   These will be drawn from teachers' experiences, professional resources, or instructional suggestions provided in this document.

4. *What is the purpose for assessment? How will the assessment be used?*
   Various assessment audiences and purposes are suggested on page 29 and in the "Principles of Assessment" chart on page 29.

5. *What assessment tasks will allow students to demonstrate their understanding in authentic ways?*
   Assessment tasks will be drawn from teachers' experiences, professional resources, or suggestions provided in this document.

Phases of Learning

When preparing instructional plans and goals, teachers should consider three learning phases:

1. activating (preparing for learning)
2. acquiring (integrating and processing learning)
3. applying (consolidating learning)

These phases are not entirely linear, but are a useful way of thinking and planning. A variety of activating, acquiring, and applying strategies are discussed in *Success for All Learners: A Handbook on Differentiating Instruction* (Manitoba Education and Training, 1996). Many of these strategies have been incorporated into the suggestions for instruction and assessment provided in this document.

- **Activating (Preparing for Learning)**

  One of the strongest indications of how well students will comprehend new information is their prior knowledge of the subject. Some educators observe that more student learning occurs during the activating phase than at any other time. In planning instruction and assessment, teachers develop learning activities and select strategies for activating students' prior knowledge. These learning activities provide information about the extent of students' prior knowledge of the topic to be studied, and about their knowledge of and proficiency in applying skills and strategies needed for learning in this topic area.

  Prior knowledge activities include the following:

  — helping students relate new information, skills, and strategies to what they already know and can do

  — allowing teachers to correct misconceptions that might otherwise persist and make learning difficult for students

— allowing teachers to augment and strengthen students' knowledge bases in cases where students do not possess adequate prior knowledge and experience to engage with new information and ideas

— helping students recognize gaps in their knowledge

— stimulating curiosity, and initiating the inquiry process that will direct learning

- **Acquiring (Integrating and Processing Learning)**

  In the second phase of learning, students absorb new information and integrate it with what they already know, adding to and revising their previous knowledge. Part of the teacher's role in this phase is to present this new information, or to help students access it from other sources.

  Because learning is an internal process, facilitating learning requires more of teachers than the simple presentation of information. In the acquiring phase, teachers instruct students in strategies that help them make meaning of information, integrate it with what they already know, and express their new understanding. In addition, teachers monitor these processes to ensure that learning is taking place, using a variety of instruments, tools, and strategies such as observations, interviews, and examination of student work.

- **Applying (Consolidating Learning)**

  New learning that is not reinforced is soon forgotten. Teachers need to move students beyond guided practice and into independent practice. The products and performances by which students demonstrate new learning are not simply required for assessment; they have an essential instructional purpose in providing students with opportunities to demonstrate and consolidate their new knowledge, skills and strategies, and attitudes.

  Students also need opportunities to reflect on what they have learned and to consider how new learning applies to new situations. By restructuring information or integrating what they have learned in one strand with other strands or subject areas, students strengthen and extend learning.

Planning for Instruction

The use of essential questions (Jacobs, 1997, Wiggins and McTighe, 1998) can be an important planning tool for teachers. Essential questions help to organize instruction and focus the science learning related to a specific cluster or combination of clusters. They allow teachers to group related learning outcomes and target key ideas. They lead to the selection of learning activities that will aid students in the pursuit of answers to the essential questions. This pursuit involves the skills and processes of Cluster 0: Scientific and Technological Skills and Attitudes and balances the knowledge component of the answer to the essential question with the skills and thinking involved in acquiring that knowledge. The benefits of planning based on essential questions are summarized as follows:

How Do Essential Questions Enhance Student Learning?

1. They motivate students and allow them to activate their thinking related to a cluster.
2. They focus student learning.
3. They allow students to have a variety of learning experiences that develop and reinforce key concepts/answers to a limited number of big questions.
4. They clarify what is expected of students (students must know the answer to the questions and be able to explain how they gained that understanding).

How Do Essential Questions Help Organize Instruction?

1. They focus instruction and create links among learning outcomes.
2. They highlight conceptual priorities related to the cluster.
3. They guide the design of learning experiences.
4. They can be sequenced so that they lead naturally from one to another.
5. They engage students in uncovering the important ideas at the heart of a subject.
6. They guide the design of assessment tasks that allow students to demonstrate their understanding of the cluster-related knowledge and skills.

Generally, two to five essential questions are required to address the learning outcomes related to a particular cluster. Teachers first must become familiar with the content of the clusters in order to group related learning outcomes and identify an essential question that would encompass them. There is no one set of “ideal” essential questions for any cluster. The questions must be shaped according to an individual teacher’s way of thinking and relate to his or her students. Essential questions may also change and evolve over the course of study, or from one year to the next.

What Makes a Question an Essential Question?

1. It can and should be asked over and over.
2. It cannot be answered satisfactorily in one sentence.
3. It is provocative and multi-layered to reveal the richness and complexity of the subject.
4. It points to the key inquiries and core ideas.
5. It brings together the content from several learning outcomes.
6. It is understood by each student.

Teachers may choose to post the essential questions on their classroom bulletin board and construct the “answers” with students as they progress through a series of learning experiences. Sample essential questions from Grade 5, Cluster 4: Weather include:

- What is weather?
- How can we predict weather?
- How does weather affect humans and other animals?

These questions encompass the learning outcomes for this cluster on weather. Using these questions, a teacher can identify what student answers would look like upon completion of a unit of study (and confirm that the required learning outcomes would in fact be addressed) and identify what learning experiences the students would need to undertake in order to generate the needed answers. The essential questions would also guide the selection of assessment tasks that would allow students to demonstrate what they have learned and explain how they know what they know.

Planning based on essential questions represents only one possible approach to planning that teachers may use. It is important for teachers to develop a way of planning that suits their needs and results in the development of balanced, meaningful science programs.

Planning for Assessment

Assessment is a "systematic process of gathering information about what a student knows, is able to do, and is learning to do" (Manitoba Education and Training, *Reporting on Student Progress and Achievement*, p. 5). Assessment is an integral part of instruction that enhances, empowers, and celebrates student learning.

Meaningful Assessment

One purpose of meaningful assessment is to inform instruction by providing information about student learning. This information can then be used to provide direction for planning further instruction. Assessment should occur in authentic contexts that allow students to demonstrate learning by performing meaningful tasks.

Meaningful content and contexts for assessment help students by engaging their attention and encouraging them to share their work and talk about their progress. Students need to take an active part in assessment. When students understand assessment criteria and procedures, and take ownership for assessing the quality, quantity, and processes of their own work, they develop self-assessment skills. The ultimate goal of assessment is to develop independent, lifelong learners who regularly monitor and assess their own progress.

This evolving definition of meaningful assessment reflects changes in thinking that have taken place nationally and internationally. The following chart summarizes the changing emphases in assessment.

CHANGING EMPHASES*

The *National Science Education Standards* envision change throughout the system.
The assessment standards encompass the following changes in emphases:

LESS EMPHASIS ON	MORE EMPHASIS ON
Assessing what is easily measured	Assessing what is most highly valued
Assessing discrete knowledge	Assessing rich, well-structured knowledge
Assessing scientific knowledge	Assessing scientific understanding and reasoning
Assessing to learn what students do not know	Assessing to learn what students do understand
Assessing only achievement	Assessing achievement and opportunity to learn
End of term assessments by teachers	Students engaged in ongoing assessment of their work and that of others
Development of external assessments by measurement experts alone	Teachers involved in the development of external assessments

*__Changing Emphases:__ Reprinted with permission from the NATIONAL SCIENCE EDUCATION STANDARDS.

The Teacher's Role in Assessment

In the classroom, teachers are the primary assessors of students. Teachers design assessment tools with two broad purposes: to collect information that will inform classroom instruction, and to monitor students' progress toward achieving year-end science learning outcomes. Teachers also assist students in developing self-monitoring and self-assessment skills and strategies. To do this effectively, teachers must ensure that students are involved in setting learning goals, developing action plans, and using assessment processes to monitor their achievement of goals. Teachers also create opportunities to celebrate their progress and successes.

Teachers learn about student learning and progress by regularly and systematically observing students in action, and by interacting with students during instruction. Because students' knowledge and many of their skills, strategies, and attitudes are internal processes, teachers gather data and make judgments based on observing and assessing students' interactions, performances, and products or work samples. Teachers demonstrate that assessment is an essential part of learning. They model effective assessment strategies and include students in the development of assessment procedures, such as creating rubrics or checklists.

Assessment Purposes and Audiences

The quality of assessment largely determines the quality of evaluation. Evaluation is "the process of making judgments and decisions based on the interpretation of evidence gathered through assessment" (Manitoba Education and Training, *Reporting on Student Progress and Achievement*, p. 39). Valid judgments can be made only if accurate and complete assessment data are collected in a variety of contexts over time. Managing assessment that serves a multitude of purposes and audiences is a challenging task. Teachers must continually balance the assessment of their students' progress in the development of knowledge, skills, strategies, and attitudes with the purposes and audiences for the information collected.

Principles of Assessment*
1. An Integral Part of Instruction and Learning Assessment . . . • is meaningful to students • leads to goal setting • fosters transfer/integration with other curricular areas and application to daily life • reflects instructional strategies used • uses a wide variety of strategies and tools • reflects a definite purpose
2. Continuous and Ongoing Assessment . . . • occurs through all instructional activities • occurs systematically over a period of time • demonstrates progress towards achievement of learning outcomes *(continued)*

Note: These principles of assessment apply to all subject areas.

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*__Principles of Assessment:__ Adapted from Manitoba Education and Training, *Kindergarten to Grade 4 Mathematics: Classroom-Based Assessment*. Winnipeg, MB: Manitoba Education and Training, 2000, p. 3.

Principles of Assessment *(continued)*

3. Authentic and Meaningful Learning and Contexts

Assessment . . .
- focuses on connecting prior knowledge and new knowledge (integration of information)
- focuses on authentic problem-solving contexts and tasks
- focuses on application of strategies for constructing meaning in new contexts

4. Collaborative and Reflective Process

Assessment . . .
- encourages meaningful student involvement and reflection
- involves parents as partners
- reaches out to the community
- focuses on collaborative review of products and processes to draw conclusions
- involves a team approach

5. Multidimensional—Incorporating a Variety of Tasks

Assessment . . .
- uses a variety of authentic strategies, tasks, and tools
- is completed for a variety of purposes and audiences
- reflects instructional tasks

6. Developmentally and Culturally Appropriate

Assessment . . .
- is suited to students' developmental levels
- is sensitive to diverse social, cultural, and linguistic backgrounds
- is unbiased

7. Focused on Students' Strengths

Assessment . . .
- identifies what students can do and are learning to do
- identifies competencies in the development of knowledge, skills and strategies, and attitudes
- considers preferred learning approaches
- focuses on celebrations of progress and success
- provides for differentiation
- provides information to compare a student's performance with his or her other performances

8. Based on How Students Learn

Assessment . . .
- uses sound educational practice based on current learning theory and brain research
- fosters development of metacognition
- considers multiple intelligences and learning approaches
- uses collaborative and cooperative strategies
- considers research on the role of memory in learning
- reflects current models of learning

9. Offer Clear Performance Targets

Assessment . . .
- encourages student involvement (setting criteria, measuring progress, working towards learning outcomes and standards)
- encourages application beyond the classroom
- provides a basis for goal setting
- provides students with a sense of achievement
- provides information that compares a student's performance to predetermined criteria or standards

Purposes of Ongoing Assessment

Ongoing assessment helps teachers decide

- whether students have mastered certain learning outcomes
- whether they are making progress in attaining other learning outcomes
- which learning outcomes need to be the focus of further instruction and assessment
- whether instructional resources, activities, and strategies need to be adapted
- which tools would be most appropriate for assessment
- whether individual students need alternative learning experiences or further support

Formative Assessment

Formative assessment is data collected about the individual students and/or the whole group during classroom instruction.

Formative assessment is designed to guide instruction and to improve student learning. This is done by

- identifying specific learning needs
- providing feedback describing students' performance

The instruments used in formative assessment provide information or data that teachers, parents/guardians, and students may use to identify factors that facilitate or hinder student learning.

Possible assessment strategies/tools that can be used for formative assessment include:

- observations recorded on checklists or in teacher notes
- performance tasks with scoring rubrics
- diagnostic interviews
- group/peer assessments
- self-assessment
- paper-and-pencil tasks
- science notebooks

Note: "The thrust of formative assessment is toward improving learning and instruction. Therefore, the information should not be used for assigning marks as the assessment often occurs before students have had full opportunities to learn content or develop skills" (Manitoba Education and Training, *Reporting on Student Progress and Achievement*, p. 9).

Summative Assessment

Summative assessment (evaluation) is based on an interpretation of the assessment information collected. It helps determine the extent of each student's achievement of identified learning outcomes. Evaluation should be based on a variety of assessment information. Summative assessment is used primarily to

- measure student achievement
- report to parent(s)/guardian(s), students, and other stakeholders
- measure the effectiveness of instructional programming

Suggestions for Assessment

In *Grades 5 to 8 Science: A Foundation for Implementation*, a variety of assessment types and tools have been suggested. The intent is to reflect a variety of assessment practices and emphasize the need for frequent and varied assessment to gain information for formative and summative assessments. Teachers must be aware that the same tool may be used with different types of assessment, and to collect either formative or summative data.

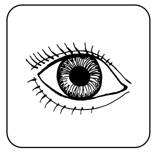
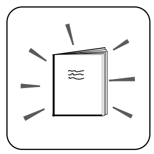
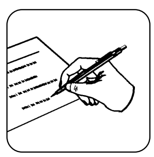
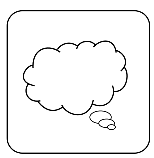
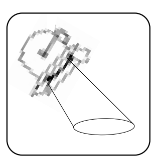
Assessment can take place during a learning experience through *observation*. Tools such as rating scales, checklists, and anecdotal records can help gather and record information. This type of assessment addresses the activating and acquiring stages of learning where group work or teacher-guided practice takes place. A teacher is looking for students to demonstrate a particular behaviour/skill and record its presence. A particular emphasis and/or group of students are usually identified as a focus for a particular observation period. Observational assessments are mainly used to assess process skills (scientific inquiry, design process, or group skills). A number of observations would need to be compiled in order to obtain a clear and accurate picture of student knowledge and skills.

Assessment tools that follow learning experiences allow students to apply knowledge gained or to reflect on the learning process. A *product or work sample* can be assessed through the use of tools such as rating scales, checklists, rubrics, and anecdotal comments. This assessment can be carried out by the student, by peers, or by the teacher. *Quizes and tests* (restricted response/extended response) can be used, accompanied by answer keys (for restricted response questions) or checklists and rating scales (for extended response questions). Short quizes are often used as Admit Slips or Exit Slips, to be given out at the beginning or the end of a class as a quick check of student understanding of concepts that have recently been introduced. *Reflection*, through the use of peer- or self-assessments, can allow students to reflect on the process and/or product. Reflective comments can also allow students to reflection on their own learning. Rating scales, checklists, and dialogues or interviews are useful tools in this area.

Performance tasks allow students to synthesize and apply a broad range of knowledge and skills gained through previous learning activities. They represent realistic tasks and result in a wide range of complex performances. The focus may be on a performance and/or a product. Rating scales or rubrics are used to assess the richness of the performance.

The following table summarizes the assessment types and tools used in the Suggestions for Assessment column.

Summary of Assessment Types and Tools

Formative or Summative Assessment (depending on stage of learning and purpose for assessment)		Learning Stage	Icon	Types of Assessment	Tools
	During the Learning Experience	**Activating** **Acquiring** **(group work or teacher-guided practice)**		**Observation** • to assess scientific inquiry skills, design process skills, group skills	rating scales, checklists, anecdotal records
	Following the Learning Experience	**Applying** **Reflecting** **(group, individual)**		**Product/Work Sample** • may be assessed by self, peers, and/or teacher	rating scales, checklists, rubrics, anecdotal comments
				**Quizzes/Tests** • may be restricted or extended response	restricted response: answer keys; extended response: checklists, rating scales
				**Reflection** • includes peer or self-assessment of the process and/or product, and general reflection on learning	rating scales, checklists, dialogue/interview
				**Performance Tasks** • synthesize a broad range of knowledge and skills from previous learning activities • focus may be on the performance and/or a product • result in a wide range of complex performances	rating scales, rubrics

Notes

Suggestions for Instruction, Assessment, and Learning Resources: Grades 5 to 8

Manitoba Education and Training
2000

SUGGESTIONS FOR INSTRUCTION, ASSESSMENT, AND LEARNING RESOURCES: GRADES 5 TO 8

Section Organization

The suggestions for instruction, assessment, and learning resources contained in this section of the document provide teachers with a foundation for implementing the student learning outcomes identified in *Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes* (2000). This section of the Grades 5 to 8 document is organized by grade, each containing four clusters or thematic units, accompanied by blackline masters (BLMs) that are intended to support and enhance learning and assessment.

Guide to Reading the Four Columns

A two-page, four-column format is used for each grade:

- Column one cites the student learning outcome statements that define what students are expected to achieve at the end of each grade. They include the learning outcomes related to thematic clusters as well as learning outcomes related to Cluster 0: Overall Skills and Attitudes, selected to correspond to the suggestions for instruction.
- Column two contains suggestions for instruction directly related to the attainment of specific learning outcomes.
- Column three contains suggestions for assessing specific student learning outcomes.
- Column four cites suggested learning resources to support instruction and assessment.

Teacher notes providing background information and/or planning hints are incorporated in either column two or three.

The following pages provide further clarification on reading the four-column format and the specific learning outcomes.

Links to Supporting Resources

Suggested Learning Resources

The suggested learning resources contained within column four include student and teacher resources (print and multimedia) that were identified through a Manitoba Learning Resource Review, as well as additional items for teacher reference. A complete list and description of the recommended learning resources appear in *Grades 5 to Senior 1 Science Learning Resources: Annotated Bibliography: A Reference for Selecting Learning Resources*, published online at: <http://www.edu.gov.mb.ca/metks4/curricul/learnres/mr-1.html>. Learning resources selected in subsequent reviews will be posted at the same website. The learning resources may be ordered from the Manitoba Text Book Bureau (MTBB) online catalogue at: <http://edu.gov.mb.ca/metks4/curricul/learnres/mtbb>.

The suggested learning resources are intended to be a starting point for teachers in the selection of learning resources for their students and should be supplemented by locally selected items to support a resource-based learning approach.

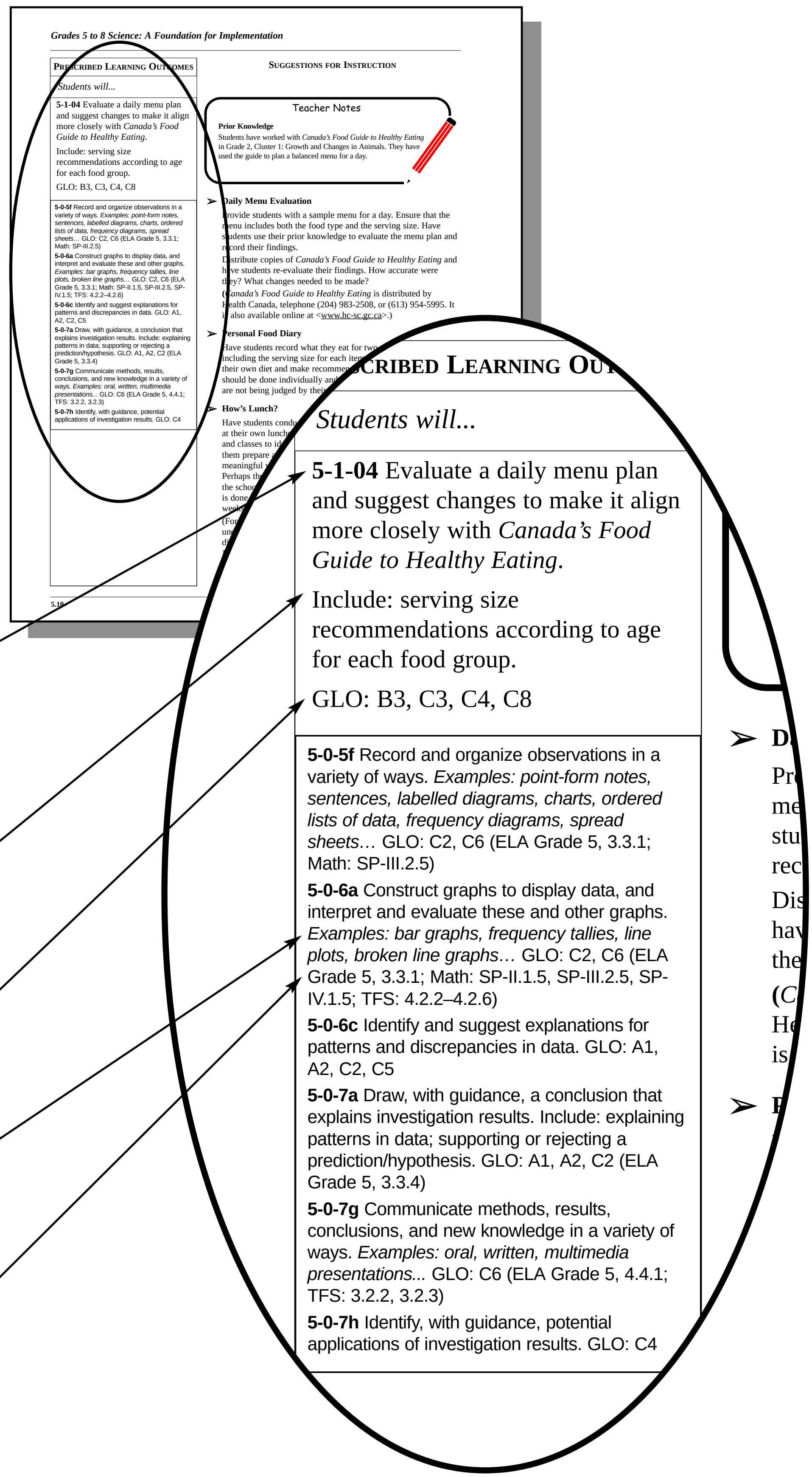
Other Links

Grades 5 to 8 Science: A Foundation for Implementation includes links to a number of related documents (see summary table below). Within Cluster 0: Overall Skills and Attitudes, cross-references are made to specific student learning outcomes identified in Manitoba's mathematics and English language arts curricula to facilitate curricular integration and the application of numeracy and literacy skills within a science context. Cross-references are also made to *Technology As a Foundation Skill Area: A Journey Toward Information Technology Literacy* (1998) to facilitate the development of skills related to information technology.

Within the suggestions for instruction and the suggestions for assessment (columns two and three), references are made to several other Manitoba Education and Training documents that provide strategies for learning, teaching, and assessment, and/or background information related to the suggested learning experiences or specific student learning outcomes. A summary of these documents and the abbreviations used (if any) is provided below:

Document Titles	Abbreviations
• *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* (2000)	
• *Grades 5 to 8 English Language Arts: A Foundation for Implementation* (1998)	• *5-8 ELA*
• *Grades 5 to 8 Mathematics: A Foundation for Implementation* (1997)	• *5-8 Math*
• *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* (2000)	
• *Native Studies: Middle Years (Grades 5 to 8): A Teacher's Resource Book* (1997)	
• *Native Studies: Middle Years (Grades 5 to 8): A Teacher's Resource Book Framework* (1997)	
• *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* (1997)	
• *Senior 3 Agriculture: A Full Course for Distance Education Delivery, Field Validation Version* (1999)	
• *Senior Years Science Teachers' Handbook: A Teaching Resource* (1997)	• *SYSTH*
• *Success for All Learners: A Handbook on Differentiating Instruction: A Resource for Kindergarten to Senior 4 Schools* (1996)	• *Success*
• *Technology As a Foundation Skill Area: A Journey Toward Information Technology Literacy* (1998)	• *TFS*

Guide to Reading Specific Learning Outcomes



First digit indicates grade; second digit indicates cluster number; third digit(s) indicates specific learning outcome number

Include: Indicates a mandatory component of the specific learning outcome

Cross-reference to general learning outcomes (see Appendix A)

Example: Provides ideas of what could be included (non-mandatory)

Cross-reference to other areas: Math, ELA (English language arts), TFS (Technology As a Foundation Skill Area)

The Four-Column Format

Prescribed learning outcome statements that define what students are expected to achieve at the end of each grade

Suggestions for student learning experiences directly related to the attainment of specific learning outcome(s)

Teacher planning hints and/or background information on science concepts

Learning outcome(s) related to thematic clusters

Learning outcomes related to Cluster O: Overall Skills and Attitudes, selected to correspond to Suggestions for Instruction

Reference to other curricula/support documents to facilitate integration

Grades 5 to 8 Science: A Foundation for Implementation

Prescribed Learning Outcomes

Students will...

5-1-04 Evaluate a daily menu plan and suggest changes to make it align more closely with *Canada's Food Guide to Healthy Eating.*

Include: serving size recommendations according to age for each food group.

GLO: B3, C3, C4, C8

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have worked with *Canada's Food Guide to Healthy Eating* in Grade 2, Cluster 1: Growth and Changes in Animals. They have used the guide to plan a balanced menu for a day.

➢ **Daily Menu Evaluation**

Provide students with a sample menu for a day. Ensure that the menu includes both the food type and the serving size. Have students use their prior knowledge to evaluate the menu plan and record their findings.

Distribute copies of *Canada's Food Guide to Healthy Eating* and have students re-evaluate their findings. How accurate were they? What changes needed to be made?

(*Canada's Food Guide to Healthy Eating* is distributed by Health Canada, telephone (204) 983-2508, or (613) 954-5995. It is also available online at <www.hc-sc.gc.ca>.)

➢ **Personal Food Diary**

Have students record what they eat for two or three days, including the serving size for each item. Have them evaluate their own diet and make recommendations for change. (This should be done individually and privately so that students' diets are not being judged by their peers.)

➢ **How's Lunch?**

Have students conduct a lunch-bag study that involves looking at their own lunches or the lunches of students from other grades and classes to identify what food groups are represented. Have them prepare a report with the data organized and displayed in a meaningful way, along with conclusions and recommendations. Perhaps the findings of the investigation could be published in the school newsletter and sent home to parents/guardians. If this is done, students could undertake another investigation a few weeks later to determine whether changes were made.

(For strategies and assessment suggestions to aid students in understanding the data collection process, grouping data, displaying data, and drawing conclusions from data, refer to *5-8 Math*, Statistics and Probability, pp. C-3 to C-15.)

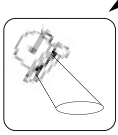
5.10

Suggestions for assessing specific learning outcome(s)

Suggested student learning resources and teacher support materials (print and multimedia)

Grade 5, Cluster 1: Maintaining a Healthy Body

Suggestions for Assessment



Menu Evaluation

Provide students with the following:

Menu Evaluation: Sam's Daily Menu

Breakfast:
- Frosted cereal
- Milk

Lunch:
- Soda pop
- French fries
- Chicken fingers
- Chocolate brownie

Supper:
- Potatoes
- Steak
- Mixed vegetables
- Pudding

Snack:
- Potato chips
- Soda pop

Look at Sam's menu for the day.

a. Is this a healthy diet?

b. If not, what changes would you recommend? Explain your thinking.

Look for:

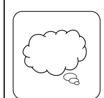
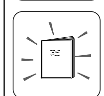
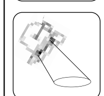
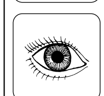
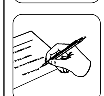
- Sam's breakfast is not balanced. He needs to have something from each food group.
- Sam's lunch has too many high-fat foods. He needs to add vegetables and dairy products.
- Sam's supper is balanced.
- Sam's snack is not nutritional. He needs to substitute fruit and milk or something comparable.

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 3)

5.11

Icon indicating type of assessment:

Icon	Type
	**Reflection**
	**Product/ Work Sample**
	**Performance Task**
	**Observation**
	**Quiz/Test**

Icon (spiral coil) indicating assessment task, presented in a format suitable for student use

Notes

Grade 5 Science

Manitoba Education and Training
2000

Grade 5

Cluster 1: Maintaining a Healthy Body

Overview

The study of the human body at Grade 5 focuses on the maintenance of good health. Students learn about the role that nutrients play, and how to plan balanced and nutritious meals using *Canada's Food Guide to Healthy Eating*. Students gain experience in interpreting nutritional information on food labels, and in evaluating images presented by the media. A study of the major body systems and their role in the healthy functioning of the human body helps students to appreciate the nature and function of each, and the interrelationships that exist between systems. Students explore how lifestyle choices and environmental factors can affect personal health.

Prescribed Learning Outcomes

Students will...

5-1-01 Use appropriate vocabulary related to their investigations of human health.

Include: nutrients; carbohydrates; proteins; fats; vitamins; minerals; *Canada's Food Guide to Healthy Eating*; food group; serving size; terms related to the digestive, skeletal, muscular, nervous, integumentary, respiratory, and circulatory systems.

GLO: B3, C6, D1

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 3, Cluster 2: Materials and Structures; in Grade 2, Cluster 1: Growth and Changes in Animals; in Grade 1, Cluster 1: Characteristics and Needs of Living Things; and in Grade 1, Cluster 2: The Senses.

Refer to *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* for related learning outcomes and teacher support.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Sort and Predict**

Provide students with a set of words. Have them work in groups to predict the meaning of the words and sort them into categories. Have groups share their categories with the class. As a class, identify words for which students need more information to be able to categorize them with clarity. Post these words and clarify them as the study of the human body progresses.

(For a BLM of a Sort and Predict think sheet, see *SYSTH*, Attachment 10.3, or *Success*, p. 6.100.)

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-02 Interpret nutritional information found on food labels.

Examples: ingredient proportions, identification of potential allergens, information related to energy content and nutrients...

GLO: B3, C4, C5, C8

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

SUGGESTIONS FOR INSTRUCTION

➢ **Investigating Food Labels**

Bring to class a variety of foodstuff boxes/cans that provide nutritional information on the labels. Have students

- look at the information provided
- list the information that the labels have in common
- identify the differences that they see
- give reasons for the information provided

Example:

Nutrient Content

Information	**Cereal**	**Crackers**	**Soup**
Proportion/Serving Size			
Energy/Calories			
Protein			
Fat			
Carbohydrates			
Sugars			
Starch			
Dietary Fibre			
Sodium			
Potassium			
Vitamin List			
Ingredient List			

➢ **Interpreting Nutritional Information**

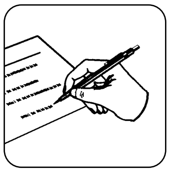
Have students bring to class a collection of foodstuff boxes/cans and sort them according to product (e.g., cereal, crackers). Have small groups of students each take one set of boxes and order them in different ways.

Examples:

- Order the boxes from the greatest to the smallest quantity of calories/energy per serving.
- Order the boxes from the lowest to the highest fibre content.
- Order the boxes from the lowest to the highest sugar content.

Math Link: The boxes can also be used to determine perimeter, area, and volume.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Food Product Analysis

Nutrition Information Per 28 g Serving

Energy	150 cal/620 kj
Protein	2.0 g
Fat	9.1 g
Cholesterol	0 mg
Carbohydrates	15 g
Dietary Fibre	3.8 g
Sodium	178 mg
Potassium	386 mg

Percentage of Recommended Daily Intake

Vitamin E	23%
Vitamin C	15%
Thiamine	3%
Riboflavin	2%
Niacin	10%
Vitamin B6	1%
Calcium	1%
Iron	3%
Zinc	3%

Review the nutrition information above. What can you tell about the product that it came from?

Look for:
- low serving size
- high calorie and fat content
- high potassium content
- relatively high fibre content
- very few vitamins or minerals

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 5: *Body Works* (Lesson 3)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-03 Describe the types of nutrients in foods and their function in maintaining a healthy body.

Include: carbohydrates, proteins, fats, vitamins, minerals.

GLO: B3, D1

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-2b Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8

5-0-2c Record information in own words and reference sources appropriately. GLO: C6 (ELA Grade 5, 3.3.2)

5-0-4d Assume various roles and share responsibilities as group members. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

- *Carbohydrates* are the body's main source of energy. There are two types of carbohydrates: simple and complex.
  - — *Simple carbohydrates* are sugars. They are naturally found in foods such as milk and fruit. They are also added to foods such as candy, cake, and ice cream.
  - — *Complex carbohydrates* are starches and cellulose. They are found in foods such as potatoes, bread, vegetables, and rice.
- *Proteins* are the building blocks needed for growth and maintenance of the body. They are found in meat, dried beans, grains, and vegetables.
- *Fats* are a high-calorie source of energy needed for growth and maintaining healthy skin. They are found in meat, nuts, cheese, butter, margarine, oil, and milk.
- *Vitamins and minerals* are important to the body for growth and nourishment. Milk products and raw vegetables and fruits are good sources of these nutrients. Food processing causes loss of vitamins and minerals.

➢ Nutrient Research

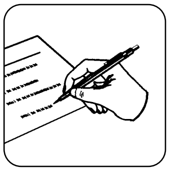
Use the Jigsaw technique (Aronson et al, 1978) to have students research each of the five nutrients: carbohydrates, proteins, fats, vitamins, and minerals. Divide the class into home groups of four members. Have each home group member select one of the nutrients to research. Individuals from each home group then meet with members of other home groups who are assigned the same nutrient, to form expert groups. Each expert group researches its own nutrient to determine what it is, where it is found, and what function it serves in maintaining a healthy body. Finally, each group expert member shares findings with the home group.

(For strategies to aid students in recording information in their own words and referencing sources, refer to *5-8 ELA*, Grade 5, learning outcome 3.3.2, pp. 262-268.)

➢ Graphing Nutrient Content

Give each student one of the foodstuff boxes/cans that the class has contributed. Have students graph the nutrient content. Instead of having students put the name of the food on the graph, have them put it on the back of the page. Suggest that students look at the graphs and predict which food is being represented.

Suggestions for Assessment



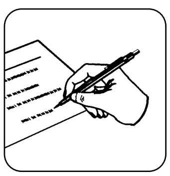
Extended Response

Provide students with the following:

Nutrients

In your science notebook, explain how each of the following types of nutrients helps you maintain a healthy body.

1. carbohydrates
2. proteins
3. fats
4. vitamins
5. minerals



Extended Response

Provide students with the following:

Diets: Healthy or Not Healthy?

Many different diets are available for people who want to lose or gain weight. Explain why each of the following diets is either healthy or not healthy.

1. the Low or No Carbohydrate Diet
2. the High Protein Diet
3. the No Fat Diet

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 2)

Prescribed Learning Outcomes

Students will...

5-1-04 Evaluate a daily menu plan and suggest changes to make it align more closely with *Canada's Food Guide to Healthy Eating*.

Include: serving size recommendations according to age for each food group.

GLO: B3, C3, C4, C8

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have worked with *Canada's Food Guide to Healthy Eating* in Grade 2, Cluster 1: Growth and Changes in Animals. They have used the guide to plan a balanced menu for a day.

➢ **Daily Menu Evaluation**

Provide students with a sample menu for a day. Ensure that the menu includes both the food type and the serving size. Have students use their prior knowledge to evaluate the menu plan and record their findings.

Distribute copies of *Canada's Food Guide to Healthy Eating* and have students re-evaluate their findings. How accurate were they? What changes needed to be made?

(*Canada's Food Guide to Healthy Eating* is distributed by Health Canada, telephone (204) 983-2508, or (613) 954-5995. It is also available online at <www.hc-sc.gc.ca>.)

➢ **Personal Food Diary**

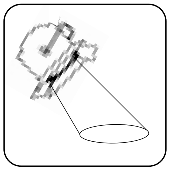
Have students record what they eat for two or three days, including the serving size for each item. Have them evaluate their own diet and make recommendations for change. (This should be done individually and privately so that students' diets are not being judged by their peers.)

➢ **How's Lunch?**

Have students conduct a lunch-bag study that involves looking at their own lunches or the lunches of students from other grades and classes to identify what food groups are represented. Have them prepare a report with the data organized and displayed in a meaningful way, along with conclusions and recommendations. Perhaps the findings of the investigation could be published in the school newsletter and sent home to parents/guardians. If this is done, students could undertake another investigation a few weeks later to determine whether changes were made.

(For strategies and assessment suggestions to aid students in understanding the data collection process, grouping data, displaying data, and drawing conclusions from data, refer to *5-8 Math*, Statistics and Probability, pp. C-3 to C-15.)

SUGGESTIONS FOR ASSESSMENT



Menu Evaluation

Provide students with the following:

Menu Evaluation: Sam's Daily Menu

Breakfast:
- Frosted cereal
- Milk

Lunch:
- Soda pop
- French fries
- Chicken fingers
- Chocolate brownie

Supper:
- Potatoes
- Steak
- Mixed vegetables
- Pudding

Snack:
- Potato chips
- Soda pop

Look at Sam's menu for the day.

a. Is this a healthy diet?

b. If not, what changes would you recommend? Explain your thinking.

Look for:

- Sam's breakfast is not balanced. He needs to have something from each food group.
- Sam's lunch has too many high-fat foods. He needs to add vegetables and dairy products.
- Sam's supper is balanced.
- Sam's snack is not nutritional. He needs to substitute fruit and milk or something comparable.

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 5: *Body Works* (Lesson 3)

Prescribed Learning Outcomes

Students will...

5-1-05 Evaluate prepared food products using the design process.

Examples: frozen pizza, snack foods, beverages...

GLO: B3, C3, C4, C8

5-0-1c Identify practical problems to solve. *Examples: How can I determine the mass of air? Which prepared pizza should I buy?…* GLO: C3

5-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

5-0-5b Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

5-0-6e Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

5-0-7d Propose and justify a solution to the initial problem. GLO: C3

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

(continued)

Suggestions for Instruction

➢ **Product Evaluation: Microwave Popcorn**

The following is an example of how a product evaluation could take place using the design process. Teachers may choose to demonstrate it as a model for students to follow when they select their own food product for evaluation. Refer to page 20 of this document for a description of the stages of the design process for evaluating consumer products.

1. Identify the problem. For example: What is the “best” butter-flavoured microwave popcorn? Once the problem has been identified, obtain samples of the popcorn to test, ensuring that all are of the same type (all butter-flavoured), with the only variable being different brands.
2. As a class, discuss what “best” means and identify criteria to test, such as
   a. quantity of popcorn produced (flakes/popped corn) versus unpopped kernels)
   b. cost per serving
   c. taste
   d. nutrient value related to grams of fat and energy/calories per serving
   e. packaging related to appearance and use of recycled materials
3. Either as a class or in small groups, determine the method needed to test the popcorn according to each criterion identified. Groups of students may then be assigned to carry out the different tests.
4. Test the products using the predetermined criteria. For example:
   a. Pop each brand. Measure the volume of popcorn produced and count the unpopped kernels.
   b. Calculate the cost per serving by dividing the cost of the whole package by the number of bags in the package. Now, calculate the number of servings in an individual bag (based on the data collected in part “a” and the serving size suggested on the package).
   c. Conduct a taste test. This could be done with other classrooms. (Results are more reliable when students are asked to mark a ballot.) Represent the results in a graph form.
   d. Compare the number of grams of fat and the energy/calories per serving.

(continued)

Suggestions for Assessment

Checklist: Product Evaluation

During the Product Evaluation: Microwave Popcorn learning activity, look for indications of the following in student work:

Checklist:

- ❑ identifies the problem
- ❑ identifies the criteria
- ❑ determines the method/procedure for conducting the test
- ❑ tests the product using predetermined criteria
- ❑ analyzes the data
- ❑ arrives at a conclusion

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 3)

PRESCRIBED LEARNING OUTCOMES
Students will...
5-1-05 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

e. Look at the packaging to determine whether it is aesthetically pleasing and whether it is made from recycled materials.

5. Have groups analyze their own data, as well as the data gathered by other groups, and prepare a report providing a conclusion (which popcorn was best). Have each group share their report. As a class, discuss why groups may have come to different conclusions when they used the same data (one group may have thought taste was most important, another group may have thought cost was most important).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-06 Identify the major components of the digestive system, and describe its role in the human body.

Include: teeth, mouth, esophagus, stomach, and intestines break down food.

GLO: D1, E2

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Digestive Tract Model**

Have students form small groups. Ask one member of each group to lie on a large piece of paper. Have the other group members trace around the person and then cut out the tracing. Have students use the following dimensions to calculate the length of the traced figure's digestive tract:

Digestive System

Parts	Length
mouth	10 cm
esophagus	25 cm
stomach	15 cm
small intestine	3 times the person's height
large intestine	the person's height + 15 cm

Provide each group with a roll of crepe paper streamers and have each group follow these steps:

- Cut a piece the length of the traced figure's digestive tract.
- Glue the strip onto the paper cut-out.
- Add to the model a stomach made from construction paper.
- Label all parts.

Have students fill in the "Function" column of the "Body Systems Chart" (BLM 5-A) as they complete the learning activities that follow.

➢ **How the Esophagus Works**

To demonstrate the function of the esophagus, provide pairs of students with a long, thin balloon, cooking oil, and a slice of soft bread. Have students complete the following:

- Cut the closed end off the balloon so that it makes a long, flexible tube.
- Pour one teaspoon of oil into the balloon.
- Take a small piece of bread from the centre of the slice and roll it into a ball about the size of a marble.
- Put the bread in one end of the balloon.
- Squeeze the balloon behind the "bread ball" with one hand. Keeping that hand still, cross the other hand over the first hand and squeeze the balloon. Continue to squeeze, hand over hand.
- Observe what happens. (The bread ball moves down the tube until it comes out the other end.)

(continued)

Suggestions for Assessment

Teacher Notes

While students are not expected to gain an in-depth knowledge of the body systems through the study of this cluster, they should be aware of the main components listed in the “Include” section of the systems-related specific learning outcomes, be able to locate them generally in the body, and state their function. Have students fill in their own summary chart listing the components and functions of each body system as they study the different systems (see BLM 5-A).

Background Information

The *digestive system* helps the body break down food so it can be used for growth and repair.

- The *teeth* tear and grind food into smaller parts.
- *Saliva*, an enzyme produced by glands in the mouth, helps break down the food.
- The *tongue* flips food to the back of the mouth.
- The *esophagus* is a 25 cm tube that leads to the *stomach*. The muscles in the esophagus move the food down into the stomach.
- The *stomach* muscles shake and churn the food while adding a strong acid to help break it up. The stomach sends food into the intestines.
- The *small intestine* is a coiled tube about 6.5 m long. Most of the digestion takes place here. Any food that is not digested in the small intestine moves into the large intestine.
- The *large intestine* is about 1.5 m long. The undigested material is passed through the large intestine and is excreted from the body.

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 4)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

5-1-06 *(continued)*

(continued)

➢ **Mouth and Stomach Demonstration**

To demonstrate the function of the stomach, bring to class a blender, put a slice of bread and a little water into the blender, and mix. Have students observe what happens. Try the same thing with large and small pieces of apple and observe the differences. (Large pieces take longer to break down.)

Put small pieces of luncheon meat into one container with vinegar and a large piece into a second container. Observe what happens. (The acid in the vinegar breaks down the meat in both containers but it takes longer for the larger piece.)

Ask students why the teeth and mouth are important for digestion. (They break food into smaller pieces, making them easier to digest.)

➢ **Working Intestines**

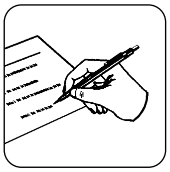
To demonstrate the function of the small intestine, provide students with coffee filters and muddy water. Have students pass the water through a system of filters and observe what happens. (Cleaner water escapes through the filter while the mud remains.)

To demonstrate the function of the large intestine, place the remaining mud from the filter onto several paper towels. (The large intestine—paper towel—removes the remaining liquid, leaving solid waste to be expelled from the body.)

➢ **Function**

Ask students to refer to the Digestive Tract Model learning activity in conjunction with learning outcome 5-1-06 and the learning activities above. Have them fill in the appropriate section of the “Body Systems Chart” (BLM 5-A).

SUGGESTIONS FOR ASSESSMENT

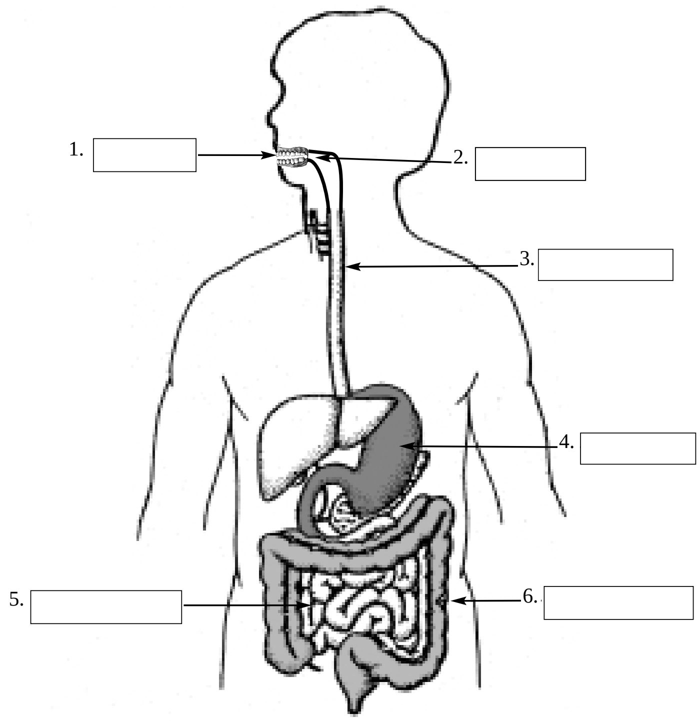


Restricted Response

Provide students with the following:

Digestive System

Label the major parts of the digestive system and explain what they do.



Look for:

1. teeth
2. mouth
3. esophagus
4. stomach
5. small intestines
6. large intestines

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-07 Identify the major components of the skeletal, muscular, and nervous systems, and describe the role of each system in the human body.

Include: the skeleton provides protection and support; muscles, tendons, and ligaments enable movement; brain, spinal cord, and nerves receive sensory input, process information, and send out signals.

GLO: D1, E2

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-2c Record information in own words and reference sources appropriately. GLO: C6 (ELA Grade 5, 3.3.2)

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Body Systems

Have students brainstorm and record in the K (Know) section of a K-W-L Chart (Ogle, 1986) what they know about the three systems. Have them work in pairs to complete the W (Want to Know) section.

(For a BLM of a K-W-L Chart, see *SYSTH*, Attachment 9.1, or *Success*, p. 6.94.)

➢ What System Is It?

Bring to class a collection of household items (e.g., a bicycle helmet, coat hanger, remote control, elastic band). Ask students to indicate what system each item represents and to give reasons for their answers (e.g., bicycle helmet and coat hanger—skeleton; remote control—nervous system; elastic band—muscular system).

➢ Skeletal System

Use an inexpensive small model of a skeleton to show the different types of bones in the body. Have students observe the skeleton and make notes of their observations. If possible, obtain an X-ray of a hand or a foot so that students can see the many small bones that make up these body parts. (Over half the 206 bones in an adult human are found in the hands and feet.) Have students suggest the functions of the skeletal system. (It provides protection for internal organs, and, along with the muscles, it provides support and strength, allowing us to move and to stand.)

➢ Strong Bones

To demonstrate the strength of bones, have students perform the following steps:

- Place a roll of paper towels or toilet paper on its side and place a heavy book on top of it. Observe what happens. (The tube will flatten.)
- Now, place the roll on end and place the book on top of it. Observe. Try placing more than one book on the roll. (The cylinder will hold up the book. Refer to students' understanding of the strength of various shapes from their study of structures in Grade 3, Cluster 2: Materials and Structures.)
- Explain why strong bones are necessary in the body.

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

The *skeletal system* or *skeleton* is the body's hard, tough framework made of bones. It protects the softer inside parts of the body and works together with the *muscular system* to allow us to sit, stand, or move. The *muscles* also help us control organs inside the body. *Tendons* are tough, cord-like bands of tissue that bind the muscles to the bones. *Ligaments* are strong bands of tissue that connect bones or hold organs in place.

The *brain* and the *nervous system* control all body systems. The nervous system enables the body to sense changes in the environment and to adjust to them. Working with the nervous system, the brain tells the other systems what to do.

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lessons 10-12)

Prescribed Learning Outcomes
Students will...
5-1-07 *(continued)*
(continued)

Suggestions for Instruction

(continued)

➢ **Observing Tendons**

Have each student form one hand into a claw and then wiggle the index finger. They will be able to see the tendon move over the knuckle and slide over the back of the hand.

➢ **Muscles and Bones Working Together**

Have students try the following investigations:

1. *Muscle Contractions:* Provide students with a thin ruler and a hairpin or a bent piece of wire. Have students do the following:
   - Balance the pin/wire on the ruler and then stand in front of a table.
   - Hold the ruler in one hand so that the tip of the pin is just touching the table. The arm should not be touching the table nor be braced in any way. Try to keep the wire and the ruler still.

   (Inside the muscle, some fibres are always contracting, while others are relaxing. When the fibres switch roles, they cause the muscle to twitch. It is therefore impossible to hold the arm perfectly still.)
2. *Tired Muscles:* Provide students with clothespins and a stopwatch. Have students see how many times they can squeeze open the clothespin in 30 seconds. Take a 10-second break and then repeat, then another 10-second break and repeat. Ask students to record what they observe. Was there a change? Why do you think this happened? (Muscles become fatigued when they make the same movement over and over again.)
3. *Model Arm:* Provide students with cardboard, adhesive tape, paper clips, scissors, and long balloons. Have students follow these steps:
   - Cut three cardboard squares equal to the length of their arm—one from shoulder to elbow, and two from elbow to wrist.
   - Roll each square into a cylinder and tape it in place.
   - Connect all three cylinders (representing bones) by straightening a paper clip, punching a hole through each “bone,” and then putting the paper clip through all three “bones” and bending the ends to keep it in place.
   - Tape the two smaller cylinders together at the end.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

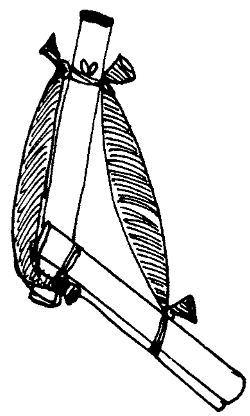
PRESCRIBED LEARNING OUTCOMES
Students will...
5-1-07 *(continued)*
(continued)

SUGGESTIONS FOR INSTRUCTION

(continued)

- Slightly inflate the balloon (representing muscles) and tie the ends.
- Connect the balloon by tying it onto the cylinders.
- Move the arm model and observe what happens to the balloon "muscles." (They stretch and contract, depending on the movement.)

  Example:



➢ **Nervous System**

Show a video about the nervous system and ask students to jot notes on what they see. Have them use this information to fill in the appropriate section of the "Body Systems Chart" (BLM 5-A).

➢ **Working Together**

Have students conduct a demonstration of how the brain, nerves, and muscles work together, following these steps:

- Take turns standing in a doorway, lifting both arms until the backs of the hands are touching the door frame on either side.
- Push against the door frame as hard as possible and slowly count to 30.
- Move away from the door frame and let the arms hang loose.
- Observe what happens. (The arms will rise.)
- Predict why this occurs. (While the students' hands are pushing against the door frame the brain is sending messages along the nerves telling the muscles to lift the arms. When the student steps away from the door frame, messages are still on their way to the muscles. The arms rise when the messages get to the muscles.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES
Students will...
5-1-07 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Testing Reflexes**

Have Student A hold a ruler (with the lower numbers facing downward) just above a partner's thumb and index finger (held slightly apart). Have Student A drop the ruler without letting Student B know when this will happen. Record the number at which Student B caught the ruler. Repeat several times. Ask students if they think this practice will improve their reaction time. Have students test their prediction. (This is an example of voluntary reflexes.)

➢ **Putting It Together**

Have students refer to the Testing Reflexes learning activity and describe in as much detail as possible the role that the skeletal, muscular, and nervous systems played in accomplishing this task.

➢ **Continuing the Body Systems Chart**

Have students add to their "Body Systems Chart" (BLM 5-A).

Suggestions for Assessment

Suggested Learning Resources

Restricted Response

Provide students with the following:

Skeletal, Muscular, and Nervous Systems

Fill in the blanks using the words below.

brain	skeleton	muscles	ligaments
tendons	spinal cord	nerves	

1. _________ are strong bands of tissue that connect bones.
2. The _____________ works with the nervous system to control the body systems.
3. The __________ is made up of 206 bones.
4. __________ are tough, cordlike bands of tissue that bind muscles to bones.
5. __________ help us to sit, stand, and move.
6. Messages travel back and forth through the __________.
7. Another name for the _______________ is backbone.

Look for:

1. ligaments
2. brain
3. skeleton
4. tendons
5. muscles
6. nerves
7. spinal cord

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-08 Identify skin as the major component of the integumentary system, and describe its role in protecting and supporting the human body.

GLO: D1, E2

5-0-3a Formulate, with guidance, a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.5)

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

The skin's main role is to keep the internal body parts from drying up. Skin also protects the body from bacteria, dirt, and the Sun's rays. In addition, skin plays a role in controlling the body's temperature. Sweating, goose bumps, and simple heat loss from the skin all help keep the internal temperature comfortable. The skin also contains thousands of nerve endings that help provide the brain with information about the environment outside the body.

➢ The Role of the Skin

Perform the following class demonstration:

- Prepare a bowl of gelatin/jelly. Hold a pointed pencil above the bowl and drop it into the gelatin. Observe what happens. (The pencil penetrates the gelatin.)
- Have a student place a sheet of paper over the bowl. Drop the pencil again. Add another sheet of paper and drop the pencil again. Observe what happens. (The paper prevents the pencil from penetrating the gelatin.)
- Put several sheets of paper over the bowl. Tip the bowl upside-down onto the paper. Observe what happens. (The paper prevents the gelatin from falling onto the table.)

Have students make predictions about the role of the skin based on the demonstration.

➢ Keeping out Bacteria

Use two apples to demonstrate how an apple's skin helps to protect it. Leave one apple as it is. In the other apple, cut various sizes of "wounds." Observe the apples over a period of days.

➢ Continuing the Body Systems Chart

Have students add to their "Body Systems Chart" (BLM 5-A).

Suggestions for Assessment

The Importance of Skin

Provide students with the following:

The Importance of Skin

Imagine what it would be like if you had no skin.
What problems would you have?
Explain.

Look for:
- internal organs would dry up
- internal organs would not stay in place
- bacteria and dirt would enter the body
- the Sun's rays would damage internal organs
- the body would overheat
- the sense of touch would disappear

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 10)

Prescribed Learning Outcomes

Students will...

5-1-09 Identify components of the human body's defenses against infections, and describe their role in defending the body against infection.

Include: tears, skin, white blood cells.

GLO: D1, E2

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-9e Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment.
GLO: B5

Suggestions for Instruction

➢ **White Blood Cells**

Present students with factual information about the function of white blood cells in the body. Example: "Here and there a white blood cell was busy destroying disease germs. 'White blood cells are like soldiers protecting your body from enemies'" (Cole, 1989). Have students answer the question: Who is the enemy?

Students will not have studied the *cell* but should be able to use the term in this context. Formal study of the cell occurs in Grade 8, Cluster 1: Cells and Systems.

➢ **Body Defenses Game**

Have students invent a game, to be played in the gymnasium or outdoors, in which certain students represent germs/bacteria that have to get through the body's defenses to the bloodstream. The game should include: tears, skin, and white blood cells.

Students should already be familiar with tears from the study of the senses in Grade 1, Cluster 2: The Senses. They should also be familiar with the defensive function of the skin from their study of that system in an instructional strategy suggested for learning outcome 5-1-08.

➢ **Bacteria Blues**

Have students write a short story or create a rap about a harmful bacterium and how it tries to infect someone. The bacterium can try to enter through the eye, the mouth, the skin, and then through the bloodstream.

➢ **Prevention Poster**

Have students design educational posters for younger students on how to keep germs/bacteria at bay (for example, hand washing, proper care of cuts).

SUGGESTIONS FOR ASSESSMENT

Checklist: Bacteria Blues

When assessing students' Bacteria Blues story or rap, look for indications of the following:

Checklist:

- ❑ identifies the main components of the human body's defense system
  - tears
  - skin
  - white blood cells
- ❑ shows the function of each defense
- ❑ is well-sequenced and clearly written

Teacher Notes

Background Information

The body has many defenses against infection, but they do not make up one body system.

- *Tears* are a salty fluid that prevents germs from entering the eye.
- *Skin* helps protect the internal body parts from the entry of bacteria.
- *White blood cells* reproduce quickly when bacteria enter the body. Then they get rid of the bacteria either by "swallowing them up" or by making antibodies that label the bacteria as intruders and lead to their destruction by other elements in the blood system.

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 5: *Body Works* (Lesson 14)

Prescribed Learning Outcomes

Students will...

5-1-10 Identify the major components of the respiratory and circulatory systems, and describe the role of each system in the human body.

Include: the nose, trachea, and lungs take in oxygen and expel carbon dioxide; the heart, blood vessels, and blood transport oxygen, nutrients, and waste products such as carbon dioxide.

GLO: D1, E2

5-0-1a Formulate, with guidance, specific questions that lead to investigations. Include: rephrase questions to a testable form, focus research questions. GLO: A1, C2 (ELA Grade 5, 3.1.1; Math: SP-I.1.5)

5-0-1b Identify various methods for finding the answer to a specific question and, with guidance, select one to implement. *Examples: generating experimental data; accessing information from a variety of sources…* GLO: C2 (ELA Grade 5, 3.2.2; Math: SP-II.1.5)

5-0-3a Formulate, with guidance, a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.5)

5-0-3b Identify variables that might have an impact on their experiments and, with guidance, variables to hold constant to ensure a fair test. GLO: A2, C2

5-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow. GLO: C2 (ELA Grade 5, 3.1.4)

5-0-4a Carry out, with guidance, procedures that comprise a fair test. Include: controlling variables, repeating measurements to increase accuracy and reliability. GLO: C2

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

(continued)

Suggestions for Instruction

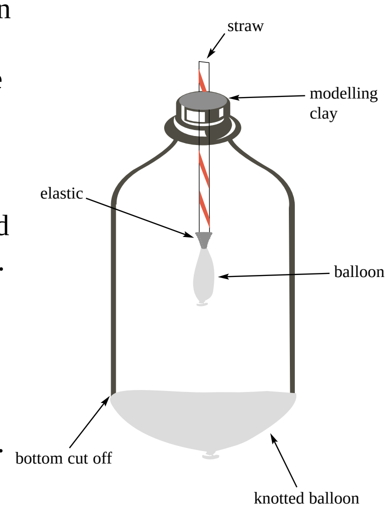
➢ **Respiratory System Model**

Provide small groups of students with the following materials: one clear two-litre soft drink bottle (with bottom cut off), two balloons, modelling clay, one plastic drinking straw, and one elastic band.

Have students follow these directions to make a model of the respiratory system:

1. Tie a knot in one end of a balloon and then cut a small piece off the other end of the balloon. Stretch the hole of the balloon over the bottom of the bottle. (The knot will serve as a handle.)
2. Insert the drinking straw into the opening of the other balloon, using the elastic to attach it.
3. Push the straw and the balloon through the opening (pour spout) of the bottle so that the balloon hangs down in the bottle and part of the straw remains outside.
4. Seal the bottle opening around the straw with modelling clay. Make sure the opening is airtight.
5. Push up on the balloon covering the bottom of the bottle. Observe what happens. (The deflated balloon inside collapses.)
6. Pull down on the balloon at the bottom of the bottle. Observe what happens. (The deflated balloon inside inflates.)
7. Hold the straw near your face. What do you feel as you repeat steps 5 and 6? Why?

   (In step 5 air is blown out; in step 6 air is drawn in. The bottle represents the chest and the balloon stretched across the bottom is like the diaphragm. The balloon in the bottle is like a lung. The straw represents one of the bronchial tubes leading to the lung. When the balloon is pushed up, the balloon shrinks and air comes out of the straw. This is what happens when we breathe out. When the balloon is pulled down, air is sucked into the "lung" and fills it. This is what happens when we breathe in.)
8. Explain the function of the parts of the respiratory system.



(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Background Information

The Respiratory System: This system helps provide the body with oxygen and helps remove carbon dioxide (a waste product).

- The *nose* takes in air. Inside the nose, the air is warmed and moistened. Dust particles and harmful bacteria are trapped by the hairs inside the nose or by a sticky fluid called *mucus* in the nasal passage.
- The *trachea*, also known as the *windpipe*, is the tube that leads to the lungs. It forks into two main *bronchi*, or tubes, one tube leading to each lung. The trachea has mucus to trap harmful bacteria or dust. It also has millions of tiny hairlike *cilia* that sweep back and forth, driving anything harmful back to the throat.
- The *lungs* are spongy masses of tissue that are sealed inside the ribs. The chest muscles pull the ribs to help the chest cavity expand and contract.
- Another set of muscles, the *diaphragm*, moves up and down like an elevator to draw air into the lungs as the chest expands and to force air out of the lungs as the chest contracts.
- Oxygen passes from the lungs into the bloodstream through tiny air sacs or *alveoli* at the same time that carbon dioxide goes in the other direction, from the blood to the lungs, to be breathed out.

The Circulatory System: This system transports oxygen, nutrients, and waste products.

- The *heart* is a two-pump system. One pump controls the flow of blood from the heart to the lungs, where carbon dioxide waste is exchanged for fresh oxygen. The other pump sends the blood to cells throughout the body.
- There are three types of *blood vessels:*
  - — The *arteries* carry the blood out and away from the heart. They are large with thick elastic walls.
  - — *Capillaries* are the smallest vessels. They are so small that blood cells can only pass singly through them. This allows for the in-and-out filtering of nutrients and waste products.
  - — *Veins* return the blood to the heart and lungs. They appear blue under the skin because they are carrying carbon dioxide. Mature red blood cells carry oxygen in the blood.

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 5: *Body Works* (Lessons 6-7)

Prescribed Learning Outcomes

Students will...

5-1-10 *(continued)*

5-0-5d Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5)

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-6f Evaluate the methods used to answer a question or solve a problem. GLO: C2, C3 (ELA Grade 5, 3.3.4)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7b Base conclusions on evidence rather than preconceived ideas or hunches. GLO: C2, C4

5-0-7c Identify, with guidance, a new prediction/hypothesis, based on investigation results. GLO: A1, C2 (ELA Grade 5, 3.3.4)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

5-0-9c Demonstrate confidence in their ability to carry out investigations. GLO: C5

5-0-9d Appreciate the importance of creativity, accuracy, honesty, and perseverance as scientific and technological habits of mind. GLO: C5

Suggestions for Instruction

(continued)

➢ Function of the Circulatory System

Provide students with the information about the circulatory system presented below. Ask them to use this information to add to their “Body Systems Chart” (BLM 5-A).

The Circulatory System: The circulatory system supports all body systems. The heart pumps blood to all parts of the body through blood vessels, arteries, and capillaries. The circulatory system

- helps the digestive system by carrying nutrients in the blood to all parts of the body
- helps the respiratory system by carrying oxygen from the lungs to the body and removing carbon dioxide
- works with the brain and nervous system by carrying messages to muscles in all parts of the body
- helps defend the body by transporting white blood cells in blood
- helps transport waste materials from the body

Without the circulatory system our body systems would not be able to function.

➢ Observing the Heartbeat

Have students use a small piece of modelling clay and a toothpick to make a pulse meter, following these steps:

- Stick the toothpick into the modelling clay and then place the meter on the wrist.
- Move it around until the spot with the strongest pulse is found.
- Count the number of times the toothpick bobs up and down in one minute.

➢ Effects of Exercise Experiment/Investigation

Have students design an experiment/investigation to determine the effect of exercise on pulse rate. Instruct students to

- make a prediction or formulate an hypothesis identifying cause and effect relationships
- conduct a fair test (controlling variables)
- repeat their measurements to ensure accuracy
- graph the results of several trials or graph class data
- write up the experiment/investigation
- present findings to the class

Students may use “Experiment Report” (BLM 5-K) to record their work.

Suggestions for Assessment

When assessing the Effects of Exercise Experiment/Investigation, refer to “Experiment Report: Assessment” (BLM 5-L).

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-11 Describe how the human body gets rid of waste.

Include: kidneys filter blood and dispose of waste as urine; lungs give off waste carbon dioxide; the rectum collects and expels undigested food matter.

GLO: D1, E2

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Body Waste**

Have students brainstorm ways in which the body gets rid of waste material. They should recall that carbon dioxide goes out through the lungs and that solid waste leaves the body through the rectum. If students mention the kidneys, ask them to list what they know about them. As a class, summarize the role of the kidneys, lungs, and rectum in disposing waste products.

➢ **Making Connections**

Have students make connections between the body's methods of getting rid of waste and the ways in which a city/town manages waste (e.g., use of garbage trucks for solid waste, a water treatment plant for liquid waste, and air pollution controls for gaseous waste).

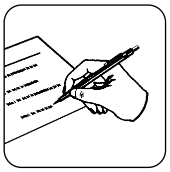
Teacher Notes

Background Information

The body uses many methods to eliminate waste, not all of which are part of the excretory system.

- The *kidneys,* located near the spine in the middle of the back (waist level), filter blood and dispose of waste as urine. When food is burned in the cells for energy, carbon dioxide gas is produced. Ammonia, which is a poison to the body, is also produced. It is changed in the *liver* to a harmless chemical called urea, which is then passed in the blood to the kidneys where it is filtered out. Useful materials and the cleaned-up liquid (about 99%) are returned into the bloodstream. The remaining liquid, called urine, travels down tubes called *ureters*, to the *bladder*. The urine is stored in the bladder until it is eliminated through the *urethra*.
- The *lungs* give off carbon dioxide gas.
- The *rectum* is the final part of the large intestine. In the large intestine the water from undigested food is removed by passing through its walls into the blood. What remains is then passed into the rectum and stays there until it is removed from the body through the *anus*.

Suggestions for Assessment



Extended Response

Have students describe, in point form, how the human body gets rid of waste.

Look for:

- identifies the main components of the body's means of getting rid of waste
  - — kidneys
  - — lungs
  - — rectum
- identifies the function of each component
  - — kidneys filter blood and dispose of waste as urine
  - — lungs give off waste carbon dioxide
  - — rectum collects and expels undigested food

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 9)

Prescribed Learning Outcomes	Suggestions for Instruction

Students will...

5-1-12 Give examples of how systems of the human body work together.

Examples: the circulatory system transports nutrients from the digestive system and oxygen from the respiratory system to the muscular system...

GLO: D1, E2

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

➢ **Linking Systems**

Have students refer to the student information about the circulatory system provided in relation to learning outcome 5-1-10 and identify the ways in which this system works with other body systems.

Prepare chain-like links and write one body system on each link. Distribute the links among groups of four or five students. Have students link up two or more pieces and have them explain how they are connected. Give a bingo chip to a group each time they make a correct link. These chips can be placed on a letter in the word SYSTEMS. The group that covers the most letters could present their best links either first or last.

5-1-13 Identify and describe factors necessary to maintain a healthy body.

Include: daily physical activity, a balanced diet, fluid replacement, adequate sleep, appropriate hygiene practices, regular check-ups.

GLO: B3, C4, D1

5-0-9f Frequently and thoughtfully evaluate the potential consequences of their actions.
GLO: B5, C4

➢ **Health Factors**

Brainstorm with the class the factors required to maintain a healthy body, including the following: daily physical activity, a balanced diet, fluid replacement, adequate sleep, appropriate hygiene practices, and regular check-ups.

➢ **Necessary or Unnecessary?**

Prepare a list of statements, or have students contribute 15 different statements, that describe factors that are necessary to maintain a healthy body and factors that are not necessary (e.g., Limit time spent watching television and playing video games. Drink at least eight glasses of water a day.). Have students work with a partner to determine whether the statements belong in the necessary category or the unnecessary category. Ask each pair to discuss their findings with another pair and try to reach a consensus.

Suggestions for Assessment

Analogy

Provide students with the following:

Your Body As a House

Complete *one* of the following tasks:

1. Imagine that your body is like a house. Write a descriptive paragraph explaining what parts of the house would represent a body system, and how the systems work together.

OR

2. Imagine that your body is like a house. Draw and label a picture indicating where the body systems are in the house and how they work together.

Newspaper Article

Provide students with the following:

Maintaining a Healthy Body

You have been asked to write an article for the school newspaper entitled "How to Maintain a Healthy Body." Your article should contain at least five key points and an explanation for each point.

Scoring Rubric

Score	Criteria
4	The student identifies five or more factors and gives a clear explanation for each.
3	The student identifies four factors and gives a clear explanation for each.
2	The student identifies three factors and gives an explanation for each.
1	The student identifies four or more factors with no explanation.
	The student identifies two factors and gives an explanation for each.

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 14)

Prescribed Learning Outcomes

Students will...

5-1-14 Evaluate information related to body image and health from media sources for science content and bias.

Examples: glamorization of smoking in movies, promotion of unrealistic role models in magazines, trivialization of scientific information on television...

GLO: B3, C4, C5, C8

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…*
GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-9e Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment.
GLO: B5

5-0-9f Frequently and thoughtfully evaluate the potential consequences of their actions.
GLO: B5, C4

(continued)

Suggestions for Instruction

➢ **Media Images**

Bring to class texts such as newspapers, flyers, teen magazines, and so on. Have students look at the advertisements and make notes of how they are alike and how they are different (e.g., consider gender, body type, racial groups).

➢ **Advertising Strategies**

Have students use the advertisements from the previous Media Images learning activity, as well as viewing additional examples from television, radio, and print, to identify and describe different advertising strategies used.

Examples:

- showing the “ideal” child or family
- using a celebrity
- including a catchy tune/phrase
- omitting significant information

Have students share their findings through a Gallery Walk (Brownlie and Close, 1992). Ask students to note any scientific information presented in the advertisements, to reflect on why advertisers use these strategies, and to indicate how they can become “smart” consumers. (For a discussion of Gallery Walks, see *Success*, p. 6.80, or *5-8 ELA*, Strategies, p. 202.)

See <http://www.media-awareness.ca> for related learning activities.

➢ **Who’s Cool**

Have students brainstorm media images of being cool.

Ask:

- Who are the most influential people in determining what is cool? (e.g., television/movie characters, rock stars, models in magazines, athletes)
- Do we make assumptions about the lives of people whom we consider to be cool?
- How do you view what you are wearing and the way you look? (Did you buy a particular item of clothing because you considered it cool? Are you wearing your hair in a certain way because it is cool? Are you trying to lose or gain weight or muscle to fit a cool, popular image?)
- What do advertisers say we must have or be in order to be cool?

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES
Students will...
5-1-14 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Analogy**

Statistically, the people we see in the media represent only 5% of the population. That means that 95% of the population is being told to look the way only a small number of people look. Demonstrate this using 95 multi-coloured candies to represent "regular people." Toss in five candies of another colour not included in the 95, explaining that these five candies represent the people shown by the media.

Ask:

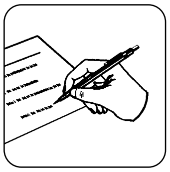
- Does it seem fair that only five of the 100 people (candies) are shown in advertisments on television, in magazines, etc.?
- How would it make you feel to be one of the 95 "regular people" who never see someone like them in the media?
- Does colour seem to be a good criterion to use to determine who is represented in the media?
- Who should be represented in the media?

➢ **Science in the Media**

Show the class print advertisements for cigarettes. What scientific information is given? What facts are missing?

Have students brainstorm other advertisements that overlook or downplay important scientific information that could have an impact on human health.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Media Images

1. Describe four advertising strategies and explain how they work to attract customers.
2. How do the media influence beliefs about body image and health?
3. Describe the characteristics of a "cool" person and explain your reasoning.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

5-1-15 Explain how human health may be affected by lifestyle choices and natural- and human-caused environmental factors.

Include: smoking and poor air quality may cause respiratory disorders; unhealthy eating and physical inactivity may lead to diabetes or heart disease; prolonged exposure to the Sun can cause skin cancer.

GLO: B3, B5, C4, D1

5-0-1a Formulate, with guidance, specific questions that lead to investigations. Include: rephrase questions to a testable form, focus research questions. GLO: A1, C2 (ELA Grade 5, 3.1.1; Math: SP-I.1.5)

5-0-1b Identify various methods for finding the answer to a specific question and, with guidance, select one to implement. *Examples: generating experimental data; accessing information from a variety of sources…* GLO: C2 (ELA Grade 5, 3.2.2; Math: SP-II.1.5)

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-2b Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-8b Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

5-0-8e Describe hobbies and careers related to science and technology. GLO: B4

5-0-8g Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

5-0-9a Appreciate that women and men of diverse cultural backgrounds can contribute equally to science. GLO: A4

5-0-9b Show interest in the activities of individuals working in scientific and technological fields. GLO: B4

SUGGESTIONS FOR INSTRUCTION

➢ Interview an Expert

Have students do small-group projects to generate and find answers to questions concerning human health and lifestyle choices and environmental factors.

Examples:

- What causes respiratory problems?
- What is diabetes and how can it be prevented in later life?
- What environmental factors affect the skin?
- What is heart disease and how can it be prevented?

Have students proceed as follows:

- Make up a set of interview questions, including questions about how scientific and medical advances have improved the treatment and quality of life for people with given problems.
- Contact in person, on the Internet, or in writing a resource person to answer the interview questions, provide a brief autobiography, and describe what his or her job is. Once you have answers to the questions, prepare an oral class presentation (e.g., in the form of a mock interview with an “expert” or with a person living with one of these conditions).

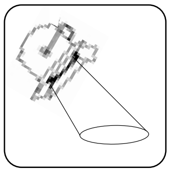
➢ Science in Practice

Invite a speaker (e.g., medical doctor, health care professional, research scientist) to the class. Ask the invited guest to speak about the following points:

- Describe what you do in your occupation.
- Describe what equipment you use and/or how this equipment has changed during your career.
- Talk about other related fields or specialties.
- Talk about the different people with whom you work (e.g., men and women, people of different cultures, other professionals).

Note: This is a good opportunity to highlight the range of science-related careers available, and the fact that men and women of diverse cultural backgrounds can contribute equally to science.

Suggestions for Assessment



Interview an Expert: Oral Presentation

Look for indications of the following in student work:

Scoring Rubric	
Score	**Criteria**
3	• organization is logical and creative • detailed preparation is evident • material is relevant to topic • highly creative elements exist
2	• some organization is evident • some preparation is evident • most of the material is relevant to topic • some creativity is evident
1	• organization and structure are lacking • minimal preparation is evident • material is irrelevant or inapproriate • creativity is lacking

Suggested Learning Resources

Pan Canadian Science Place 5: *Body Works* (Lesson 14)

Notes

Grade 5

Cluster 2: Properties of and Changes in Substances

Overview

In this cluster, students deepen their understanding of the characteristics and properties of substances, and the changes that occur in substances in different situations. Through their explorations, students identify the three states of matter—solids, liquids, and gases—and describe the properties of each. Students observe examples of reversible and non-reversible changes, including changes of state. Students also investigate how the characteristics and properties of substances are altered during physical and chemical changes. Students identify examples of these changes in the world around them. Safety practices related to chemical products in the home are addressed. Students evaluate household products by using criteria such as efficiency, cost, and environmental impact.

PRESCRIBED LEARNING OUTCOMES
Students will...
5-2-01 Use appropriate vocabulary related to their investigations of properties of, and changes in, substances. Include: characteristic, property, substance, matter, volume, state, solid, liquid, gas, reversible and non-reversible changes, physical change, chemical change, chemical product, raw material. GLO: C6, D3

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 3, Cluster 2: Materials and Structures; and in Grade 2, Cluster 2: Properties of Solids, Liquids and Gases.

- Introduce, explain, use, and reinforce vocabulary throughout this cluster.

- **Word Games**

  Use word games (e.g., crosswords, word searches, puzzles) to familiarize students with terms and definitions.

  To assist students in developing contextual knowledge of terms, provide them with opportunities to use the terms in new contexts.

Suggestions for Assessment

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

5-2-02 Identify characteristics and properties that allow substances to be distinguished from one another.

Examples: texture, hardness, flexibility, strength, buoyancy, solubility, colour, mass/weight for the same volume...

GLO: D3, E1

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

Suggestions for Instruction

➢ **Describing Substances**

Have students identify characteristics and properties (in Grade 5 these terms may be used interchangeably) that need to be considered in describing substances and in distinguishing one substance from another by conducting the following three investigations. Ask students to record their observations in their science notebooks.

Investigation 1

Provide students with two different liquids such as water and oil. Have them identify the similarities and differences between the two substances by observing

- appearance
- feel/texture
- smell

What happens when

- one drop of each substance is placed on a flat surface (e.g., a plate) and then tipped on an angle?
- a paper towel is used to try to absorb the same amount of each substance?

Investigation 2

Provide students with two different solids such as flour and sugar. Have them identify the similarities and differences between the two substances by observing

- appearance (including particle size)
- feel/texture
- mass/weight

What happens when water is added?

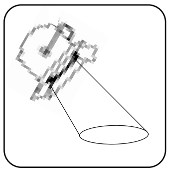
Investigation 3

Provide students with two different solids such as a straw and a tongue depressor. Have them identify similarities and differences between the two substances by observing

- appearance
- texture
- hardness
- flexibility
- strength
- buoyancy
- mass/weight

Following the investigations, have students discuss the characteristics and properties they used in the investigations. Record students’ responses on a chart and post the chart in the classroom to guide their observations throughout the study of this cluster.

Suggestions for Assessment



Describing Substances

Provide students with two different solids, such as a pencil and a pipe cleaner. Ask students to compare the two objects in at least five different ways, listing both the similarities and differences.

Look for:

The student compares the substances, considering their

- appearance
- texture
- hardness
- flexibility
- strength
- mass/weight
- purpose or use

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 2)

Observing the Properties of Matter (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-03 Investigate to determine how characteristics and properties of substances may change when they interact with one other.

Examples: baking soda in vinegar produces a gas; adding flour to water produces a sticky paste...

GLO: C2, D3, E3

5-0-4d Assume various roles and share responsibilities as group members. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

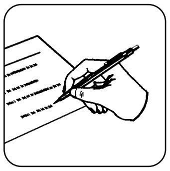
SUGGESTIONS FOR INSTRUCTION

➢ **What Changed?**

Have students mix different solids and liquids. Ask them to record the characteristics of the substances individually and then the characteristics of the mixture. Remind them to include their observations of what happened when the substances were combined.

Following the investigations, have students analyze their results and, as a class, develop a conclusion that summarizes their findings. Example: When two substances are mixed together their original characteristics and properties may change.

Suggestions for Assessment



Extended Response

Provide students with the following:

What Changed?

In your science notebook, describe what changes occur when the following substances are combined:

1. baking soda and vinegar
2. drink mix and water
3. cornstarch and water
4. oil and water

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 1)

Changes in Matter (Video)

Prescribed Learning Outcomes

Students will...

5-2-04 Recognize that matter is anything that has mass/weight and takes up space.

GLO: D3

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

Suggestions for Instruction

➢ **Identifying Matter**

Introduce the term *matter*.

Have students give examples of the three states of matter: solids, liquids, and gases. List their responses on a chart.

Example:

States of Matter

Solids	**Liquids**	**Gases**
• desk • table • pencil	• water • pop • orange juice	• oxygen • carbon dioxide • helium

Ask students to discuss how the three states are alike. (They all have mass/weight and take up space.)

5-2-05 Identify properties of the three states of matter.

Include: solids have definite volume and hold their shape; liquids have definite volume but take the shape of their container; gases have no definite volume and take the volume and shape of their container.

GLO: D3

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

➢ **Investigating Matter**

Activate students' prior knowledge by having them investigate each state of matter at three different stations. At each station, have students answer the following questions:

- Can the shape be changed easily?
- Can the volume be changed easily?

Station 1: Solids

Have students observe and investigate a collection of solids to answer the specified questions. Initially, provide solids that retain their shape and volume. After some exposure to these solids, introduce solids such as modelling clay (shape is easily changed) and rice (a collection of individual rice grains can appear to take on the shape of different containers). Have students reflect on whether these substances are solids.

Station 2: Liquids

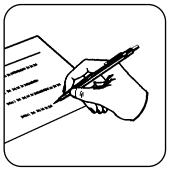
Provide students with water, food colouring, and several graduated containers of varying shapes. Have students investigate the liquids to answer the specified questions. (Liquids change shape easily. The volume remains constant.)

Station 3: Gases

Provide students with balloons of different sizes. Have students inflate and deflate the balloons to answer the specified questions. (Gases change both shape and volume easily.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Extended Response

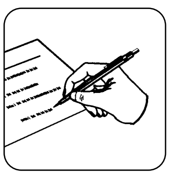
Provide students with the following:

Defining Matter

You have been asked to explain the term *matter* to a new student in the class. Explain the term using examples.

Look for:
- an accurate definition of the term matter
- an identification of the three states of matter
- examples of each state of matter

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 3)



Restricted Response

Note: This learning experience can be used as an Admit Slip or an Exit Slip. Provide students with the following:

States of Matter

Identify the correct state of matter in each of the following statements:

1. ___________ has no definite volume.
2. ___________ has a definite volume and holds its shape.
3. ___________ takes the volume and shape of its container.
4. ___________ has a definite shape but takes on the shape of its container.

Look for:
1. gas
2. solid
3. gas
4. liquid

Measuring Matter (Video)

Observing the Principles of Matter (Video)

Prescribed Learning Outcomes

Students will...

5-2-06 Experiment to compare the mass/weight of a substance in its liquid and solid states.

Examples: compare the mass of ice cubes with the mass of the liquid that results when they melt...

GLO: C2, D3, E3

5-0-1a Formulate, with guidance, specific questions that lead to investigations. Include: rephrase questions to a testable form, focus research questions. GLO: A1, C2 (ELA Grade 5, 3.1.1; Math: SP-I.1.5)

5-0-1b Identify various methods for finding the answer to a specific question and, with guidance, select one to implement. *Examples: generating experimental data; accessing information from a variety of sources…* GLO: C2 (ELA Grade 5, 3.2.2; Math: SP-II.1.5)

5-0-3a Formulate, with guidance, a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.5)

5-0-3b Identify variables that might have an impact on their experiments and, with guidance, variables to hold constant to ensure a fair test. GLO: A2, C2

5-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow. GLO: C2 (ELA Grade 5, 3.1.4)

5-0-4a Carry out, with guidance, procedures that comprise a fair test. Include: controlling variables, repeating measurements to increase accuracy and reliability. GLO: C2

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4d Assume various roles and share responsibilities as group members. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5d Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5)

(continued)

Suggestions for Instruction

➢ **Comparing Mass/Weight in Different States**

Have groups of students design and then conduct an experiment to answer the following question: Does changing the state of a substance from a solid to a liquid or from a liquid to a gas affect its mass/weight? Students may use “Experiment Report” (BLM 5-K) to record their work.

As a class, begin by identifying the cause and effect components of the question (cause: changing the state of a substance; effect: possible change in mass/weight). The hypothesis that each group develops should be a prediction about this cause and effect relationship.

Examples:

- The mass/weight will not change when a change of state takes place.
- The mass/weight will increase when a substance changes from a liquid to a solid.
- The mass/weight will decrease when a substance changes from a liquid to a solid.

As a class or in small groups, have students identify variables to ensure a “fair test” (e.g., keeping the amount of a substance constant—not losing anything), and develop a plan to carry out the experiment.

Example:

- Brainstorm a list of substances commonly found in solid and liquid states such as water, milk, olive oil, margarine, and chocolate (e.g., miniature chocolate chips).
- Place the substances in individual sealable plastic bags, use a balance to determine the mass of each substance, and repeat measurements to ensure accuracy.
- Freeze or refrigerate the liquids and place the solids in a warm water bath or in sunlight to melt them, and repeat measurements to ensure accuracy.

Ensure that students record their observations in an appropriate format and share their findings as part of a class data chart. This will help identify patterns and any discrepancies in measurement. The class chart should include the following headings:

(continued)

Suggestions for Assessment

Teacher Notes

Different groups may test different substances, or everyone may work with the same substances. If different substances are used, have more than one group work with each so that students can compare the results (similar to having more than one trial). Groups do not need to work with the same amount of substance as the comparison is mass "before and after"; however, measurement will be easier with larger amounts than with smaller amounts. Ensure that students dry off the bags to remove excess water before reweighing them.

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 8)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-06 *(continued)*

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-6f Evaluate the methods used to answer a question or solve a problem. GLO: C2, C3 (ELA Grade 5, 3.3.4)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7b Base conclusions on evidence rather than pre-conceived ideas or hunches. GLO: C2, C4

5-0-7c Identify, with guidance, a new prediction/hypothesis, based on investigation results. GLO: A1, C2 (ELA Grade 5, 3.3.4)

5-0-9c Demonstrate confidence in their ability to carry out investigations. GLO: C5

5-0-9d Appreciate the importance of creativity, accuracy, honesty, and perseverance as

SUGGESTIONS FOR INSTRUCTION

(continued)

Class Data Chart: Comparing Mass/Weight in Different States

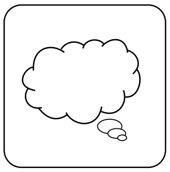
Substance	
Original State	
Mass/Weight before Change	
Final State	
Mass/Weight after Change	
Difference in Mass	

Have students evaluate, in their science notebooks, the method they used to carry out the experiment and draw a conclusion, using the term *matter* in their writing (e.g., The mass/weight did not change. The amount of matter did not change.).

Refer to page 12 in this document for a description of the stages of scientific inquiry.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Comparing Mass/Weight in Different States

Provide students with the following self-assessment tool:

Self-Assessment of Experiment

1. My prediction/hypothesis was ______________________
   ____
2. I identified the following variables to hold constant:
   ____
   ____
3. Place a checkmark in the appropriate boxes below.
   - ❑ I made a plan to carry out the experiment.
   - ❑ I followed my plan.
   - ❑ I repeated my measurements so that I know they are accurate.
   - ❑ I recorded my data accurately.
   - ❑ I arrived at a conclusion based on the data collected.
   - ❑ I shared my findings with the class.
4. Next time I would ______________________________
   ____
   ____

PRESCRIBED LEARNING OUTCOMES
Students will...
5-2-07 Demonstrate that the mass/weight of a whole object is equal to the sum of the mass/weight of its parts. *Examples: compare the mass/weight of a pencil case and its contents with that of the individual components weighed separately and added together...* GLO: C2, D3, E3
5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5 **5-0-5d** Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5) **5-0-5e** Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3) **5-0-6a** Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6) **5-0-6c** Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

SUGGESTIONS FOR INSTRUCTION

➢ Predicting Mass/Weight

Show students a pile of 10 interlocking cubes and an object made from 10 cubes. Ask: Will the pile and the object weigh the same?

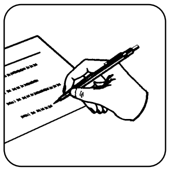
Have students give reasons for their prediction, using the term *matter* in their writing. Use a balance to demonstrate that the weights are equal.

➢ Determining Mass/Weight

Provide students with a set of objects that can be taken apart (e.g., an object made with interlocking cubes, a pencil case and contents, a lunch kit and contents). Have students complete these steps:

- Predict the mass/weight of the whole object.
- Find the mass/weight of the whole object.
- Take apart the object and weigh each component part.
- Predict the sum of the mass/weight of each individual part.
- Add up the masses to determine whether the sum equals that of the whole object. (Accuracy in measurement is important.)
- Organize your findings graphically and write a summary statement that includes the term *matter*.

Suggestions for Assessment



Extended Response

Provide students with the following:

What Is the Mass?

In your science notebook, explain why the mass of a whole apple is the same as the mass of the apple when it is cut into four sections.

Look for:

- the amount of matter does not change when the apple is cut into sections
- because the amount of matter is the same, the mass will be the same

Suggested Learning Resources

Measuring Matter (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-08 Demonstrate that changes of state are reversible through the addition or removal of heat.

Include: melting, freezing/solidification, condensation, evaporation.

GLO: D3, E3, E4

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

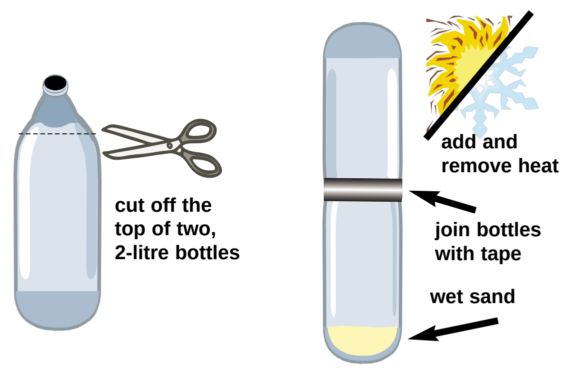
5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ Investigating the Addition and Removal of Heat

1. Have students reflect on the Comparing Mass/Weight in Different States learning activity in conjunction with learning outcome 5-2-06. Ask:
   - What did you do to cause the substances to change state? (added or removed heat)
   - Could you make the substances return to their original state?

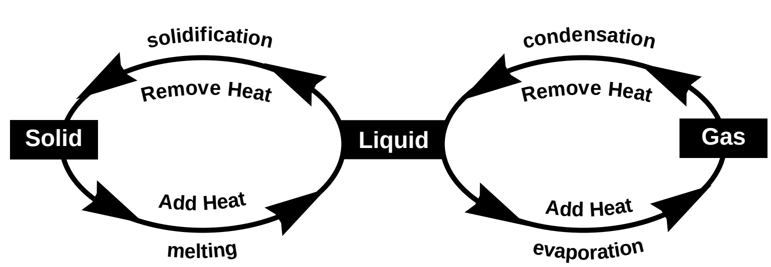
   Introduce the term *reversible change*.
2. Provide students with two 2-litre plastic drink bottles with the tops cut off. Have students put wet sand in the bottom of one bottle. Place the second bottle on top of the first so that the open ends are together, and attach them with strong adhesive tape (e.g., duct tape). Put the bottles in sunlight and have students observe what happens over several hours or days. (Water changes state as it goes through the water cycle.)



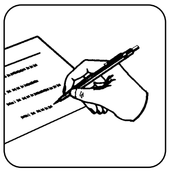
Have students summarize what they saw using the following terms: *solid, liquid, gas, melting, solidification, condensation, evaporation, add heat, remove heat, reversible, change of state*.

➢ Changing States

Have students view videos to observe more examples of changes in state. Have students summarize what they have learned about changing states using a diagram (e.g., using red arrows for the addition of heat and blue arrows for the removal of heat).



SUGGESTIONS FOR ASSESSMENT



Restricted Response: Changes in States

Provide students with the following:

Changing States

Complete the following statements:

1. Water changes from a liquid to a gas through the ________________ of heat. This process is called ________________.
2. Water changes from a gas to a liquid through the ________________ of heat. This process is called ________________.
3. Water changes from a liquid to a solid through the ________________ of heat. This process is called ________________.
4. Water changes from a solid to a liquid through the ________________ of heat. This process is called ________________.

Look for:

1. addition, evaporation
2. removal, condensation
3. removal, freezing/solidification
4. addition, melting

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 3)

Changes in Matter (Video)

Exploring Phases of Matter (Video)

How Do They...? Recycle Paper (Video)

How Do They...? Recycle Steel (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-09 Explore to identify reversible and nonreversible changes that can be made to substances.

Examples: reversible—folding paper, mixing baking soda and marbles; nonreversible—cutting paper, mixing baking soda and vinegar...

GLO: C2, D3, E3

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

SUGGESTIONS FOR INSTRUCTION

➢ **Investigating Changes**

Provide small groups of students with a collection of objects/materials (e.g., a rubber band, paper, scissors, modelling clay, an unsharpened pencil, a whole carrot, an ice cube, vinegar, baking soda, marbles, and a balloon). Ask students to change the objects/material in some way and to record the changes made. Have students classify the changes as either reversible or nonreversible and ask them to justify their classification.

Example:

Classification of Changes Made to Substances

Object/ Material	Change Made	Classification: Reversible or Nonreversible	Explanation for Classification
paper	folded it	reversible	can unfold the paper
paper	cut it	nonreversible	cannot put paper back to its original shape without using tape
balloon	popped it	nonreversible	cannot blow up the balloon again because it has a hole
balloon	inflated it	reversible	can let out air, and inflate again
baking soda	added vinegar	nonreversible	cannot separate the baking soda from the vinegar

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 5-2-10.

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 5)

Changes in Matter (Video)

How Do They...? Recycle Paper (Video)

How Do They...? Recycle Steel (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-10 Recognize that a physical change alters the characteristics of a substance without producing a new substance, and that a chemical change produces a new substance with distinct characteristics and properties.

GLO: D3, E3

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7b Base conclusions on evidence rather than preconceived ideas or hunches. GLO: C2, C4

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **What Is the Change?**

1. Burn a piece of paper and have students observe the result. Ask them to compare and contrast the results with the paper folding in the learning activities suggested for learning outcome 5-2-09.
   - How are the two changes the same? (Both change the appearance of the paper.)
   - How are they different? (New material is produced by burning the paper but not by folding the paper. The folded paper change is reversible but the burned paper change is not.)

   Introduce the terms *physical change* and *chemical change*.

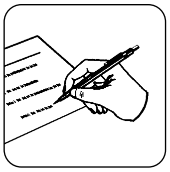
   Ask students whether paper cutting is more like paper folding or paper burning. Have them explain why. (It is more like paper folding because, even though the change is not reversible, no new substance is produced.) Have students label the three changes as physical (no new substances are produced) or chemical (new substances are produced).
2. Bring to class two jars, two dishes, steel wool, and water. Pack the wad of steel wool at the bottom of one jar. In each dish put the same amount of water (2 to 3 cm). Turn the jars upside down and stand them in the dishes.

   Have students observe changes in these objects and materials for one week. Have them identify the initial characteristics, record the changes that occur, and indicate whether the changes are chemical or physical and explain why.

3 Have students view videos to observe more examples of chemical and physical changes.

4. Have students work in small groups to re-examine their chart, Classification of Changes Made to Substances (see instructional strategies suggested for learning outcome 5-2-09) and indicate which changes are chemical and which are physical. Ask each group to join another group and compare designations and justify their answers. Pairs of groups should come to a consensus on their designations. The combined group then repeats the process with another combined group. This can be repeated until a class designation is agreed upon.
5. Have students place a banana on a windowsill to ripen. Have them record the initial characteristics, note the changes that occur, and indicate whether the changes are chemical or physical and explain why. (As the banana ripens it changes from starch to sugar—a chemical change. Tincture of iodine can be used to test for the presence of starch. It turns black if starch is present.)

Suggestions for Assessment



Extended Response

(Learning outcomes 5-2-09 and 5-2-10)

Provide students with the following:

Reversible and Nonreversible Changes

1. Give two examples of reversible changes. Explain why they are reversible.
2. Give two examples of nonreversible changes. Explain why they are nonreversible.
3. Identify your examples as chemical or physical changes. Give reasons to support your classification.

Teacher Notes

Background Information

- *Chemical change* is any change that results in a new kind of matter with a new set of properties. Examples: adding baking soda to vinegar, cooking an egg or any raw food.
- *Physical change* is any change that does not result in a new kind of matter. In a physical change only the shape or appearance of the matter is altered. Examples: boiling water changes it to vapour but it is still water, mixing salt with water.
- *Nonreversible changes* are not always chemical changes and *reversible changes* are not always physical changes. Example: cutting paper is a nonreversible change but it is a physical change, not a chemical one.

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 6)

Changes in Matter (Video)

How Do They...? Recycle Paper (Video)

How Do They...? Recycle Steel (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-11 Observe examples of changes in substances, classify them as physical or chemical changes, and justify the designation.

Examples: physical—bending a nail, chopping wood, chewing food; chemical—rusting of a nail, burning wood, cooking food...

GLO: C2, D3, E3

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

5-0-8c Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

SUGGESTIONS FOR INSTRUCTION

➢ **Observing Household Changes**

Have students observe and record changes that take place in items within their homes. Remind them to take care when observing someone cooking, cleaning, and so on. Ask them to share their data with the class and to classify the changes as chemical or physical. Have students justify their classifications.

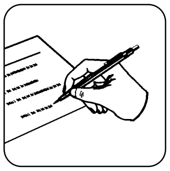
Teacher Notes

It may be difficult to differentiate between chemical and physical changes because they often take place at the same time and because students do not have the scientific background needed to analyze the changes taking place.

➢ **Home Assignment**

As a home assignment, have students, with adult support, bake cookies, bread, or cake. Ask students to compare the batter to the cooked product and identify whether the changes noted are physical, chemical, or both. Have students discuss the science of baking. As a class, brainstorm hobbies that involve science.

Suggestions for Assessment



Restricted Response

Provide students with the following:

What Is the Change?

Label the following as physical or chemical changes:
1. rusting a nail
2. cutting a piece of paper
3. mixing sugar and water
4. burning a piece of wood
5. sharpening a pencil
6. cooking an egg

Look for:
1. chemical
2. physical
3. physical
4. chemical
5. physical
6. chemical

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 6)

Changes in Matter (Video)

How Do They...? Recycle Paper (Video)

How Do They...? Recycle Steel (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-12 Identify potentially harmful chemical products used at home, and describe practices to ensure personal safety.

Include: use of products with parental supervision, recognition of safety symbols, procedures to follow in case of an emergency, proper storage of chemical products.

GLO: B1, C1, D3

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-8g Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

5-0-9e Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment. GLO: B5

SUGGESTIONS FOR INSTRUCTION

➢ **Household Inventory**

Have students, with adult supervision, identify three potentially harmful chemical products used in their homes and determine what safety practices are in place to ensure the safety of family members. Ask students to share their findings with the class and discuss how some products of science and technology have a possible negative impact on humans or the environment.

Example:

Household Product Inventory

Product Information

- *Product*: oven cleaner
- *Use*: clean oven

Safety Information on Product

- *Safety Symbols:*
  - — flammable
  - — corrosive
- *Personal Safety:*
  - — Wear gloves and protect arms.
  - — Use in cold oven.
  - — Do not swallow or breathe mist.
- *Proper Storage:*
  - — Store away from all sources of heat (not more than 50°C).
- *What to Do in Case of Emergency:*
  - — If splashed in eyes or on skin, flush with water.
  - — If swallowed, drink three to four glasses of milk or water and call a poison control centre immediately.

Safety Practices at Home

- Store product in locked cupboard.
- Use only with an adult present.

Teacher Notes

For related learning outcomes and teacher support, refer to General Learning Outcome 3—Safety, in *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* (2000).

Suggestions for Assessment

Safety Poster

Provide students with the following:

Safety Poster

Design a poster that shows and describes how to use potentially harmful chemical products safely in the home.

Look for:

- appropriate safety symbols
- a demonstration of the proper storage of chemical products
- a description of what to do in case of an emergency
- an understanding that adult supervision is required when using chemical products

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-13 Evaluate household chemical products using the design process.

Examples: glass-cleaner, laundry soap, toothpaste...

GLO: B5, C3, C4, C8

5-0-1c Identify practical problems to solve. *Examples: How can I determine the mass of air? Which prepared pizza should I buy?…* GLO: C3

5-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

5-0-3e Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

5-0-5b Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

5-0-6e Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

5-0-7d Propose and justify a solution to the initial problem. GLO: C3

5-0-7e Identify new practical problems to solve. GLO: C3

SUGGESTIONS FOR INSTRUCTION

➢ **Product Evaluation: Stain Remover**

Present students with the following scenario:

A consumer group has asked you to recommend the best stain remover. Homemade products and commercially made products are to be considered. The group is interested in having the product clean effectively, as well as being safe for the environment, easy to use, and reasonably priced. Conduct your investigation and provide a written report to the consumer group with your recommendations.

Students will need to define clear criteria, determine how to test or gather information related to each criterion, and decide how to make an overall decision. Example: Rate each product as good, fair, or poor for each criterion and then determine which one has the most “good” ratings.

Refer to page 20 of this document for a description of the design process for evaluating consumer products.

Suggestions for Assessment

Checklist: Product Evaluation

During the Product Evaluation: Stain Remover learning activity, look for indications of the following in student work:

Checklist:

The student

- ❑ identifies the problem
- ❑ identifies the criteria
- ❑ determines the method/procedure for conducting the test
- ❑ tests the product using predetermined criteria
- ❑ analyzes the data
- ❑ arrives at a conclusion

Product Evaluation

Following the Product Evolution: Stain Remover learning activity, provide students with the following self-assessment tool:

I chose to evaluate ______________________________

1. One problem I had was ______________________________
2. One thing I did well was ______________________________
3. If I did this project again I would ____________________
4. I would still like to learn more about__________________

   ____

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 10)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-2-14 Research and describe how raw materials are transformed into useful products.

Examples: food processing, oil refining, paper milling, plastic moulding, gold smelting...

GLO: B1, B4, C2, E3

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-2b Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8

5-0-2c Record information in own words and reference sources appropriately. GLO: C6 (ELA Grade 5, 3.3.2)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-8c Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

5-0-9b Show interest in the activities of individuals working in scientific and technological fields. GLO: B4

SUGGESTIONS FOR INSTRUCTION

➢ **How Are Things Made? (Research Report)**

Have small groups of students each select a different product and conduct research to determine the process followed from raw material to final product. Have students present their findings to the class, including an oral description of the process and a labelled diagram.

(For strategies and assessment suggestions to aid students in developing appropriate delivery skills for use in presentations, as well as appropriate public listening and viewing behaviour, refer to *5-8 ELA*, learning outcomes 4.4.1-4.4.3, pp. 383-404.)

➢ **Field Trip**

Take the class on a field trip to observe raw materials being transformed into useful products (e.g., visit the Royal Canadian Mint or a cheese factory).

SUGGESTIONS FOR ASSESSMENT

Peer Assessment: Research Report

Provide students with the following peer assessment tool:

Peer Assessment Rating Scale

Group members: ______________________

____

____

How informative was the report?

1 2 3 4 5

not informative — very informative

How would you rate the presentation format?

1 2 3 4 5

did not keep my attention — kept my attention

Did the students use correct terminology?

1 2 3 4 5

not at all — frequently

Overall, how would you rate the report?

1 2 3 4 5

poor — excellent

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Changes in Matter* (Lesson 7)

How Do They...? Recycle Paper (Video)

How Do They...? Recycle Steel (Video)

Notes

Grade 5

Cluster 3: Forces and Simple Machines

Overview

In this cluster, students increase their understanding of forces through the study of simple machines. Emphasis is placed on investigating a variety of simple machines and recognizing their usefulness for moving and lifting loads. Students explore how simple machines are used in daily life, and they identify advantages and disadvantages of using simple machines for a given task. Students apply their knowledge of simple machines by designing, constructing, and evaluating a prototype.

Prescribed Learning Outcomes

Students will...

5-3-01 Use appropriate vocabulary related to their investigations of forces and simple machines.

Include: applied force, balanced and unbalanced forces, fulcrum, load, friction, terms related to types of simple machines.

GLO: C6, D4

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have investigated force, the inclined plane, and wheel and axles in Grade 2, Cluster 3: Position and Motion. Students have also investigated force (magnetism, gravity, and static electricity) in Grade 3, Cluster 3: Forces That Attract or Repel. In both grades, force has been defined as a push or a pull.

- Introduce, explain, use, and reinforce vocabulary throughout this cluster.

- **Sort and Predict**

  Have students use the Sort and Predict strategy (Brownlie and Close, 1992) to learn new terms (early in the cluster) or to review terms (later in the cluster). Provide a list of 15 to 20 key terms from the cluster and have student groups develop four categories for the terms, each with its own criteria. In groups, have students place the terms so that each category has at least three terms. (This sorting can be done physically using cut-out terms.) Each group then selects a spokesperson to share their categories with the class.

  (For a BLM of a Sort and Predict Frame, see *SYSTH*, Attachment 10.13, or *Success*, p. 6.100.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Set up a Simple Machines centre featuring devices that consist of simple machines. Have students add to the centre throughout the study of the cluster. At the centre, have students identify what each device is used for, then take each device apart and observe and describe the simple machines that it contains.

Prescribed Learning Outcomes

Students will...

5-3-02 Describe, using diagrams, the forces acting on an object and the effects of increasing or decreasing them.

Include: force arrows representing direction and relative strength of forces acting in the same plane, balanced and unbalanced forces.

GLO: C6, D4

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

(continued)

Suggestions for Instruction

Teacher Notes

Background Information

Newton's laws of motion state:

1. Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless they are acted upon by some outside force. (A moving ball eventually stops due to the friction of the surface it is moving upon. A ball sitting on the floor will not move unless it is pushed or pulled in some way.)
2. The greater the force acting on an object, the more it changes in speed or direction; the heavier an object is, the less it changes in speed or direction. (Greater force is required to throw a ball that travels quickly than to throw a ball that travels slowly. It is easier to throw a light rock a long distance than it is to throw a heavier one a long distance.)
3. For every action there is an equal and opposite reaction. (Example: When a filled balloon is released the air escaping from the balloon propels the balloon forward.)

➢ Looking at Forces

Ask students to define a *force*. Have them demonstrate what is meant by a *push* or a *pull*.

➢ Balanced and Unbalanced Forces

Arrange teams that are fairly equal and have students participate in a tug-of-war. What happens when students try pulling on the rope?

Form unequal teams and have students tug on the rope. Observe what happens. Ask students to state reasons for what they observed using the term *forces*. Ask them how this might be represented on paper. Record their suggestions. Demonstrate how to use the arrows to represent the forces, introducing the terms *balanced forces* and *unbalanced forces*.

(continued)

Suggestions for Assessment

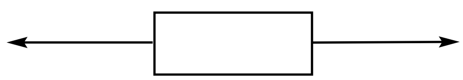
Suggested Learning Resources

Teacher Notes

Background Information

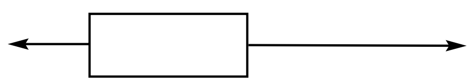
The direction and strength of a force is represented by arrows called *vectors*. A longer arrow represents a stronger force. The point of the arrow shows the direction in which the force is being applied. This can be illustrated by imagining a rope being attached to the location where the force is applied, and pulling in the direction the force is applied. Pairs of forces are usually included in force diagrams and it is possible to predict the movement of the object by comparing the relative size of the forces.

Balanced forces:



The object will remain in place because the forces are equal.

Unbalanced forces:



The object will move to the right because the force pulling to the right is greater than that pulling to the left.

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION

Students will...

5-3-02 *(continued)*

(continued)

➢ **Forces Investigation**

Using a gymnasium or a large room, divide the class into small groups. Give each group a soccer ball or a "sponge-type" ball and the following directions:

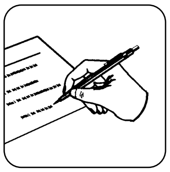
You have six problems to solve. Work together and do one problem at a time. Record your solutions both in words and diagrams, using force arrows to show what is happening.

1. How can you set the ball in motion?
2. How can you change the speed of a moving ball so that it continues to move faster?
3. How can you slow down the speed of a moving ball without stopping it?
4. How can you slow down the speed of a moving ball without touching it?
5. How can you stop a moving ball?
6. How can you change the direction of a moving ball?

After all groups are finished, have each group share their solutions. Use the following questions for discussion:

- Based on your observations, what evidence shows that an applied force can cause an object to change speed or direction?
- Can you think of instances when an applied force might not cause change in an object?

SUGGESTIONS FOR ASSESSMENT



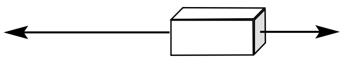
Extended Response

Provide students with the following:

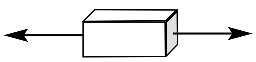
Balanced and Unbalanced Forces

Explain what will happen to the object in each of the following situations.

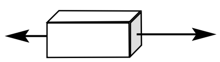
1.



2.



3.



4. Explain, using diagrams, balanced and unbalanced forces.

Look for:

1. It will move to the left because the force pulling to the left is greater than the force pulling to the right.
2. It will remain in place because the forces are equal and balanced.
3. It will move to the right because the force pulling to the right is greater than the force pulling to the left.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

5-3-03 Investigate a variety of levers used to accomplish particular tasks in order to compare them qualitatively with respect to fulcrum position, applied force, and load.

Include: first-class, second-class, and third-class levers.

GLO: C2, D4, E1

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

5-0-9c Demonstrate confidence in their ability to carry out investigations. GLO: C5

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Exploring Levers: The Teeter-Totter

Introduce the concept of a *lever* to students. Have the class visit a local playground to examine the workings of a teeter-totter. Place two students of approximately the same size on opposite ends of a teeter-totter and have them balance so the teeter-totter is parallel to the ground. Replace one student with an adult and let the teeter-totter come to rest. Challenge students to figure out how to balance the teeter-totter without adding more force. (Moving the adult closer to the fulcrum [shortening the load arm] will achieve balance.)

➢ Investigating Levers

Have students test whether the use of a lever (class one) can make it easier to move an object. Divide students into small groups and provide each group with a metre stick or light board (lever), a spring scale, a wooden block (fulcrum), an empty tin can with a handle attached, small objects or other cans to act as weights, adhesive tape, and string. (If a spring scale is not available, use an identical can with a set of weights, or small objects used as weights, to balance the lever.) The emphasis is on the relative force needed to balance the load, not on precise measurements.

Part 1: Fulcrum in the Middle

1. Place the weights in the can and suspend it from the spring scale.
2. Record the weight of the can when it is lifted from the ground.
3. Set the fulcrum (wooden block) on the corner of a desk or on a ledge to allow free movement of the lever (metre stick or board) and balance the lever on the fulcrum at the 50 cm mark (or midway point of the lever). A piece of tape can be placed loosely over the lever and fulcrum to keep the lever from slipping.
4. Remove the can with weights from the spring scale and place it on one end of the lever (holes can be made on both ends of the lever to facilitate this).
5. Attach the spring scale to the other end of the lever. Pull down on the spring scale and achieve balance by raising the can to the same level as the wooden block.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Teacher Notes

Background Information

- A *lever* is a bar or rod that is hinged or pivoted to turn around a fixed point called a *fulcrum*. It is used to transfer force and motion. A force at one end of the lever causes a load on the other end to move in the opposite direction.
- Levers are categorized into three classes, depending on the relative positions of the weight and the force applied. (For a description of class one, class two, and class three levers, see "Types of Levers," BLM 5-B.)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION

Students will...

5-3-03 *(continued)*

(continued)

(continued)

6. Record the force required. Compare it with amount of force required to lift the can with and without the lever.
7. Repeat this same test with different amounts of weight in the can.
8. Have students summarize their findings in their science notebooks. (The amount of force needed to balance the lever is equal when the fulcrum is in the middle of the lever.) Identify a practical example to illustrate the findings. (Two people of equal size are needed to balance a teeter-totter when they are the same distance from the fulcrum.)

Part 2: Moveable Fulcrum

1. Predict what will happen when the fulcrum is placed closer to the load, and when the fulcrum is placed closer to the applied force.
2. Place the fulcrum at the 75 cm mark of the lever (or halfway between where it was placed originally and where the load is applied).
3. Record the applied force needed to balance the original load used in Part 1. Observe the distance the applied force end of the lever needs to move to achieve balance, compared to when the fulcrum was located in the centre of the lever in Part 1. (The force required to achieve balance is less than when the fulcrum is in the centre, but the force must be applied over a longer distance to achieve balance.)
4. Move the fulcrum to the 25 cm mark (or halfway between where it was placed originally in Part 1 and where the load is applied).
5. Record the applied force needed to balance the original load and observe the distance the applied force end of the lever needs to move in order to achieve balance, compared to when the fulcrum was located in the centre of the lever in Part 1. (The force required to achieve balance is more now than when the fulcrum was in the centre, but the force is applied over a shorter distance.)
6. Predict and then test the force needed to balance the load and the distance the applied force end of the lever needs to move when the fulcrum is moved to the 85 cm and 15 cm positions.
7. Have students summarize their findings in their science notebooks and include a labelled diagram.

(continued)

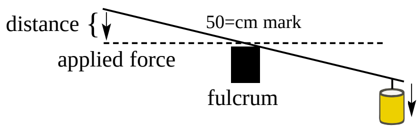
Suggestions for Assessment

Suggested Learning Resources

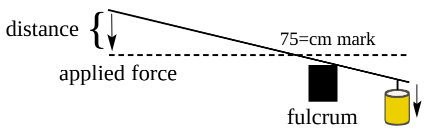
Teacher Notes

Moveable Fulcrum

a.

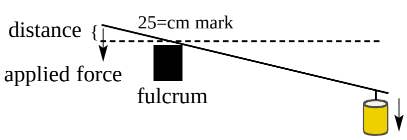


b.



Less force is required to balance the load, but it is applied over a longer distance.

c.



Greater force is required to balance the load, but it is applied over a shorter distance.

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

5-3-03 *(continued)*

(continued)

(continued)

8. Have students use their findings to explain where they would place the fulcrum on a lever designed to move a large boulder on a driveway, and explain why they chose the particular placement.

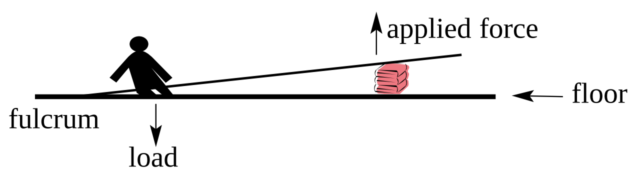
➢ Class Two Levers

Introduce the concept of different classes of levers to students. Explain that the lever students used in the previous learning activities is called a *class one lever* because the fulcrum is placed between the applied force and the load. In a *class two lever* the load is between the applied force and the fulcrum. In this type of lever the applied force always travels a greater distance than the load and is less than the load force.

To demonstrate how a class two lever works, put one end of a sturdy board on a small stack of books or another object that will keep it off the floor. Have a student sit near the other end (approximately one quarter of the distance along the board). The end of the board that stays on the ground is the fulcrum. Lift the end of the lever that is sitting on the books to raise the student a short distance. Have the student move closer to the applied force. Does this make it easier or more difficult to move the student? (It makes it more difficult.) Have students take turns lifting the lever.

Repeat the learning activity with a longer board, and the same student. Students should observe that a longer board arm makes the student easier to lift, but that the applied force end of the longer board has to travel farther to make the student move than was required with the shorter board. Ask students to summarize their findings in their science notebooks, and include labelled diagrams.

Class Two Lever



(continued)

Suggestions for Assessment

Suggested Learning Resources

Journal Reflection

Provide students with the following:

Class Two Lever

In your science notebook, explain why a bottle opener is a class two lever.

Look for:

The fulcrum is the end that touches the top of the bottle cap. The force is applied to the other end. The hook that is between the fulcrum and the end where the force is applied pulls up the bottle cap.

PRESCRIBED LEARNING OUTCOMES
Students will...
5-3-03 *(continued)*

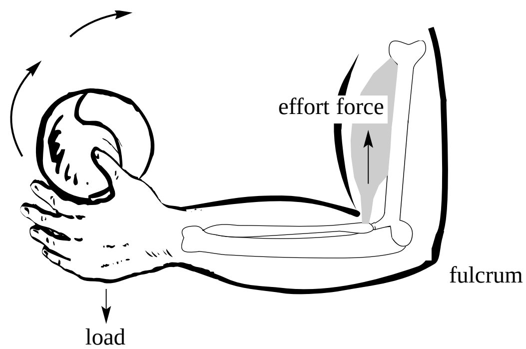
SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Class Three Levers**

Introduce the concept of a *class three lever* to students. In a class three lever the applied force is placed between the load and the fulcrum, and the applied force always travels a shorter distance than the load and must be greater than the load force. Have students work in small groups to determine how their arm, curling a weight (see diagram), is a lever. Ask them to demonstrate this action and draw a diagram. Have students label the position of the fulcrum, the applied force, and the load.

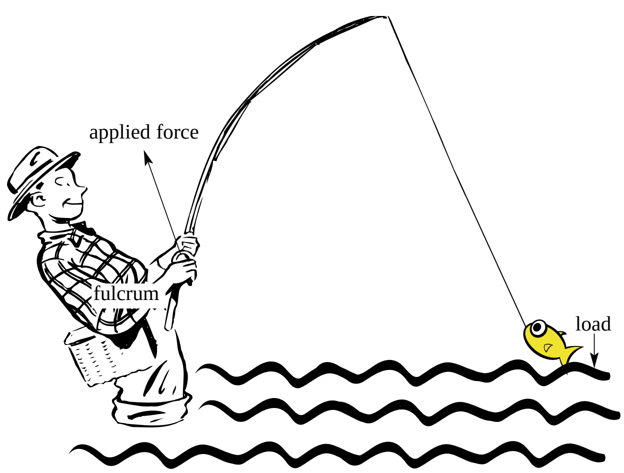
Class Three Lever



Following a class discussion of students' diagrams, allow students to select one of the following tools and use a labelled diagram to illustrate how it is a class three lever.

- fishing rod
- baseball bat
- hammer

Example (fishing rod):



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

In investigating a class three lever, remind students to consider not only the device but also the role the human body plays in the lever. For example: a fishing rod is a lever that is actually an extension of the human arm. The wrist is the fulcrum and the arm is the force arm. The fulcrum is at one end of the lever, with the effort applied partway along the lever and the load at the opposite end of the fulcrum.

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

5-3-03 *(continued)*

(continued)

➢ Putting It All Together

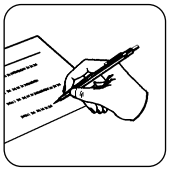
Have students use the Three-Point Approach (Simons, 1991) to

- write definitions of the terms *class one lever*, *class two lever*, and *class three lever* in their own words
- draw a labelled diagram representing each term
- give an example of an everyday device representing each term

Note: The terms *lever, fulcrum*, *applied force*, and *load force* should be used with each definition and diagram.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2 or *Success*, p. 6.101.)

Suggestions for Assessment



Extended Response

Provide students with the following:

Levers

A **B** **C**

1. Identify the class of lever shown in each picture.
2. Explain how you know.

Look for:

A = class two because it has the fulcrum at one end and the load acts downward between the applied force and the fulcrum.

B = class one because it has the fulcrum in between the load and the applied force.

C = class three because it has the fulcrum at one end and the load at the other end with the applied force between them.

<table>
<tr><th colspan="2">Scoring Rubric</th></tr>
<tr><th>Score</th><th>Criteria</th></tr>
<tr><td>3</td><td>Correctly identifies the lever class for the three pictures.
Provides a clear explanation for each picture.</td></tr>
<tr><td rowspan="2">2</td><td>Correctly identifies the lever class for the three pictures.
Explanation is unclear or has minor errors or omissions.</td></tr>
<tr><td>Correctly identifies the lever class for two pictures.
Provides a clear explanation for both.</td></tr>
<tr><td rowspan="3">1</td><td>Correctly identifies the lever class for the three pictures.
Explanation is missing.</td></tr>
<tr><td>Correctly identifies the lever class for two pictures.
Explanation is unclear or has minor errors or omissions.</td></tr>
<tr><td>Correctly identifies the lever class for one picture.
Explanation is clear and correct.</td></tr>
</table>

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

5-3-04 Identify objects in the school and at home that use wheels and axles, and describe the forces involved.

Examples: doorknob, manual pencil sharpener, hinge, bicycle...

GLO: B1, D4, E1

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5d Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5)

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

➢ **Wheel and Axle Hunt**

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to think of objects in the home and the school that use a wheel and axle. Make a class list of the suggestions.

➢ **Wheel and Axle Investigation**

Provide pairs of students with a compass for drawing circles. If compasses are not available, have students use a large plastic lid as a tracer, a manila tag at least 10 cm square, a pencil, scissors, and a metre stick.

Have students:

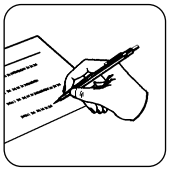
1. Use the compass to make a circle on the paper and then cut it out.
2. Insert the pencil through the centre of the circle to make a wheel and axle.
3. Predict how many times the pencil will rotate when the wheel rotates once.
4. Roll the wheel and axle along a tabletop and observe how many times the pencil rotates when the wheel rotates once.
5. Measure the distance the wheel travels in one complete rotation. (Put a small mark on the wheel so you can see when it has completed one rotation.)
6. Remove the pencil from the wheel, place the pencil on the table, and measure the distance the pencil travels in one complete rotation.
7. Predict how far the pencil will travel if the wheel rotates 10 times.
8. Reinsert the pencil (axle) through the centre of the wheel and measure how far the pencil travels in 10 rotations.
9. Draw a diagram of the wheel and axle used in this investigation, including force arrows to show the forces involved.

➢ **Identifying Forces**

Have students refer to the class list of wheels and axles found at school and at home (see the Wheel and Axle Hunt learning activity in conjunction with learning outcome 5-3-04). Have pairs of students select one of the objects listed and use diagrams to explain the forces involved.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



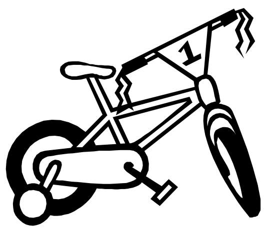
Extended Response

Provide students with the following:

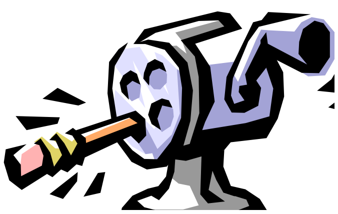
Wheels and Axles

Both the following objects use wheels and axles. Explain how they work. Be sure to describe the forces involved.

1\.



2\.

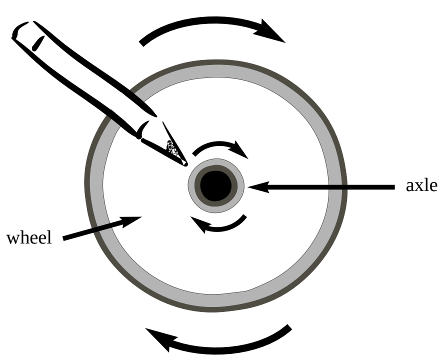


Teacher Notes

Background Information

The wheel and axle comprise a simple machine made up of a small wheel (axle) attached to the centre of a large wheel. The axle is usually a rod and it always turns as the large wheel turns.

Example of a pencil and wheel drawing:



Prescribed Learning Outcomes

Students will...

5-3-05 Recognize that a gear is a wheel and axle used to turn another wheel and axle.

GLO: D4, E2

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

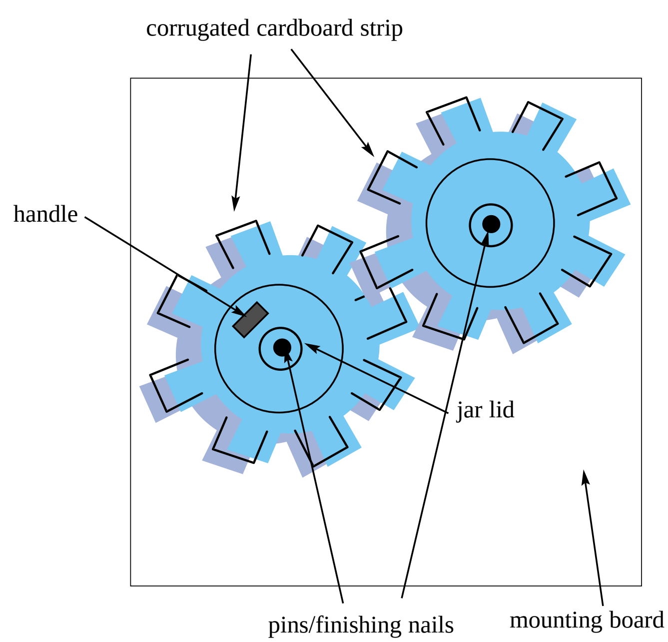
Suggestions for Instruction

➢ Investigating Gears

Have students bring to class a collection of differently sized jar lids. Cut corrugated cardboard into strips about 1 cm wide. Provide pairs of students with three jar lids, a strip of cardboard, pieces of mounting board (plywood/particleboard), styrofoam, pins or small finishing nails, a small piece of wood or game marker to use as a handle, and glue.

Have students follow these directions to make a gear system:

1. Peel away the cardboard on one side so that the corrugation is exposed. Glue the corrugated cardboard onto the outside rim of a jar lid so that the corrugation faces out.
2. Make a small hole in the centre of the lid (with teacher assistance). Pin the gear to the mounting board so that it spins freely.
3. Select a lid of a different size and attach it to the board so that the teeth of both gears mesh.
4. Glue a small piece of wood or a game marker to one of the lids. Use it as a handle to turn the gear. Observe what happens.
5. See whether you can attach another lid and have it turn with the other two.
6. Record your findings in your science notebook.



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Refer to the assessment strategy suggested for learning outcome 5-3-06.

PRESCRIBED LEARNING OUTCOMES

Students will...

5-3-06 Identify common devices and systems that incorporate pulleys and/or gears.

GLO: A5, B1, D4, E1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

SUGGESTIONS FOR INSTRUCTION

➢ **Gear and Pulley Hunt**

Have students look at home and at school for objects that make use of gears and/or pulleys. Have them share their findings with the class.

Teacher Notes

This learning activity could follow learning outcome 5-3-08. It could also be done at several stages in the cluster, where students look for gears at this time and pulleys at another time.

SUGGESTIONS FOR ASSESSMENT

Extended Response

(Learning outcomes 5-3-05 and 5-3-06)

Provide students with the following:

Pulleys and Gears

In your science notebook, list common devices and systems that use pulleys or gears. Name a device that uses both pulleys and gears.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

5-3-07 Explore to determine how the direction and amount of the applied force and the speed of rotation vary within a two-gear system.

GLO: C2, D4, E2

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

SUGGESTIONS FOR INSTRUCTION

➢ **Investigating Direction and Speed of a Two-Gear System**

Have students use the gears and board from the Investigating Gears learning activity in conjunction with learning outcome 5-3-05. Ensure students have small, medium, and large lid gears.

Have students investigate the direction and space of a two-gear system, following these steps:

1. Attach the largest gear to the board.
2. Attach the smallest gear so that it interlocks with the largest one.
3. Move the largest gear one rotation clockwise. In what direction does the small gear move? (Counterclockwise.) How many rotations does the small gear make?
4. Turn the small gear one rotation clockwise. In what direction does the large gear turn? (Counterclockwise.) How many rotations does the large gear make?
5. Turn the small gear four full rotations. How many rotations does the small gear make?
6. Remove the small gear and attach the middle-sized gear. Repeat steps 3 through 5.
7. Record your findings about the relationships between gears in your science notebook.

➢ **Investigating Force**

For this investigation students need three gears: one with 12 teeth, one with six teeth, and one with four teeth. These can be cut from cardboard (see “Gear Template,” BLM 5-C). Have students attach the gears to a board or a styrofoam tray with bendable fasteners.

Ask students to investigate the gears and answer the following questions:

1. How many times do you have to turn the small gear to have the large gear make one complete turn? (Three.)
2. How far do you think the large gear will turn if you turn the small gear once? (One third of the way.)
3. Repeat the investigation using the medium-sized gear with the large gear, and then the medium-sized gear with the small gear. Ask students to draw a diagram of each two-gear system, making sure to include appropriate force arrows.
4. Which gear requires the least force to move?
5. Which gear must travel the greatest distance for one rotation?
6. Write a paragraph in your science notebook summarizing what you have learned about gears in this learning activity.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Extended Response

Provide students with the following:

Two-Gear System

In your science notebook, explain how a two-gear system works. In your explanation, include information about direction, applied force, and speed of rotation.

Prescribed Learning Outcomes

Students will...

5-3-08 Compare, quantitatively, the force required to lift a load using a pulley system versus a single fixed pulley, and recognize the relationship between the force required and the distance over which the force is applied.

Include: a system of pulleys reduces the force required while increasing the distance over which the force is applied; a single fixed pulley requires a greater force but applies it over a shorter distance.

GLO: C2, D4, E2

5-0-1a Formulate, with guidance, specific questions that lead to investigations. Include: rephrase questions to a testable form, focus research questions. GLO: A1, C2 (ELA Grade 5, 3.1.1; Math: SP-I.1.5)

5-0-3a Formulate, with guidance, a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.5)

5-0-3b Identify variables that might have an impact on their experiments and, with guidance, variables to hold constant to ensure a fair test. GLO: A2, C2

5-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow. GLO: C2 (ELA Grade 5, 3.1.4)

5-0-4a Carry out, with guidance, procedures that comprise a fair test. Include: controlling variables, repeating measurements to increase accuracy and reliability. GLO: C2

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5d Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5)

(continued)

Suggestions for Instruction

Teacher Notes

Background Information

A *fixed pulley system* is one in which the pulley is attached to a structure and does not move. A pulley system in which one pulley supports the load and is not fixed to a structure while a second pulley is fixed is called a *moveable pulley system.*

➢ Single Fixed Pulley

Ask students to imagine how difficult it would be for people to raise the flag every day if they did not have a simple machine to help them. Provide students with a single pulley, a metre stick, string, several textbooks, and a spring scale.

Have students make a model of the single fixed pulley system, following these directions:

1. Tie the string around the books in the way that you would a parcel, leaving one end of the string loose (1 metre).
2. Tie the pulley to the middle of the metre stick and support the stick between two chairs.
3. Place the books on the floor below the pulley and thread the loose end of the string through the pulley.
4. Attach a spring scale to the string and pull down, lifting the books off the floor.
5. Detach the books from the pulley and, using the spring scale, lift the books to the same height (as in step 4) without using the pulley.
6. Record your results.
7. Explain your findings in your science notebook, using the terms *force* and *direction*.

(The spring scale reading should be the same in both cases because the single pulley changes the direction of the force but does not change the amount of force required. Single pulleys are often used to lift a load vertically, as it is easier to pull down to lift the load than to pull up to lift it.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

5-3-08 *(continued)*

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-6f Evaluate the methods used to answer a question or solve a problem. GLO: C2, C3 (ELA Grade 5, 3.3.4)

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

5-0-7b Base conclusions on evidence rather than preconceived ideas or hunches. GLO: C2, C4

5-0-7c Identify, with guidance, a new prediction/hypothesis, based on investigation results. GLO: A1, C2 (ELA Grade 5, 3.3.4)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

(continued)

Suggestions for Instruction

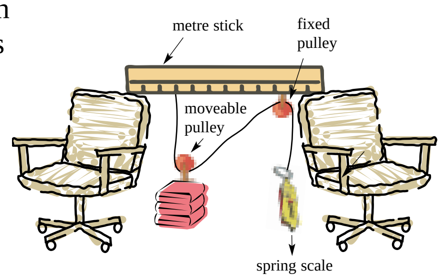
(continued)

➢ Moveable Pulley Systems

Ask students whether they think a pulley system with one pulley that moves can make it easier to lift a load than a single pulley that is fixed (see Single Fixed Pulley learning activity, learning outcome 5-3-08). Provide small groups of students with a metre stick, string, two pulleys, several books, and a spring scale.

Have students compare pulley systems, following these directions:

1. Attach one end of the string to a metre stick supported by two chairs.
2. Thread the string through a moveable pulley that is attached to the same books that were used in the Single Fixed Pulley learning activity.
3. Thread the string through the fixed pulley attached to the metre stick.



4. Attach the spring scale to the other end of the string.
5. Pull down on the spring scale to lift the books (adjust the length of the string as needed). Record the force required.
6. Answer the following questions in your science notebook:
   a. How does the force needed to lift the books with this pulley system compare to the force required in the single fixed pulley? (It is less—approximately half.)
   b. What did you notice about how far the string needed to be pulled with the moveable pulley system? (It was pulled a greater distance.)
   c. Based on your investigations, write a summary statement describing your understanding of the relationship between force and distance operating in pulley systems. If you reduce the force required to lift a load, you increase the distance over which the force must be applied.)

(continued)

Suggestions for Assessment

Extended Response

Provide students with the following:

Advantages and Disadvantages

In your science notebook, explain the advantages and disadvantages of using a moveable pulley system and a single fixed pulley.

Look for:

- a moveable pulley system reduces the force required, while increasing the distance over which the force is applied
- a single fixed pulley requires greater force than a moveable pulley system but applies it over a shorter distance

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES	**SUGGESTIONS FOR INSTRUCTION**

Students will...

5-3-08 *(continued)*

(continued)

➢ **Pulley Investigations**

Have students investigate to determine the effect of using more than one pulley to lift a load. Ask students to make a prediction identifying cause and effect (e.g., increasing the number of pulleys will make it easier to lift a specified load). Have students

- identify the variables
- create a written plan for the investigation
- carry out the experiment
- collect data and present them in graph form, including force arrows in the diagrams
- identify potential applications of their findings

Students may use the "Experiment Report" (BLM 5-K) to record their work.

Refer to page 12 of this document for a description of the scientific inquiry process.

5-3-09 Identify and make modifications to their own pulley and/or gear systems to improve how they move loads.

Include: reducing friction.

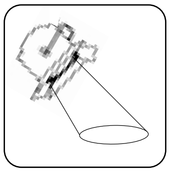
GLO: C3, D4, E2

5-0-6d Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

➢ **Improving Your Pulley or Gear System**

Have students provide suggestions on how to improve the pulley system constructed in conjunction with learning outcome 5-3-08, or the gear system constructed in conjunction with learning outcome 5-3-07. Ensure that students identify ways to reduce friction in their systems.

SUGGESTIONS FOR ASSESSMENT



The Hole

Provide students with the following:

The Hole

Imagine that a large man has fallen into a deep hole with slippery sides. The man tries to climb out but cannot. At the top of the hole there is a long rope and a pair of pulleys that the man was taking to work. A small child is travelling with the man. The man can shout directions, but he cannot expect the child to run for help or to pull him up.

What should the man tell the child to do in order to help him out of the hole? Write the directions and then draw a diagram of what you suggest.

Look for:

The student

- describes how to assemble a two-pulley system
- gives clear directions
- includes a labelled diagram

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

5-3-10 Identify and describe types of simple machines.

Include: levers, wheel and axle, pulley, gear, inclined plane, screw, wedge.

GLO: D4

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

Suggestions for Instruction

- **Types of Simple Machines**
  Use explicit instruction to summarize the types of simple machines students have studied in Grade 5 and in previous grades (levers, wheel and axle, pulley, gear, inclined plane) and introduce two new types, the *screw* and the *wedge* (variations of the inclined plane).

- **Screws in the Environment**
  Have students hunt for evidence of the use of the screw in objects in the environment. Have them note its location, describe its function, and draw a diagram of how it works.

  I found a screw ________________________________.

  It is used to ____________________________________

  ____.

  Diagram:

- **Identifying Simple Machines**
  Have students write down the names of the six different simple machines. (See "include," learning outcome 5-3-10. The gear is considered to be a type of wheel and axle.) Have them work with a partner to think of objects that use each simple machine.

  Some objects may fit into several categories. Students should be able to justify the placement of the object in a given category. Have them share their lists with the class.

- **Simple Machine Posters**
  Have students select one simple machine and design a poster explaining what it is, what it does, and where it can be found.

- **Simple Machine Rap**
  Divide students into small groups and have each group select one simple machine and create a verse for a simple machine rap, poem, or song. Suggest that students present their creation to another class.

- **Machine Families**
  All simple machines are modifications of either inclined planes or levers. Have students sort the simple machines into these two categories and give reasons for their placement.

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 5-3-11.

Teacher Notes

Background Information

- A *wedge* is a simple machine that is used to push things apart. It acts as a moving inclined plane. Most cutting tools, such as knives, are wedges.
- An *inclined plane* is a sloping surface, such as a ramp. It makes moving or lifting an object easier.
- A *screw* is a simple machine that is adapted from an inclined plane. If you follow the thread from the tip of the screw, you will see an inclined plane constantly curving upward around a central shaft. A screw is used to apply tremendous force with very little effort.

Note: Students have not been introduced to the wedge or screw but they have had experience with the inclined plane in Grade 2, Cluster 3: Position and Motion.

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

5-3-11 Describe the advantage of using simple machines to move or lift a given load.

Include: to decrease the force required; to increase the resulting force; to change the direction of the applied force.

GLO: D4

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

5-0-8c Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

SUGGESTIONS FOR INSTRUCTION

➢ **Why Use Simple Machines?**

As a class, summarize the main advantages of using simple machines. Working in small groups, have students use the advantages as headings and list examples of types of simple machines with those advantages under each heading.

Example:

decreases the applied force required	increases the resulting force	changes the direction of the applied force
• inclined plane	• wedge	• wheel and axle
• single moveable pulley	• screw	• single fixed pulley
• class two lever		• gear

Have students complete the following summary statement in their notebooks: Simple machines are examples of technologies that help humans make work easier.

(They do this by a) decreasing the applied force required, b) increasing the resulting force, c) changing the direction of the applied force.)

5-3-12 Investigate to identify advantages and disadvantages of using different simple machines to accomplish the same task.

Examples: using a pulley, inclined plane, or lever to move a piano to the second floor...

GLO: B1, C2, C4, D4

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

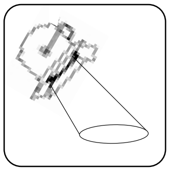
5-0-8c Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

➢ **What Works Best?**

Present students with the following scenario:

You have been hired to move the school piano from the first floor to the second floor. You must use one of the six simple machines. Identify the simple machines that might be used to complete the task. Evaluate each machine by identifying the advantages and disadvantages of using it to move the piano. Finally, prepare a written plan (including diagrams) to present to the principal on the best way to accomplish the task.

Suggestions for Assessment



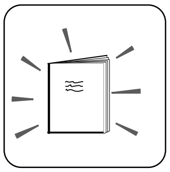
The Easy Life

(Learning outcomes 5-3-10 and 5-3-11)

Provide students with the following:

The Easy Life

Think about a typical day in your life.
What simple machines do you use over the course of the day? How do these simple machines make your life easier? Be specific.



"What Works Best?" Written Plan

Look for indications of the following in student work:

Checklist
The plan
- ❑ identifies appropriate simple machines
- ❑ states advantages for each machine
- ❑ states disadvantages for each machine
- ❑ is thorough and clearly written
- ❑ is appropriate and workable

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES
Students will...
5-3-13 Compare devices that use variations of simple machines to accomplish similar tasks. *Examples: a short- or long-handled pump, a racing or mountain bicycle...* GLO: B1, C3, C4, D4
5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1) **5-0-8c** Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2 **5-0-8d** Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

SUGGESTIONS FOR INSTRUCTION

➢ **Comparison**

Provide students with thin, long-bladed scissors; thick, short-bladed scissors; a child's scissors (blunt end, small); and other scissors, as available. Have students

- test to determine which pair of scissors is best for cutting plain paper, for cutting fabric, and for cutting cardboard
- describe the scissors using the term *lever* (Scissors are a combination of two levers. The force is applied at the handles, the fulcrum is where the two blades are connected, and the load is whatever is being cut. The closer the load is to the fulcrum, the easier it is to cut. For example, the thick, short-bladed scissors will cut thicker paper better than will the thin, long-bladed scissors.)
- explain why there are so many different types of scissors (They are used for different purposes.)

➢ **Past and Present**

Have students identify a simple machine used in the past and trace its development to the present day, highlighting major improvements (e.g., a bicycle).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

5-3-14 Use the design process to construct a prototype containing a system of two or more different simple machines that move in a controlled way to perform a specific function.

GLO: C3, D4, E2

5-0-1c Identify practical problems to solve. *Examples: How can I determine the mass of air? Which prepared pizza should I buy?…* GLO: C3

5-0-1d Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-II.1.5)

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

5-0-3e Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

5-0-4b Construct a prototype. GLO: C3

5-0-5b Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

5-0-6d Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

5-0-7d Propose and justify a solution to the initial problem. GLO: C3

5-0-9c Demonstrate confidence in their ability to carry out investigations. GLO: C5

Suggestions for Instruction

➢ **Design Process Project**

Provide students with the following:

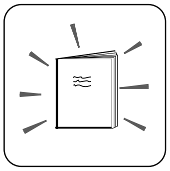
1. Select one chore that you dislike doing. Using the design process, invent a machine that will help make this chore easier. Your machine must use at least two different simple machines and must be able to be used repeatedly.
2. You have been invited to the Simple Machine Symposium, at which you will demonstrate the workings of your invented machine and explain the process that you followed to make it work.

   Students may use the "Design Project Report" (BLM 5-H) to record their work.

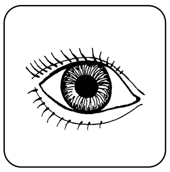
Refer to page 16 of this document for a description of the design process.

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Design Project Report: Assessment" (BLM 5-I)



"Constructing a Prototype: Observation Checklist" (BLM 5-G)

Suggested Learning Resources

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, and Technology Connections (Design Process Reference and Tools)

Notes

Grade 5

Cluster 4: Weather

Overview

In this cluster, students learn that daily weather conditions are not the result of random occurrences, but of global systems that can be predicted on a short-term and a seasonal basis. Through observations and measurements, students investigate the properties of air and other aspects of daily weather. Students learn to interpret public weather reports and investigate the usefulness of various ways of predicting the weather. Understanding the meaning of severe weather forecasts and the preparations to ensure personal safety are emphasized. Students recognize the role of technology in increasing scientific understanding of weather while appreciating the limitations in accurately predicting long-term weather trends. They also investigate factors that influence climate in Manitoba and across Canada.

Prescribed Learning Outcomes

Students will...

5-4-01 Use appropriate vocabulary related to their investigations of weather.

Include: weather; properties; volume; pressure; air masses; fronts; weather instrument; severe weather; forecast; accuracy; water cycle; climate; terms related to public weather reports, and cloud formations.

GLO: C6, D5

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 1, Cluster 4: Daily and Seasonal Changes; in Grade 2, Cluster 2: Properties of Solids, Liquids, and Gases; and in Grade 2, Cluster 4: Air and Water in the Environment.

Planning Note

Before beginning study of this cluster, collect weather predictions and weather reports from a newspaper for a period of time. Use these in relation to learning outcome 5-4-11.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Science Word Wall**

Develop a Science Word Wall (Cunningham, 1991) with key vocabulary and related terms as the study of weather ensues. Place the Science Word Wall where students can readily view it, add to it, and use it as a means of referencing vocabulary.

(For information about the Word Wall strategy, see *5-8 ELA*, Strategies, pp. 199-201).

Suggestions for Assessment

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

5-4-02 Describe how weather conditions may affect the activities of humans and other animals.

Examples: heavy rainfall may cause roads to wash out; stormy conditions may prevent a space shuttle launching; in excessive heat cattle may produce less milk...

GLO: D5

5-0-4c Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 5, 5.2.2)

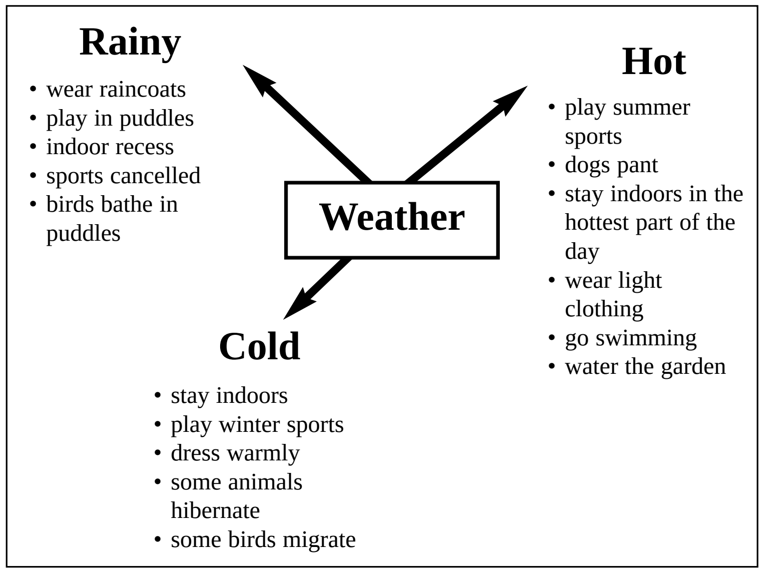
5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

Suggestions for Instruction

➢ **Weather Conditions**

Have students work in small groups to

- brainstorm possible ways that weather conditions affect the activities of humans and other animals
- consider the effect that weather has on their own activities
- display their ideas on a mind map



➢ **Making Connections**

Have students collect newspaper, magazine, and Internet articles related to the effects of weather on humans and other animals. Students can classify and sort the articles according to the type of weather being described, the part of the world affected, or the effect it is having on the people of that area.

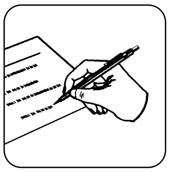
Examples:

- Rainstorms/flooding: Southern USA. People have lost their homes and animals. Crops have been destroyed.
- Drought: Africa. People are starving. Animals are dying. Crops are being destroyed.

➢ **Storm Alert**

Have students imagine they are an animal found in the wild in Manitoba. Describe the development of a storm using a passage from a book or a teacher-created description. Ask students to consider the options they have and determine the action they might take before the storm and during the storm. Have students reflect on their thoughts, feelings, and actions.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Effects of Weather

How do weather conditions affect the activities of humans and other animals? Identify at least six ways.

Scoring Rubric	
Score	**Criteria**
3	The student lists six or more different ways in which humans and other animals are affected.
2	The student lists four or five different ways in which humans and other animals are affected.
1	The student lists two or three different ways in which humans and other animals are affected.

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Weather* (Lesson 8)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 9)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-03 Describe properties of air.

Include: has mass/weight and volume; expands to fill a space; expands and rises when heated; contracts and sinks when cooled; exerts pressure; moves from areas of high pressure to areas of low pressure.

GLO: D3

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Investigating Air**

Have students investigate the properties of air by working through the learning activities at the following five stations. At each station, have students answer the following questions in their science notebooks:

- What did you observe?
- Why do you think this happened?
- Where do you see something like this happening in daily life?

Station 1: Effects of Temperature

a. Have students attach the open end of a balloon to the mouth of a 2-litre soda bottle. Set the bottle in a pan of hot water and observe what happens to the balloon. Now have students set the bottle into a pan of ice water and observe what happens to the balloon. (The hot water heats the air in the bottle. The air expands and inflates the balloon. In the cold water, the air in the bottle cools and contracts and the balloon deflates.)

AND/OR

b. Provide each group of students with a ping-pong ball and a glass of warm water. Have students make a dent in the ping-pong ball and then place the ball in the glass of warm water, observing what happens to the dent. (The air in the ping-pong ball expands and the dent disappears.)

AND/OR

c. Provide students with crushed ice and a 2-litre soda bottle. Have students put the crushed ice into the bottle and then put on the lid. Ask them to shake the bottle and then set it down, observing what happens to the bottle as the air inside cools. (The air in the bottle cools and contracts and the bottle collapses.)

Station 2: Air Pressure

a. Have students:
   - place a small board or table upside down on the floor
   - fill plastic freezer bags or balloons with air and seal them securely with twist-ties

Safety Precaution: Station 2 should be closely supervised or done as a demonstration. The teacher should stay close by to steady the table as needed.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Pan Canadian Science Place 5: *Weatherwise* (Lesson 2)

Prescribed Learning Outcomes	**Suggestions for Instruction**

Students will...

5-4-03 *(continued)*

(continued)

(continued)

- place the bags about 15 cm apart under the board or table
- add weight to the board or table until the bags break
- record observations

  (The bags of air will support a great deal of weight before breaking because the air in the bags exerts pressure.)

AND/OR

b. Have students
   - place half a sheet of newspaper on a table
   - smooth it out
   - put a ruler under the paper so that half of it is under the newspaper and half of it sticks out over the edge of the table
   - quickly press down on the ruler to try to pick the newspaper off the table
   - observe and record

   (The pressure of the air pushing down on the newspaper is greater than the pressure of the ruler pushing up under the newspaper. The newspaper remains on the table.)

Station 3: Demonstration—Rising Air

Using two large grocery bags, tape the bottom of the first to one end of a metre stick and the bottom of the second to the other end. Hang the metre stick with a string so that it is balanced with the open end of the bags facing down. Place a lamp (no shade) 15 to 20 cm below one of the bag openings and turn on the light. Have students observe what happens.

(The light warms the air in the bag and the air rises causing the metre stick on that end to rise.)

> **Safety Precaution:** For Station 3, a lamp is recommended because it gives off the heat necessary to warm the air in the bag without the danger of an open flame.

Station 4: High and Low Pressure

Provide students with two identical balloons. Have students

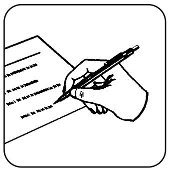
- inflate one balloon, seal the neck of the balloon with a clothespin, and stretch the opening over one end of a small empty thread spool

> **Safety Precaution:** Station 4 describes a closed system and does not reflect what happens with weather.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Extended Response

Provide students with the following:

Properties of Air

Answer the following questions in complete sentences.

1. The Grade 2 class is studying Solids, Liquids, and Gases. You have been asked to design experiments to demonstrate that air exerts pressure, warm air rises, and air has mass/weight. What experiments would you prepare?

   Explain what materials you would need and the procedure you would follow for each experiment.

   a. Air exerts pressure.

   ____

   b. Warm air rises.

   ____

   c. Air has mass/weight.

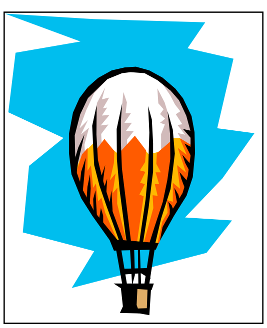
   ____

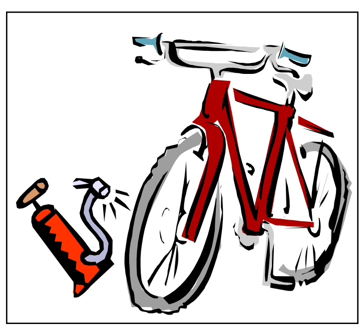
2. How does high and low pressure affect the movement of air?

   ____

   ____

3. Which property of air do the following pictures show?





Prescribed Learning Outcomes	**Suggestions for Instruction**

Students will...

5-4-03 *(continued)*

(continued)

- attach the deflated balloon to the other end of the spool, remove the clothespin from the inflated balloon and observe what happens

(The air in the inflated balloon moves into the deflated balloon because air moves from an area of high pressure [inflated balloon] to an area of low pressure [deflated balloon] until the pressure is equalized.)

Station 5: Mass/Weight

Provide students with an equal arm balance and two balloons of equal size, or deflated balls such as volleyballs or basketballs. Have students balance the scale with one balloon/deflated ball on either side. Now, fill one of the balloons with air and return it to the scale. What happens to the scale?

(The scale will become off balance because of the mass/weight of the air in the balloon.)

5-4-04 Recognize that warm and cold air masses are important components of weather, and describe what happens when these air masses meet along a front.

Include: in a cold front the cold air mass slides under a warm air mass, pushing the warm air upwards; in a warm front the warm moist air slides up over a cold air mass.

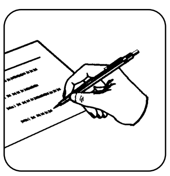
GLO: D5, E2

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

➢ **Cartoon Strip**

Provide instruction on the concept of warm and cold air masses and their importance to weather. Have students illustrate their understanding of this concept by creating a cartoon strip that shows what happens when a cold air mass meets a warm air mass (e.g., the cold air mass could be represented as a muscular, cloud-like character).

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

The Trends Meet

In your science notebook, explain what happens when warm and cold air masses meet along a front.

Look for:
- in a cold front, the cold air mass slides under a warm air mass and pushes the warm air upward
- in a warm front, the warm moist air slides up over the cold air mass

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Weather* (Lesson 7)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 7)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-05 Use the design process to construct a weather instrument.

Examples: an instrument that measures wind direction, wind speed, rainfall...

GLO: C3, D5

5-0-1c Identify practical problems to solve. *Examples: How can I determine the mass of air? Which prepared pizza should I buy?…* GLO: C3

5-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

5-0-3e Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

5-0-4a Carry out, with guidance, procedures that comprise a fair test. Include: controlling variables, repeating measurements to increase accuracy and reliability. GLO: C2

5-0-4b Construct a prototype. GLO: C3

5-0-5b Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5d Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.5)

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6d Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

5-0-7d Propose and justify a solution to the initial problem. GLO: C3

5-0-7e Identify new practical problems to solve. GLO: C3

SUGGESTIONS FOR INSTRUCTION

➢ Weather Components

Have students brainstorm a list of common components of weather. Provide students with information (print or multimedia) on how these components are measured. Have students take notes summarizing the different measurement tools and techniques.

(For strategies to aid students in recording information in their own words and referencing sources, refer to *5-8 ELA, Grade 5*, learning outcome 3.3.2, pp. 262–268.)

➢ Design Process Scenario

Refer to page 15 of this document for a description of the design process.

Provide students with a scenario such as the following:

You have been hired to construct a non-electrical device for measuring some aspect of the weather. The device is needed to determine weather conditions in the case of a power failure.

Have students follow the design process to construct their weather instrument. Students should present their prototype to the class.

Examples of criteria:

- measures the aspect of weather for which it is designed
- has some measurement system (scale if appropriate)
- must be reliable (give the same results in different trials)
- uses recycled materials
- is aesthetically pleasing

Note: To ensure that ideas come from students for this design process learning activity, do not provide them with a sheet of directions to follow. Students can draw on ideas from research they have done or samples they have seen. It is important for students to determine what tools to use, what scale to use, and what evaluation tools they will use to test their instrument.

Management Options:

1. Have students bring in the materials necessary for their design. Alternatively, provide a variety of materials and have students select from them.
2. The design can be done in class or it can be done at home following the brainstorming, setting of criteria, and creating of a plan.

Students may use “Design Project Report” (BLM 5-H) to record their work.

Math Link: (SS-1.1.5) Evaluates the appropriateness of units and measuring tools in practical contexts.

Suggestions for Assessment

When assessing students’ design process, refer to “Design Project Report: Assessment” (BLM 5-I).

Self-Assessment: Design Process

Provide students with the following self-assessment tool:

Weather Instrument Design Project

I chose to make ____

1. One problem I had was ______________________________
2. One thing I did well was ______________________________
3. If I did this project again I would ______________________
   ____
4. I would still like to learn more about ___________________
   ____
5. I think my design ___________________________________

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Weather* (Lesson 2)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 5)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, and Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-06 Observe and measure local weather conditions over a period of time, using student-constructed or standard instruments, and record and analyze these data.

GLO: A2, C2, C5, D5

5-4-07 Identify and describe components of public weather reports from a variety of sources.

Include: temperature; relative humidity; wind speed and direction; wind chill; barometric pressure; humidex; cloud cover; ultraviolet index; warm and cold fronts; amount, types, and probability of precipitation.

GLO: C6, D5

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-5c Select and use tools and instruments to observe, measure, and construct. Include: balance, thermometer, spring scale, weather instruments. GLO: C2, C3, C5

5-0-5e Estimate and measure mass/weight, length, volume, and temperature using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.5, SS-III.1.5, SS-I.1.5, SS-VIII.4.3)

5-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-III.2.5)

5-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: bar graphs, frequency tallies, line plots, broken line graphs…* GLO: C2, C6 (ELA Grade 5, 3.3.1; Math: SP-II.1.5, SP-III.2.5, SP-IV.1.5; TFS: 4.2.2–4.2.6)

SUGGESTIONS FOR INSTRUCTION

➢ **Investigating Components of a Weather Report**

Have students read, view, and listen to different weather reports to identify and describe the components that they all have in common (see “include,” learning outcome 5-4-07). Weather reports can be obtained from newspapers, the Internet, television, and radio. For each component, students should become familiar with what it measures, the units used, and how it is reported. Ask students to summarize their findings in their science notebooks in an appropriate format.

➢ **Creating a Weather Report**

Have student groups take turns making a daily weather report summarizing the day’s weather as part of the school’s afternoon announcements. The report should include at least four student-selected components, such as temperature, wind speed and direction, barometric pressure, and humidity. Have students gather the data using student-made and standard instruments. (As student-constructed instruments may not be sturdy or reliable, have commercial instruments available.) A Friday afternoon report could also include a summary and/or an analysis of the weather for the week or month, and include recorded highs, lows, averages, and so on (see Weather Tracking below).

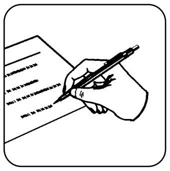
➢ **Weather Tracking**

Have students keep a record of selected weather components (such as temperature) over the course of a month and record their findings on a graph or chart. Have them analyze the data and identify patterns, discrepancies, and possible explanations, and then write a descriptive paragraph summarizing the weather for the month.

(For strategies and assessment suggestions to aid students in understanding the data collection process, grouping data, displaying data, and drawing conclusions from data, refer to *5-8 Math*, Statistics and Probability, pp. C3-C15.)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

Suggestions for Assessment



Refer to “Weather Report Terminology” (BLM 5-D).

Teacher Notes

Safety Considerations

Thermometers containing mercury should be used with extreme caution in the classroom and appropriate clean-up procedures must be in place in case one breaks. (For more information refer to *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* (1997). This resource is available in schools, online at <http://www2.edu.gov.mb.ca/metks4/curricul/k-s4curr/science> or from the Manitoba Text Book Bureau.)

Schools may choose to remove mercury thermometers from their classrooms to avoid potential hazards. Avoidance of mercury thermometers may be prudent in Grade 5 as access to formal science labs and/or resources for proper clean-up may not be available.

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Weather* (Lesson 5)

Pan Canadian Science Place 5: *Weatherwise* (Lessons 5, 8, 9)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-08 Describe the key features of a variety of weather phenomena.

Examples: wind speed and precipitation of blizzards...

GLO: D5, E1, E2

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-2b Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8

5-0-2c Record information in own words and reference sources appropriately. GLO: C6 (ELA Grade 5, 3.3.2)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Learning experiences related to learning outcomes 5-4-08 and 5-4-09 could take place at the same time.

➢ **Weather Phenomena Poster**

Have students work in groups to research the key features of a variety of weather phenomena. Each group could investigate a different phenomenon (such as tornadoes, thunderstorms, blizzards, chinooks, sun dogs, or wind shears) and try to identify its key components. Ensure that students use a variety of sources such as books, videos, CD-ROMs, and the Internet. Have students present their information as a poster. Have students do a Gallery Walk (Brownlie and Close, 1992) to view the posters.

(For a discussion of a Gallery Walk, see *5-8 ELA*, Strategies, pp. 202-203.)

5-4-09 Provide examples of severe weather forecasts, and describe preparations for ensuring personal safety during severe weather and related natural disasters.

Examples: tornado, thunderstorm, blizzard, extreme wind chill, flood, forest fire...

GLO: B3, C1, D5

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

➢ **Severe Weather Brainstorm**

Have students brainstorm different types of severe weather. Have them list the conditions related to each type. (Some of this information can come from the Weather Phenomena Research learning activity associated with learning outcome 5-4-08.)

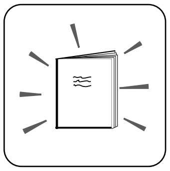
➢ **Severe Weather Forecasts**

Have students access Environment Canada resources to determine how severe weather is forecast. Ensure that students look at the terminology used in the forecasts, such as weather statement, watch, advisory, and warning.

➢ **Severe Weather Brochure**

Have students select one severe weather-related phenomenon of particular importance to Manitoba (e.g., wind chill, blizzard, flood, thunderstorm). Have them create a brochure that describes the conditions that surround this severe weather phenomenon and advises how people can best prepare for, and act during, these conditions.

Suggestions for Assessment



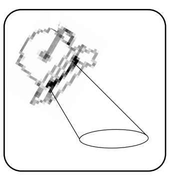
Weather Phenomena Poster

Look for indications of the following in student work:

Checklist:

The poster includes

- ❑ precipitation
- ❑ temperature
- ❑ wind speed and direction
- ❑ barometric pressure
- ❑ other



Manitoba Winter Safety

Provide students with the following scenario and have them respond in their science notebooks.

Manitoba Winter Safety

Environment Canada is forecasting a blizzard for your area tomorrow. What advice would you give to a person who is new to the area and has not experienced a Manitoba winter before?

Look for:

- appropriate safety issues are addressed
- advice is practical and accurate
- work is complete and thorough

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Weather* (Lesson 4)

Pan Canadian Science Place 5: *Weatherwise* (Lessons 4-6)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-10 Investigate various ways of predicting weather, and evaluate their usefulness.

Examples: weather-related sayings, traditional knowledge, folk knowledge, observations of the natural environment...

GLO: A2, A4, B2, C8

SUGGESTIONS FOR INSTRUCTION

➢ **Weather-Related Sayings**

Provide students with weather-related sayings. Have them discuss the possible meanings of these sayings and their usefulness (past and present) in predicting weather. Then present them with the intended meanings. Students may do research to determine the scientific validity of these sayings.

Examples:

- Red sky in the morning, sailor take warning. Red sky at night, a sailor's delight.
- Mare's tails and mackerel scales make tall ships take in their sails.
- Clear moon, frost soon.
- A year of snow, a year of plenty.
- Halo around the sun or moon, rain or snow soon.
- Rainbow in the morning gives you fair warning.

The Internet is a good source of information related to this topic.

➢ **Traditional Knowledge**

Have students investigate the accuracy of traditional knowledge related to animal behaviour and weather. Have them present their findings to the class.

➢ **Guest Speaker**

Invite professionals such as hunters, trappers, or fishers to speak to the class about how the weather affects their work and/or how their knowledge of the weather helps them in their jobs.

Suggestions for Assessment

Teacher Notes

Background Information

Most animals are vulnerable to environmental changes that humans often can not detect. Examples:

- Swallows flying low indicate the air pressure is dropping.
- Falling air pressure may affect the digestive system of cows, making them less willing to go to pasture and causing them to lie down.
- Static electricity may increase the grooming activities of cats.
- The calls of some birds, including crows and geese, become more frequent with falling air pressure.
- Deer and elk react to wind and air pressure by coming down from the mountains and seeking shelter.
- Some species feed more before a storm so they can seek shelter.
- When the air pressure drops, flying insects are more active and stay closer to the ground, so they seem to be swarming before a rainstorm.

Suggested Learning Resources

Pan Canadian Science Place 5: *Weatherwise* (Lesson 9)

Native Science: Natural Laws of Interdependence (Teacher Reference)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

The Day Niagara Falls Ran Dry! Canadian Weather Facts and Trivia (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-11 Contrast the accuracy of short- and long-term weather forecasts, and discuss possible reasons for the discrepancies.

Include: long-term forecasts may not be accurate as weather is a complex natural phenomenon that science is not yet able to predict accurately.

GLO: A1, C2

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-8a Recognize that science is a way of answering questions about the world and that there are questions that science cannot answer. GLO: A1, A3

5-0-8b Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

SUGGESTIONS FOR INSTRUCTION

➢ **Determining Accuracy: Short-Term Weather Forecasts**

1. Collect daily public weather forecasts from a newspaper, the Internet, the television, or the radio. Have students compare the daily forecast with the actual weather for a given day. Have them do this over several days, recording their findings on a chart. Ask students to determine the accuracy of short-term forecasts.
2. Have students look at the extended forecast (e.g., a five-day forecast) and record their observations of the actual weather for each day. Ask them to determine how accurate extended forecasts are and give reasons why this might be so.

➢ **Comparing Weather Forecast Sources**

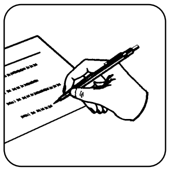
Ask students to collect weather forecasts from several sources, such as Internet sites, magazines, newspapers, television channels, and/or radio stations, and to compare the data. What might account for the differences?

➢ **Old Farmers' Almanac/Environment Canada: Long-Term Weather Forecasts**

Using either a copy of *The Old Farmers' Almanac* or The Old Farmers' Almanac Internet site available online at <http://www.almanac.com/> and the Environment Canada long-range forecast, have students judge the accuracy of the extended seasonal outlook. Ask students to compare the weather predictions made with the actual conditions over a given time period.

Note: A long-term forecast is for six months. This learning activity could be done over the course of the school year.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Long-Term Forecasts

In your science notebook, explain why long-term forecasts are often inaccurate.

Look for:
- weather is a complex natural phenomenon that science is not yet able to predict accurately
- any other reasonable explanation

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Weather* (Lesson 10)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 8)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-12 Describe examples of technological advances that have enabled humans to deepen their scientific understanding of weather and improve the accuracy of weather predictions.

Examples: satellites collect data that scientists analyze to increase understanding of global weather patterns; computerized models predict weather...

GLO: A2, A5, B1, D5

5-0-8c Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

5-0-8d Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

5-0-8e Describe hobbies and careers related to science and technology. GLO: B4

SUGGESTIONS FOR INSTRUCTION

➢ **Identifying Weather Forecasting Technology**

Have students reflect on the weather reports they have recently viewed and/or play a television weather report for the class. Ask them to focus their attention on identifying examples of technological tools used by meteorologists in weather forecasting. It should be possible to identify satellites, radar, and computer models.

➢ **Impact of Technological Advances**

Based on the technology identified in the previous learning activity, have students work in groups to

- select one type of technology and research the history of its development and how it helps us improve the accuracy of weather predictions
- record information on a class timeline showcasing these developments

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5-4-13 Explain how the transfer of energy from the Sun affects weather conditions.

Include: the Sun's energy evaporates water and warms the Earth's land, water, and air on a daily basis.

GLO: D4, D5, E4

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

➢ **Transfer of Energy**

Provide small groups of students with small sealable (zippered) bags, small paper cups, and water. Have each group

- prepare three bags in the following manner: place the cup upright in the bag, add a small amount of water to the bottom of the bag (not in the cup), and seal the bag
- place each bag in a different location: one in direct sunlight, one in an area of the room that does not get direct sunlight, and one in a closet or any other dark, cooler location
- record observations, noting the time and the changes taking place

In their science notebooks, have students

- explain why there are differences in the bags. (The bag in direct sunlight will activate the water cycle sooner because the Sun can more directly transfer its energy to drive the cycle. The precipitation will evaporate from the bottom of the bag, condense on the bag, and then drip down and collect in the cup.)
- synthesize their understandings by describing the role the Sun plays in weather, including the terms energy, air, water, land, evaporate, and warm.

SUGGESTIONS FOR ASSESSMENT

Journal Reflection

Have students reflect on the following questions in their science journals:

Technology and Weather

1. Why is technology important in predicting weather?
2. What might the technology of the future allow us to do related to predicting weather?

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Weather* (Lesson 10)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 8)

Addison Wesley Science & Technology 5: *Weather* (Lesson 6)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 3)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-14 Explain how clouds form, and relate cloud formation and precipitation to the water cycle.

GLO: D5, E2

5-0-4e Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

SUGGESTIONS FOR INSTRUCTION

➢ **Making Clouds**

Demonstration: Use two identical wide-mouthed glass containers, three ice cubes, boiling water, and food colouring. Chill one of the containers. Fill half of the other container with boiling water and add two drops of food colouring. Place the chilled container on top of the container with hot water, fitting the mouths together carefully. Place the ice cubes on top of the chilled container. Have students observe what happens.

(The water will evaporate and then condense at the top of the container. The water vapour will appear cloudy.)

➢ **Water Cycle**

Have students make a model of the water cycle using a wide-mouthed container, a tin foil pan, a glass of hot water, and ice cubes. Ask students to

- pour the hot water into the wide-mouthed container
- place the tin foil pan over the mouth of the container
- add the ice cubes to the pan
- observe what happens

Have students compare their observations from the Making Clouds investigation in the previous learning activity and the water cycle model.

(The water evaporates and then condenses on the bottom of the foil pan. The drops become heavy and fall as precipitation.)

Suggestions for Assessment

Extended Response

Provide students with the following:

Water Cycle

Explain how the water cycle works. Your explanation should include a labelled diagram.

Look for:

- a labelled diagram
- a clear explanation
- use of correct terminology
  - — *evaporation*
  - — *condensation*
  - — *water vapour*
  - — *precipitation*

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Weather* (Lesson 6)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 4)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-15 Identify and describe common cloud formations.

Include: cumulus, cirrus, stratus.

GLO: D5, E1

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

➢ **Observing Clouds**

Have students go outdoors over the course of several days to observe the cloud formations. Ask them to draw the cloud formations they see. Provide students with labelled pictures of the three main cloud types and have them place their drawings under the cloud type that most resembles their pictures.

As students are making their observations they could also keep a record of what the weather was like for that day.

➢ **Cloud Models**

Have students make models or draw diagrams representing the three types of clouds.

➢ **Cloud Cinquain**

Have students select one of the common cloud formations and then use descriptive language to create a cinquain poem (a five-line stanza that has successive lines of two, four, six, eight, and two syllables).

5-4-16 Differentiate between weather and climate.

Include: weather includes the atmospheric conditions existing at a particular time and place; climate describes the long-term weather trend of a particular region.

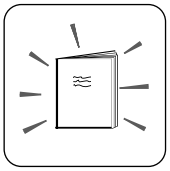
GLO: D5, E1

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

➢ **Climate and Weather Comparison**

Provide students with a set of statements related to weather and climate (see “Weather or Climate?” BLM 5-E). Ask students to sort them into the two categories and to give reasons for their placement.

Suggestions for Assessment



Peer Assessment of "Cloud Models"

Have students fill out comment cards after viewing cloud models developed by three other students. The comment should describe a positive aspect of the model.

Teacher Notes

Background Information

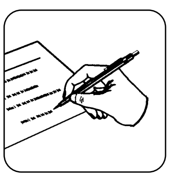
The three main cloud types are identified in learning outcome 5-4-15. Numerous combinations of cloud types are possible. It is not necessary for students to know the names of all possible types, only the main three and their characteristics.

Caution: Cloud formations are only one of the observations used to predict weather. Avoid making rigid correlations between cloud type and weather conditions.

Suggested Learning Resources

Addison Wesley Science & Technology 5: *Weather* (Lesson 4)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 4)



Weather or Climate?

Have students write one statement using the term *weather*, and one using *climate*. (This can be used as an Exit Slip.)

Addison Wesley Science & Technology 5: *Weather* (Lesson 9)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 7)

Prescribed Learning Outcomes

Students will...

5-4-17 Identify factors that influence weather and climate in Manitoba and across Canada, and describe their impacts.

Examples: jet stream, proximity to water, elevation, chinook...

GLO: D5, E2

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-6c Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

5-0-7a Draw, with guidance, a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 5, 3.3.4)

Suggestions for Instruction

➢ **Weather Differences**

Have students identify different places they have visited in Manitoba and in Canada. Have them discuss what the weather was like in those places. Ask if they can think of any site-related conditions that may have affected the weather and climate (e.g., altitude, latitude, proximity to water).

➢ **Comparing Weather**

Have students analyze data from four Canadian cities to identify facts that influence weather and climate. (See "Influences on Climate," BLM 5-F).

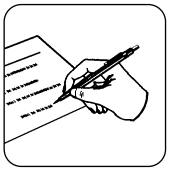
➢ **Guest Speaker**

Invite a meteorologist or weather forecast personality from a local television or radio station to speak to the class about factors that influence weather and climate in Canada. If this is not possible, students could access an "Ask the Expert" Internet site.

Teacher Notes

A Prairie Tour: A Grade 5 Integrated Unit for Teachers is online at <http://www.edu.gov.mb.ca/metks4/tech/currtech/imyn/prairietour/> an electronic resource that includes weather-related learning activities allowing students to apply graphing skills.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Manitoba Weather and Climate

In your science notebook, identify factors that influence weather and climate in Manitoba and describe their impacts.

Look for:
- location (latitude/longitude)
- proximity to water
- jet stream
- elevation

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 5: *Weather* (Lesson 9)

Pan Canadian Science Place 5: *Weatherwise* (Lesson 5)

PRESCRIBED LEARNING OUTCOMES

Students will...

5-4-18 Recognize that climates around the world are ever changing, and identify possible explanations.

Examples: volcanic eruptions, ozone depletion, greenhouse effect, El Niño, deforestation...

GLO: B5, D5, E2, E3

5-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 5, 3.2.3; Math: SP-II.3.1)

5-0-7f Use prior knowledge and experiences selectively to make sense of new information in a variety of contexts. GLO: A2, C4 (ELA Grade 5, 1.2.1)

5-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 5, 4.4.1; TFS: 3.2.2, 3.2.3)

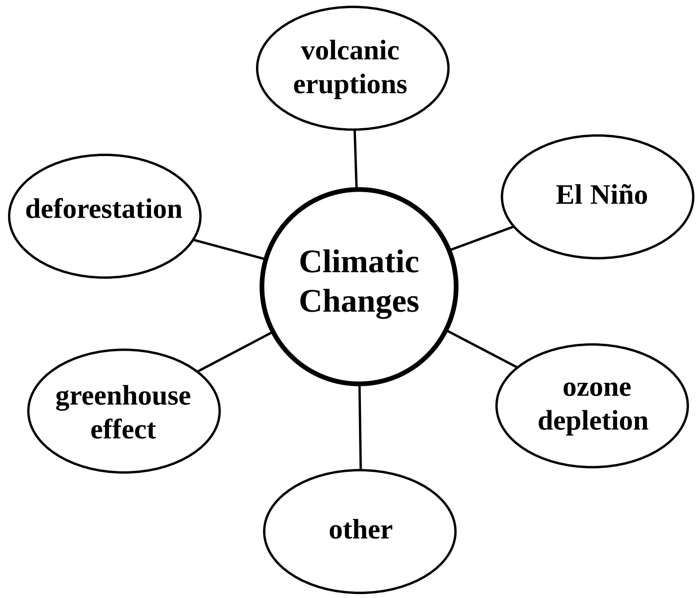
5-0-7h Identify, with guidance, potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ **Accessing Prior Knowledge**

Have students work in small groups to prepare a concept map showing what they know about climatic changes.

Example:



➢ **Active Reading/Viewing**

Have students use the following active viewing strategy to analyze an article or video on some aspect of climate change. Using this strategy, students will

- give a one-sentence summary of the main point of the reading or viewing
- draw a picture or diagram representing an important aspect
- list key points
- identify three related questions
- explain how the reading or viewing relates to what has already been studied in class

Suggestions for Assessment

Cluster Reflection

Provide students with the following sentence stems:

Weather Reflection

1. In the study of weather I learned . . .
2. I found it interesting that . . .
3. I was surprised . . .
4. I wonder . . .

Teacher Notes

Students should begin to become familiar with some of the concepts related to the much-debated subject of climate change, which they will analyze in greater depth in higher grades. The Internet is a rich source of information on this topic, including grade-appropriate reading material, and videos. The Government of Canada's website on climate change can be accessed at <www.changementsclimatiques.gc.ca>.

Suggested Learning Resources

Pan Canadian Science Place 5: *Weatherwise* (Lesson 10)

Notes

Grade 5

Blackline Masters

- Body Systems Chart (BLM 5-A)
- Types of Levers (BLM 5-B)
- Gear Template (BLM 5-C)
- Weather Report Terminology (BLM 5-D)
- Weather or Climate? (BLM 5-E)
- Influences on Climate (BLM 5-F)
- Constructing a Prototype: Observation Checklist (BLM 5-G)
- Design Project Report (BLM 5-H)
- Design Project Report: Assessment (BLM 5-I)
- Conducting a Fair Test: Observation Checklist (BLM 5-J)
- Experiment Report (BLM 5-K)
- Experiment Report: Assessment (BLM 5-L)

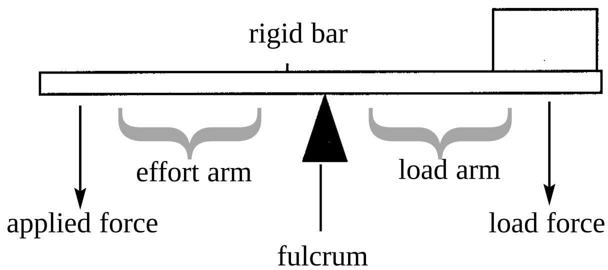
Body Systems Chart

System/Parts	Function
Digestive System **Parts** • Mouth • Esophagus • Stomach • Small Intestine • Large Intestine	• • • • •
Skeletal System (Bones)	
Muscular System **Parts** • Muscles • Tendons • Ligaments	• • •
Nervous System **Parts** • Brain • Spinal Cord • Nerves	• • •
Integumentary System (Skin)	
Respiratory System **Parts** • Nose • Trachea • Lungs	• • •
Circulatory System **Parts** • Heart • Blood Vessels/ Arteries/Capillaries • Blood	• • •

Types of Levers

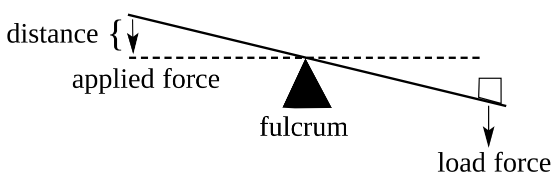
Class One Lever

In class one levers the fulcrum is situated between the load and the applied force. A teeter-totter is an example of a class one lever.



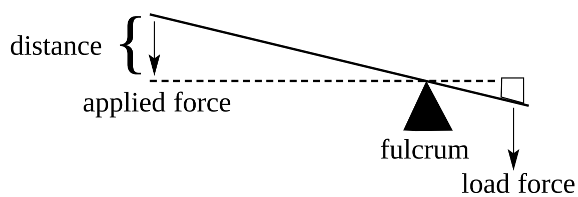
Position of Fulcrum

a.



The effort and load arms are equal in length. To achieve balance, the applied force equals load force.

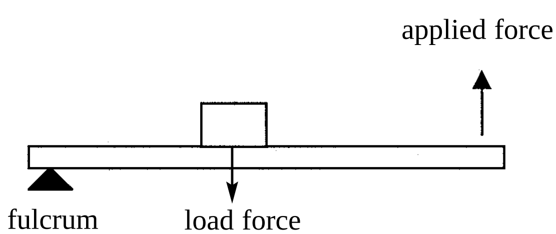
b.



The effort arm is longer than the load arm. To achieve balance, the applied force is less than the load force, but has to be applied over a longer distance.

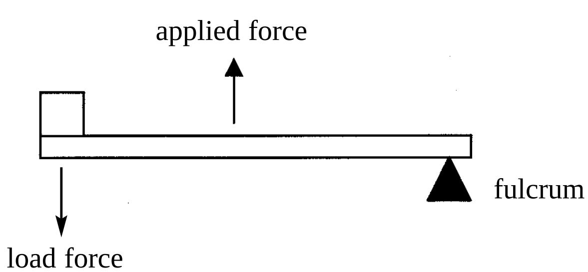
Class Two Lever

Class two levers have the fulcrum at one end of the bar, with the load acting downward between the effort force and the fulcrum and the applied force acting upward at the opposite end of the bar from the fulcrum. A wheelbarrow is an example of a class two lever.

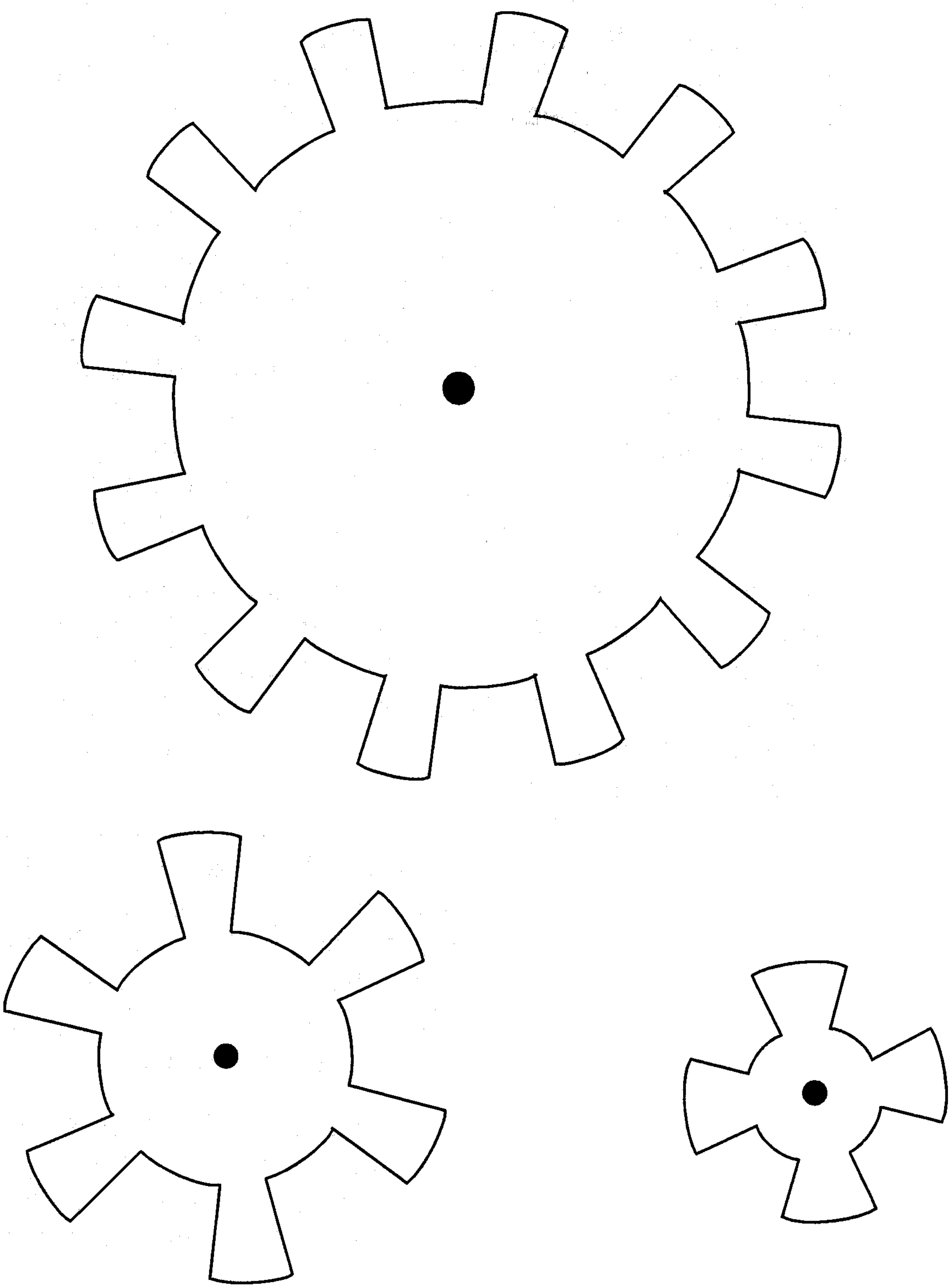


Class Three Lever

Class three levers have the fulcrum at one end and the load at the other end, with the effort force between them. A fishing rod is an example of a class three lever.



Gear Template



Weather Report Terminology

Associate the following weather report terms with the appropriate descriptions. In some cases, there may be more than one correct answer.

Terms

1. ______ temperature
2. ______ wind speed
3 ______ wind chill factor
4. ______ humidex
5. ______ UV Index
6. ______ precipitation
7. ______ relative humidity
8. ______ wind direction
9. ______ barometric pressure
10. ______ cloud cover
11. ______ front
12. ______ probability of precipitation

Descriptions

a. indicates the extent of clouds in the sky
b. indicates the possibility of rain or snow
c. indicates the intensity of the Sun's ultraviolet rays
d. the zone where two air masses meet
e. rain, snow, and hail
f. is dependent on the temperature and the speed of the wind
g. is dependent on the temperature and the relative humidity
h. indicates the amount of water present in the atmosphere
i. is expressed in degrees Celsius
j. is expressed in km/h
k. can be measured with a rain/snow gauge
l. can be measured with an anemometer
m. can be measured with a weather vane
n. can be measured with a thermometer
o. the force that the mass of the atmosphere exerts on the Earth's surface

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Look for:

1. i/n temperature
2. j/l wind speed
3. f wind chill factor
4. g humidex
5. c UV Index
6. e/k precipitation
7. h relative humidity
8. m wind direction
9. o barometric pressure
10. a cloud cover
11. d front
12. b probability of precipitation

Weather Report Terminology: Adapted/translated from Manitoba Education and Training. *Sciences de la nature 5e année : Programme d'études-Document de mise en œuvre, Version provisoire*. Winnipeg, MB: Bureau de l'éducation français Division, August 2000. p. 4.71.

Weather or Climate?

Name: ________________________________ Date: ________________________________

Identify whether the following statements describe the weather (W) or the climate (C). Explain your answers.

1. ________ Victoria is situated on the straight of Juan de Fuca, an extension of the Pacific Ocean. The warm ocean waters keep the winters mild in Victoria.
2. ________ Flin Flon and The Pas are near the Saskatchewan border. Last Saturday, it snowed in Flin Flon but not in The Pas.
3. ________ Churchill is situated along the Hudson Bay. In the spring, the community remains cold for a long time because the ice is slow to melt.
4. ________ Banff is close to Calgary, but is at a higher elevation. Consequently, it takes longer for the snow to melt in Banff than in Calgary.
5. ________ St. Malo is situated near the Rat River. Last week it rained every day and the river overflowed.
6. ________ Vancouver is on the same latitude as St. Boniface. Since Vancouver is near the sea, it receives much more rain.
7. ________ There was so much snow in St. Laurent that the schools in the region were closed.
8. ________ The winters in Thompson are so cold that some car companies test their automobiles there.
9. ________ In July, a tornado destroyed two barns in the St. Claude region.
10. ________ Every winter there are blizzards in Manitoba. In some cases, the roads must be closed.

Look for:

1. C	6. C
2. W	7. W
3. C	8. C
4. C	9. W
5. W	10. C

Influences on Climate

Use the following data and an atlas to answer the questions below.

City	Average Temperature in January	Average Temperature in July	Latitude
Churchill	–27.5°C	11.8°C	55°N
Winnipeg	–19.3°C	19.6°C	50°N
Regina	–17.9°C	18.9°C	50°N
Halifax	–6.0°C	18.2°C	40°N

1. Which city is coldest in the winter? What is a possible explanation for this?
2. Halifax is located closer to the equator than the other cities. Why is Halifax not the warmest city in the summer?
3. Which city has the least variation between summer and winter temperatures? What is a possible explanation for this?
4. Both Winnipeg and Regina experience extreme temperatures (very hot in the summer and very cold in the winter) and a wide range between summer and winter temperatures. Which of the following cities is likely to experience a climate similar to that of Winnipeg and Regina: Medicine Hat or Nanaimo? Explain why.

Look for:

1. Churchill. It is located at the highest latitude—farthest from the equator.
2. The proximity to the ocean has a moderating effect on summer temperatures.
3. Halifax. Its proximity to the ocean has a moderating effect on both summer and winter temperatures, resulting in much less seasonal variation here than in other cities across Canada.
4. While both cities are located at a similar latitude, Medicine Hat is mid-continental and would have similar temperatures to Winnipeg and Regina. Nanaimo is on the ocean and, like Halifax, would have less variation in seasonal temperatures.

Constructing a Prototype: Observation Checklist

Date: ________________________________ Problem/Challenge: _______________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Constructing a Prototype: Observation Checklist *(continued)*

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Design Project Report

Name: ______________________________ Date: ______________________________

Problem/Design Challenge:

Criteria:

Brainstorming (What are all the different ways . . .):

Planning:

Steps to Follow:

Materials:

Safety Considerations:

.

(continued)

Design Project Report *(continued)*

Testing:

Criteria	Test Used

Test Results: Attach Data Summary

Evaluating and Improving:

- Justification of changes to original design:

- Strengths and weaknesses of final design:

- Comment/reflection (Next time . . . , A new problem . . . .):

(continued)

Design Project Report *(continued)*

Prototype Sketch 1 (Plan):

Top View

Side View

Prototype Sketch 2 (Final):

Top View

Side View

Design Project Report: Assessment

Prototype: ________________________ Date: ________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Identifying the Practical Problem and Criteria for Success • the problem is clearly stated • class and/or group criteria are identified • criteria address all or some of the following: function, aesthetics, environmental considerations, cost, reliability			
Planning • all steps are included and clearly described in a logical sequence • all required materials/tools are identified • safety considerations are addressed • a labelled top- and side-view sketch of the prototype is included (Sketch 1)			
Testing the Prototype • tests are described and align with criteria (e.g., each criterion has been tested) • test results are presented in an appropriate format (data sheet is attached)			
Evaluating and Improving the Design • a final sketch of the prototype is included (Sketch 2) • changes to the original plan are justified • strengths and weaknesses of the final prototype are presented • suggestions for "next time" are included and/or "new problems" are identified			
Total Points			
Comments:			

*Note: The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Conducting a Fair Test: Observation Checklist

Experiment: ______________________________________ Date: ________________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (workspace, handling equipment)	Ensures Accuracy/ Reliability (e.g., repeats measurements)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Conducting a Fair Test: Observation Checklist *(continued)*

Names	Has Safe Work Habits (workspace, handling equipment)	Ensures Accuracy/ Reliability (e.g., repeats measurements)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Experiment Report

Name: ______________________________ Date: ______________________________

Experiment: ____

Question:

Prediction/Hypothesis: (Identify a cause and effect relationship.)

Planning for a Fair Test

- **Apparatus/Materials:**

- **Variables to Hold Constant:**

- **Method:** (Include steps to follow and safety considerations.)

(continued)

Experiment Report *(continued)*

Observations:

Analysis of Data: (Identify patterns and discrepancies.)

Note: Attach graph on a separate page, if required.

(continued)

Experiment Report *(continued)*

Strengths and Weaknesses of Approach: (State what went well and what needs to be done differently next time.)

Conclusion: (Support or reject prediction/hypothesis; pose new question(s).)

Applications/Implications: (Link to daily life or area of study.)

Experiment Report: Assessment

Experiment Title: ______________________________ Date: ____________________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Making a Prediction/Hypothesis • the prediction/hypothesis clearly identifies a cause and effect relationship			
Planning for a Fair Test • required apparatus/materials are identified • major variables to hold constant are identified • steps to follow are included • safety considerations are addressed			
Conducting a Fair Test/Making and Recording Observations • detailed data are recorded; appropriate units are used • data are recorded in a clear/well-structured/appropriate format			
Interpreting and Evaluating Results • graphs are included (where appropriate) • patterns/trends/discrepancies are identified • strengths and weaknesses of approach are identified			
Drawing a Conclusion • prediction/hypothesis is supported or rejected • new question(s) are identified			
Making Connections • potential applications to or implications for daily life are identified and/or links to area of study are made			
Total Points			
Comments:			

*Note: The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the experiment.

Grade 6 Science

Grade 6

Cluster 1: Diversity of Living Things

Overview

In this cluster, students develop an appreciation of the diversity of living things. Students study a variety of classification systems, and construct and use their own as well as those developed by others. In doing so, they recognize the advantages and disadvantages of classification systems in organizing information. The animal kingdom provides a specific focus with students investigating different types of animals to understand where they fit in the classification of living things. Students compare and contrast the adaptations of closely related vertebrates living in different habitats, and the adaptations of vertebrates living today with those that lived in the past. Students learn about the contributions of individual scientists who have increased our understanding of the diversity of living things.

Prescribed Learning Outcomes

Students will...

6-1-01 Use appropriate vocabulary related to their investigations of the diversity of living things.

Include: classification system, classification key, paleontologist, terms related to names of kingdoms and types of vertebrates and invertebrates.

GLO: C6, D1

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 4, Cluster 1: Habitats and Communities.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Three-Point Approach for Words and Concepts**

Have students work in groups to research one or more of the words related to types of vertebrates and invertebrates. Have students use a vocabulary think sheet, such as the Three-Point Approach (Simons, 1991), to record their research. Ask them to share their findings with the class. Have students update this information throughout the study of this cluster.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

6-1-02 Describe various kinds of classification systems used in everyday life, and identify related advantages and disadvantages.

Examples: organization of phone numbers in a phone book, books in a library, groceries in a supermarket...

GLO: B1, B2, E1, E2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-8e ➲ Describe hobbies and careers related to science and technology. GLO: B4

6-0-8f ➲ Recognize that science is organized into specialized disciplines. GLO: A1, B4

Suggestions for Instruction

➢ **Classification Systems**

Provide students with a variety of examples of classification systems such as mailing addresses, telephone directories, family trees, sports leagues, and the Dewey Decimal system of library classification. Ask the following questions:

- How are these systems organized?
- Why are these systems needed?

Have students list the advantages and disadvantages of each system.

➢ **Classification of Science**

Introduce the concept that science is divided into specialized areas of study through the following learning experiences:

Part A

Have students match up the scientific area with its definition.

Area of Study	Definition
1. geology	a. study of motion and energy
2. astronomy	b. study of living things
3. biology	c. study of the Earth
4. chemistry	d. study of the properties of materials and substances
5. physics	e. study of space

(1. c, 2. e, 3. b, 4. d, 5. a)

Part B

Have students indicate which area of study is associated with each of the following jobs. Ask students to explain their answers.

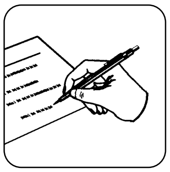
- dry cleaner
- astronaut
- miner
- farmer
- doctor
- mechanic
- chef
- lighting technician
- astronomer

Note: Jobs will fit under several areas of study, depending on what aspect of the job is focused on.

Have students answer the following questions:

1. Was it easy to place the different jobs with one specialized area of study in science? Why or why not?
2. What are the advantages of dividing science into specialized areas of study? What are the disadvantages?

Suggestions for Assessment



Extended Response

Provide students with the following:

Using Classification Systems

Discuss the advantages and disadvantages of the following classification systems:

1. a telephone directory
2. a music classification system

Look for:

1. Telephone directory
   - Advantages: names are organized in alphabetical order; names are generally easy to find
   - Disadvantages: users need to know the correct spelling of last names, as well as addresses (if there are many people with the same name); some numbers are unlisted; not everyone has a telephone or is listed in the directory
2. Music classification system
   - Advantages: music is organized according to different types; names of artists/songs can be easier to find if the type of music is known
   - Disadvantages: some artists/songs may fit in many categories; some music is difficult to classify

Suggested Learning Resources

Pan Canadian Science Place 6: *Variety of Life* (Lesson 4)

Science Everywhere 6 (pp. 31-37)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-03 Develop a system to classify common objects or living things into groups and subgroups, and explain the reasoning used in the system's development.

GLO: A1, C2, E1, E2

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

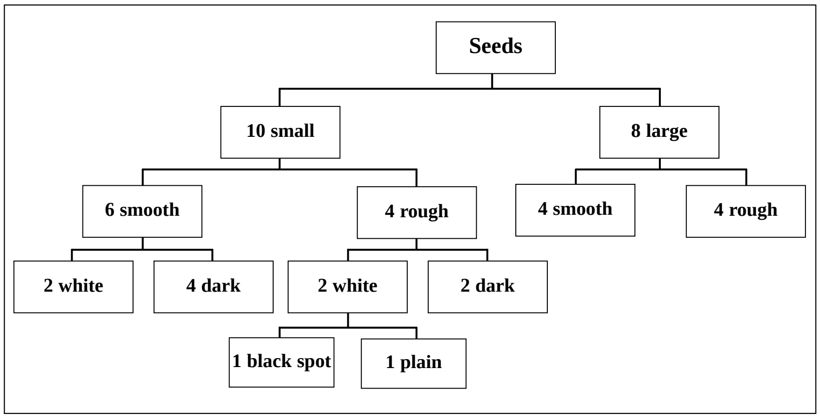
SUGGESTIONS FOR INSTRUCTION

➢ Classification of Objects and Living Things

Provide students with a collection of pictures, words, geometric shapes, and so on, or with a collection of objects such as leaves, paper clips, and seeds. Have students

- classify and sort their collections into main categories and then into sub-categories
- label categories
- present their classification systems to the class and justify the reasoning behind their classification choices

Example:



➢ Classification Mysteries

Have students

- classify a collection of pictures (e.g., of pets) or objects (e.g., seeds, paper clips)
- prepare a set of questions that lead the reader to a particular animal/object on their classification system
- try out their questions with classmates

Example:

I am a small seed. I am rough and white. I have a small spot on my side. Which seed am I?

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Classification Key Development

Provide students with the following self-assessment tool:

Classification Key Development
I classified ______________________________
1. One problem I had was ____________________
2. One thing I did well was ___________________
3. I would like to learn more about ______________
4. I think my classification key _________________ ______________________________

Prescribed Learning Outcomes

Students will...

6-1-04 Identify living things using an existing classification key, and explain the rationale used.

Examples: identification of birds, butterflies, animal tracks, winter twigs...

GLO: A1, C2, D1, E2

6-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

Suggestions for Instruction

➢ **Using a Classification Key**

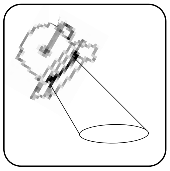
Provide students with a classification key and have them use it to identify a particular living thing. Ask students to explain their reasoning for identifying the organisms as they did.

The emphasis of this learning activity is on experiencing how an identification key works, not on becoming an expert in identifying birds, trees, and so on. A class may have "experts" in their ranks who can share their expertise in particular areas.

Teacher Notes

Local nature centres often have simplified versions of identification keys. Commercial products are also available. A fish classification key and learning outcome-related pictures and blackline masters can be found on the Manitoba Fisheries website at <www.gov.mb.ca/natres/sustain/educate>.

Suggestions for Assessment



Classifying

Provide students with a picture of a living thing to identify, using the classification key provided for the Using a Classification Key learning activity (learning outcome 6-1-04).

Have students

- use the classification key to identify the living thing
- clearly record their decisions and accompanying rationale at each decision point

Once all students have completed their identification, provide the correct identification, including the decisions at each step that led to this identification. Have students compare their decisions and identify where they went wrong (if they did) and comment on the process.

Look for:

- student decisions and rationale are clearly identified
- incorrect decisions are identified
- comments are included

Suggested Learning Resources

Science Everywhere 6 (p. 33)

Prescribed Learning Outcomes

Students will...

6-1-05 Identify advantages and disadvantages of having a common classification system for living things, and recognize that the system changes as new evidence comes to light.

GLO: A1, A2, D1, E2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7h Identify potential applications of investigation results. GLO: C4

6-0-8b ➲ Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

Suggestions for Instruction

➢ **Common Classification System**

Have students look at the classification systems they developed in relation to learning outcome 6-1-03. Have them compare the names and groupings that other students in the class used to classify the same set of objects. Ask students:

1. Are there differences?
2. What would be the advantages or disadvantages of one classification system over the other?

Ask students if they think the classification system for living things has ever changed (it has), and if so, why changes happen (scientists discover new living things or learn more about others).

If appropriate, have students share other ways of grouping/classifying living things that reflect views other than that of western science. An Aboriginal perspective, for example, may look at animals according to what they provide (e.g., food, shelter). Emphasize to students that the focus of this cluster is on the scientific way of classifying living things, and that this system has its own inherent advantages and disadvantages.

➢ **Advantages and Disadvantages**

Divide students into small groups. Have each group discuss and list either the advantages or disadvantages of a common scientific classification system for living things. Match an "advantages" group with a "disadvantages" group and have students share their ideas. Have each group share their findings with the class. Ask students how we can communicate accurately if we have different names for the same thing.

➢ **Classification Chart**

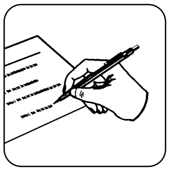
As the class works through the learning experiences suggested for this cluster, students could add appropriate vocabulary to a large classification chart posted on a classroom wall.

As the first step, have students create a heading for the classification chart: Living Things.

Living Things

Note: Students add to the classification chart as part of the learning experiences suggested for learning outcomes 6-1-06, 6-1-09, 6-1-10, and 6-1-12.

Suggestions for Assessment



Extended Response

Provide students with the following:

Scientific Classification System

List the advantages and disadvantages of a common scientific classification system. Be sure to include three advantages and three disadvantages.

Look for:

Advantages:

- uses the same terminology
- makes it easier to find and describe things
- makes it easier to determine characteristics

Disadvantages:

- may not meet everyone's needs
- implies there is only one way to classify things
- not everything may fit
- may lead to stereotyping

Suggested Learning Resources

Pan Canadian Science Place 6: *Variety of Life* (Lesson 6)

Science Everywhere 6 (p. 37)

Native Science: Natural Laws of Interdependence (Teacher Reference)

Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

Prescribed Learning Outcomes

Students will...

6-1-06 Identify the five kingdoms commonly used for the classification of living things, and provide examples of organisms from each to illustrate the diversity of living things.

Include: monerans, protists, fungi, plants, animals.

GLO: A1, D1, E1, E2

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

Suggestions for Instruction

➢ Readers Theatre

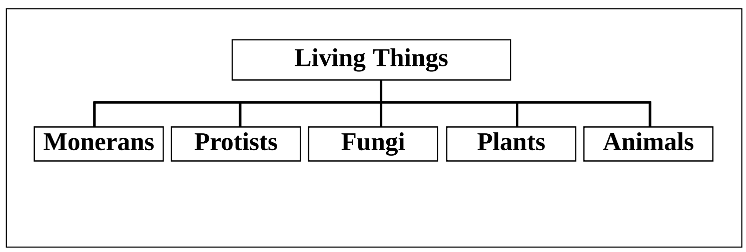
Divide students into five groups. Have each group

- research one of the kingdoms commonly used for classifying living things
- determine the general description of the kingdom and find examples of diverse organisms from that kingdom
- write a section for a Readers Theatre script describing their kingdom
- present the completed Readers Theatre to another class if possible

(Readers Theatre is a form of drama in which students read aloud from scripts with no special costumes, sets, props, or music. See *5-8 ELA*, Strategies, pp. 42-43.)

➢ Classification Chart

Add the terms *monerans, protists, fungi, plants,* and *animals* to the classroom classification chart (refer to learning outcome 6-1-05). Representative pictures can also be added to the chart.



Suggestions for Assessment

Restricted Response

Note: the following question can be used as an Admit Slip or an Exit Slip. Provide students with the following:

Five Kingdoms

Name the five kingdoms commonly used to classify living things. Give an example from each.

Suggested Learning Resources

Pan Canadian Science Place 6: *Variety of Life* (Lessons 8-9)

Science Everywhere 6 (pp. 34-35)

PRESCRIBED LEARNING OUTCOMES
Students will...
6-1-07 Recognize that many living things are difficult to see with the unaided eye, and observe and describe some examples. GLO: C2, D1, E1
6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2 **6-0-5c** Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5 **6-0-5f** ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6) **6-0-9e** ➲ Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment. GLO: B5

SUGGESTIONS FOR INSTRUCTION

➢ **Grass Observation**

Ask students to mark off a small area of the school lawn using string loops and small stakes. Ask students to look for living organisms within this marked area and to draw what they see. Then provide students with hand lenses and have them look at the same area again. Ask students to compare their findings. How did the hand lens aid their observations?

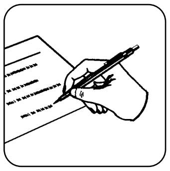
➢ **Observing Pond Organisms**

Provide groups of students with samples of pond water and ask them to describe what they can observe with the unaided eye. Next, have students observe the same sample using a hand lens and record their observations using drawings and descriptions. If a microscope is available, set up a pond water slide for students to view (instructing students not to adjust the magnification without teacher supervision). Ask students to explain how the hand lens aided their observations and what they have learned about the diversity of living things.

➢ **I've Shrunk!**

Have students imagine that they have been reduced to the size of a small insect such as an ant. Have them write and illustrate a story about the organisms they imagine themselves to be as they go through the course of a day. The stories and illustrations could be compiled into a classroom book and shared with other classes.

SUGGESTIONS FOR ASSESSMENT



Restricted Response

Provide students with the following:

How Can Tools Help Us See?

1. Name four different living things that are difficult to see with just your eyes.
2. What instruments might you use to see these living things more clearly?

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 6: *Variety of Life* (Lesson 9)

Science Everywhere 6 (pp. 56-57)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-08 Observe and describe the diversity of living things within the local environment.

Include: fungi, plants, animals.

GLO: A1, C2, D1, E1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

SUGGESTIONS FOR INSTRUCTION

➢ **Field Trip**

Take students into the schoolyard or into a surrounding area. Have them look for examples that represent the different animal kingdoms and record their findings. Back in the classroom, have students share their findings. Highlight the diversity within the samples found.

The Ducks Unlimited Canada website <http://www.ducks.ca> contains background information and student learning activities that highlight the diversity of living things found in wetland.

(For information regarding field trips, refer to *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions,* 1997.)

➢ **Diversity Reflection**

Have students use their science notebooks to reflect on the question: What happens when the diversity of living things is reduced in an area? (Example: With single-crop farming, one disease can wipe out all crops.)

6-1-09 Recognize that the animal kingdom is divided into two groups, vertebrates and invertebrates, and differentiate between the two.

Include: vertebrates have backbones, invertebrates do not.

GLO: D1, E1

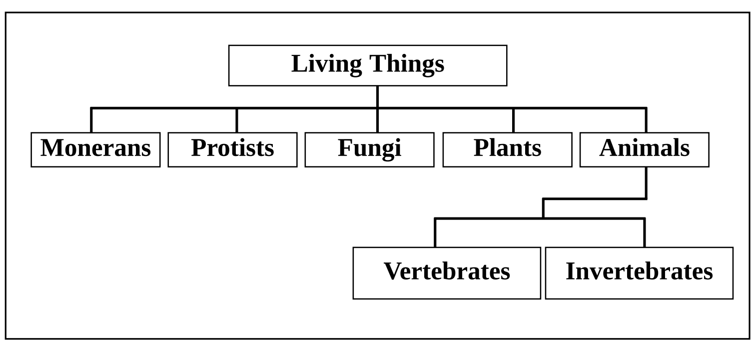
6-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

➢ **Vertebrates or Invertebrates?**

Use guided discussion and/or reading and research to distinguish between vertebrates and invertebrates. Look at some examples of each.

➢ **Classification Chart**

Add the terms *vertebrates* and *invertebrates* to the classroom classification chart (refer to learning outcome 6-1-05). Representative pictures can also be added to the chart.



Suggestions for Assessment

Suggested Learning Resources

Extended Response

Provide students with the following:

Diversity of Living Things

1. What living things would you expect to find in the environment pictured above?
2. Would you expect to find examples from all five kingdoms? Why or why not?

Pan Canadian Science Place 6: *Variety of Life* (Lesson 2)

Science Everywhere 6 (p. 29)

Restricted Response

Provide students with the following:

Animal Kingdom

The animal kingdom is divided into two groups. What are these groups? Give three examples of animals from each group.

Pan Canadian Science Place 6: *Variety of Life* (Lesson 8)

Black Widow Spider and More (Video)

Science Everywhere 6 (pp. 38-44, 50-54)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-10 Provide examples of a variety of invertebrates to illustrate their diversity.

Include: sponges, worms, molluscs, arthropods.

GLO: D1, E1

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

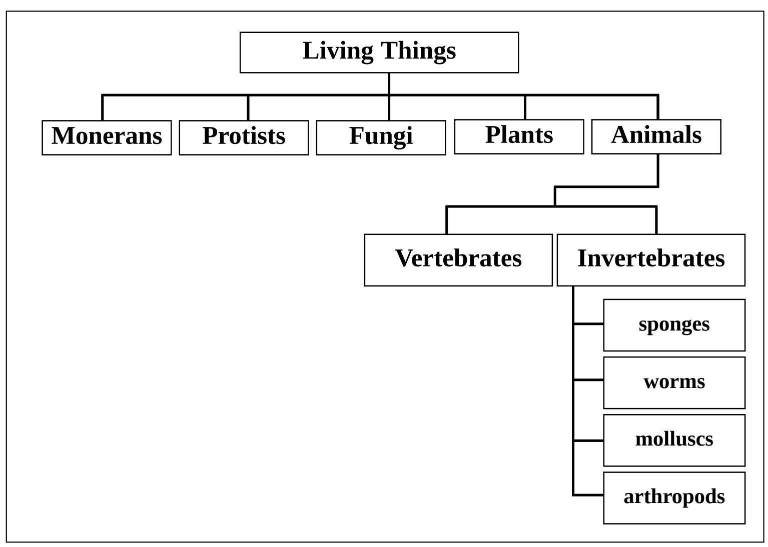
➢ Jigsaw (Cooperative Learning Strategy)

Use a Jigsaw strategy (Aronson et al, 1978) to have students learn about the four groups of invertebrates.

- Divide the class into home groups or teams, each consisting of four members.
- Assign each team member an invertebrate group.
- Students from each team who are assigned the same invertebrate meet together as an expert team to research and create their own definition and description of their invertebrate group. They also include drawings (or cut out pictures) of two or three different examples along with one interesting fact.
- Each expert team member then shares this information with the home team. All members of the home team are responsible for all the information provided by each member of their team, as well as their own information.
- Ensure that students use appropriate note-taking methods to record information in their science notebooks.

➢ Classification Chart

Add the terms *sponges, worms, molluscs,* and *arthropods* to the classroom classification chart (refer to learning outcome 6-1-05). Representative pictures can also be added to the chart.



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 6: *Variety of Life* (Lesson 7)

Black Widow Spider and More (Video)

Science Everywhere 6 (p. 53)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-11 Compare and contrast adaptations of common arthropods, and describe how these adaptations enable them to live in particular habitats.

GLO: D1, D2, E1

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-1d ➲ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ➲ Construct a prototype. GLO: C3

6-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

➢ **Crustacean-Insect Comparison**

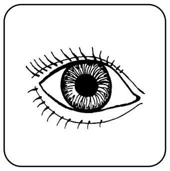
Provide small groups of students with a picture of a crayfish and a housefly (or other common arthropods). Have students use a Venn Diagram to compare and contrast the structural adaptations of the arthropods. Ask students to reflect on how such different organisms can belong to the same group: arthropods. (Students will need to apply what they have learned about the group arthropods to realize that important key characteristics are the same, even though many other characteristics are not.)

➢ **Designed to Survive**

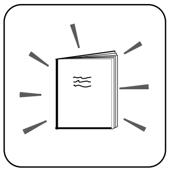
Have students follow the design process to plan and then create their own model arthropod for a given habitat (imaginary or real). The prototype, which could be made from materials such as clay, modelling paste, or papier mâché, must include physical characteristics indicating that it is an arthropod. Ensure that students include information on the food available, space needed, predators, shelter, how the animal moves, and so on. Have students present their prototypes to the class, explaining the adaptations included and how they enable the animal to live in its environment.

(For further student materials related to adaptations, visit *A Prairie Tour: A Grade 5 Interdisciplinary Middle Years Multimedia Unit for Teachers,* online at <http://www.edu.gov.mb.ca/metks4/tech/currtech/imym/prairietour/>.)

Suggestions for Assessment



When assessing the Designed to Survive prototypes, refer to "Constructing a Prototype: Observation Checklist" (BLM 6-D).



Design Process Presentations

Provide students with the following tool for peer assessment of the "Designed to Survive" projects:

Peer Assessment of Presentation

Speaker:____

Peer assessor: ____

Criteria	Yes	No	Comments
The speaker spoke so that everyone could hear.			
The speaker explained how the prototype was constructed.			
The speaker explained how the prototype met the criteria.			
The speaker kept the interest of the group.			

Suggested Learning Resources

Pan Canadian Science Place 6: *Variety of Life* (Lesson 7)

Black Widow Spider and More (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-12 Classify vertebrates as fishes, amphibians, reptiles, birds, and mammals, and provide examples to illustrate the diversity within each group.

GLO: D1, E1

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

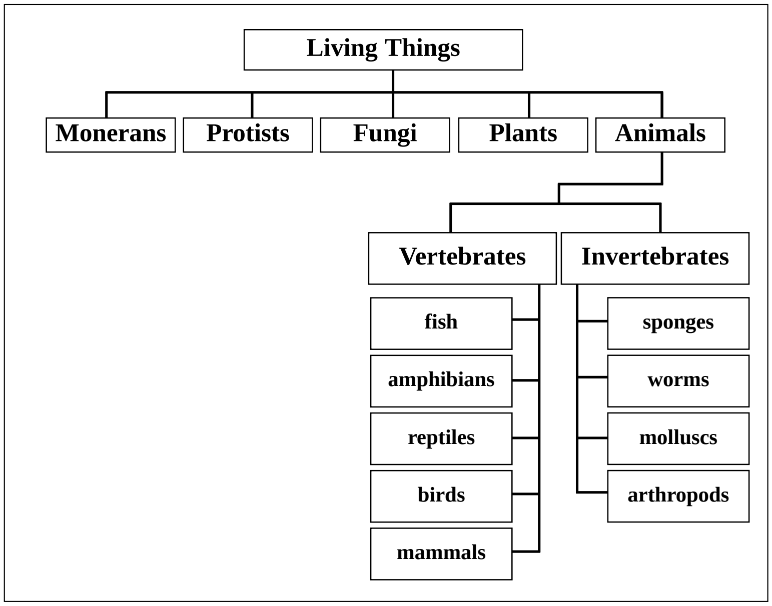
➢ **Vertebrate Brainstorm**

Have students brainstorm characteristics and examples of each vertebrate group. Use a Concept Frame (Matchullis and Mueller, 1994) to record student findings for each group.

(For a BLM of a Concept Frame, see *Success*, p. 6.111.)

➢ **Classification Chart**

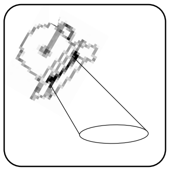
Add the terms *fish*, *amphibians*, *reptiles*, *birds*, and *mammals* to the third level of the classroom classification chart (refer to learning outcome 6-1-05). Representative pictures can also be added to the chart.



➢ **Vertebrate Identification**

Prepare a set of cards that have a picture of an animal on one side and a description of its key characteristics on the other side. Divide the class into five small groups. Give each group the cards for a specific vertebrate group. Ask students to come up with a name for their group of pictures, and to list what they think are the key characteristics of the groups.

SUGGESTIONS FOR ASSESSMENT



Vertebrate Game Show

Have students develop a set of answers and accompanying questions related to the five groups of vertebrates. Have them sort the answers according to level of difficulty.

Example:

Points	Fish	Amphibians	Reptiles	Birds	Mammals
10	The name given to the skin covering of a fish. (scales)	Where all amphibians spend part of their life cycle. (water)	The largest living lizard. (Komodo dragon)	The name given to the feet of an owl or hawk. (claw)	The name given to the skin covering of a mammal. (fur or hair)
25					

Have students choose roles (e.g., contestant and quizmaster) and conduct a game show using the answers and accompanying questions they developed.

Example:

Contestant: I'd like "Fish" for 10 points.

Quizmaster: The name given to the skin covering of a fish.

Contestant: What are scales?

etc.

SUGGESTED LEARNING RESOURCES

Pan Canadian Science Place 6: *Variety of Life* (Lesson 8)

Science Everywhere 6 (pp. 41-42)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	
6-1-13 Compare and contrast the adaptations of closely related vertebrates living in different habitats, and suggest reasons that explain these adaptations. GLO: D1, D2, E1 **6-0-2a** ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1) **6-0-2b** ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3) **6-0-2c** Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2) **6-0-7g** ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)	➢ **Comparison Research** Have students select two closely related vertebrates (e.g., polar bear/black bear, arctic fox/red fox, ptarmigan/prairie chicken, sturgeon/pike) living in different habitats. Ask them to • research the selected vertebrates to compare and contrast their adaptations and suggest reasons for the differences (habitat related) • use a Venn diagram to represent their findings • share their findings with the class
6-1-14 Identify, based on evidence gathered by paleontologists, similarities and differences in animals living today and those that lived in the past. *Examples: archaeopteryx and modern birds...* GLO: A1, A2, E1, E3 **6-0-2a** ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1) **6-0-2b** ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3) **6-0-2c** Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2) **6-0-7g** ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)	➢ **Past-Present Comparison** Have students research examples of how certain modern animals have changed, as suggested by their fossil records (e.g., woolly mammoth/elephant, Eohippus/horse). Ask students to note the similarities and differences and indicate what evidence scientists use to support their work. Have them use drama, music, or multimedia resources to present their findings. ➢ **Stories of the Past** Have students use print or electronic resources, or invite a guest speaker, to identify and share Aboriginal stories about the relatives of today's animals that lived long ago (e.g., the giant beaver).

Suggestions for Assessment

Extended Response

Provide students with the following:

Comparing Bears

Polar Bear **Grizzly Bear**

1. Compare and contrast the polar bear and the grizzly bear. Be sure to discuss their habitats and their adaptations.
2. Look at the differences related to adaptations. Why might these differences have occurred?

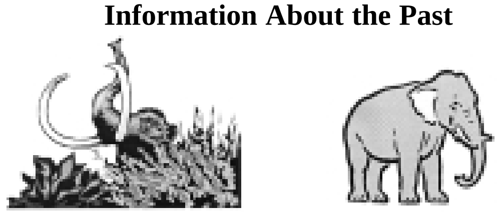
Suggested Learning Resources

Science Everywhere 6 (p. 46)

Extended Response

Provide students with the following:

Information About the Past



1. How are the wooly mammoth and the elephant alike? How are they different?
2. Explain how we are able to make these comparisons.

Look for:

1. Any reasonable response such as
   - both have tusks
   - the mammoth has much longer tusks than the elephant
   - both have trunks
   - both have large ears
2. The evidence gathered by paleontologists allows us to make these comparisons

Pan Canadian Science Place 6: *Variety of Life* (Lesson 15)

Science Everywhere 6 (p. 36)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-1-15 Identify and describe contributions of scientists and naturalists who have increased our understanding of the diversity of living things.

GLO: A2, A4, B4, D1

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-8e ➲ Describe hobbies and careers related to science and technology. GLO: B4

6-0-9a ➲ Appreciate that women and men of diverse cultural backgrounds can contribute equally to science. GLO: A4

6-0-9b ➲ Show interest in the activities of individuals working in scientific and technological fields. GLO: B4

SUGGESTIONS FOR INSTRUCTION

➢ **Research**

Post a list of scientists such as Louis Pasteur, Jonas Salk, David Suzuki, Charles Darwin, Dian Fossey, Jane Goodall, Grey Owl, John James Audobon, Thomas Seton, Jacques Cousteau, Mary Victorian, Georges Cuvier, and Dr. Baldur Stefansson (University of Manitoba). Ensure that the list includes scientists from both genders and from diverse cultural backgrounds, and highlights Canadians, when possible.

Have students select a naturalist or scientist and research his or her contributions, using a W-5 Chart (Who? What? Where? When? Why?) to record information gathered through their research. Instruct students to include: birth date, nationality, contribution, and date of contribution. Have students share the information with the class through role-played interviews, news conferences, obituary notices, curricula vitae, or newspaper articles.

(For a BLM of a W-5 Chart, see *5-8 ELA*, BLM-67.)

Suggestions for Assessment

Cluster Reflection

Have students reflect on their learning related to the diversity of living things using the following sentence stems:

Reflection

1. I learned . . .
2. I was surprised . . .
3. I still wonder . . .

Suggested Learning Resources

Pan Canadian Science Place 6: *Variety of Life* (Lessons 9, 12)

Science Everywhere 6 (p. 60)

World of Scientific Discovery (Teacher Reference)

Notes

Grade 6

Cluster 2: Flight

Overview

In this cluster, a study of the properties of fluids helps students to understand how flight can be achieved. Through the testing of models, students explore how the forces of thrust, drag, lift, and gravity act on living things or devices that fly through the air. They learn how specific adaptations or modifications can alter lift or drag. Different means of propulsion are compared and the use of unbalanced forces to steer aircraft and spacecraft are described. Students apply their understanding of forces and flight through the construction of a prototype that flies and meets specific performance criteria. Students also examine the history of the development of air travel and identify its impact on the way people work and live.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-01 Use appropriate vocabulary related to their investigations of flight.

Include: fluid, pressure, lift, gravity, thrust, drag, Bernoulli's principle, propulsion, unbalanced forces.

GLO: C6, D4

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 5, Cluster 3: Forces and Simple Machines; in Grade 5, Cluster 4: Weather; in Grade 3, Cluster 3: Forces That Attract or Repel; and in Grade 2, Cluster 2: Properties of Solids, Liquids, and Gases.

- Introduce, explain, use, and reinforce vocabulary throughout this cluster.

- **Sort and Predict**

  Give students a set of terms related to this cluster. Have them work in groups to predict the meaning of the words and sort them into categories. Have groups share their categories with the class. As a class, identify words for which students need more information to be able to categorize with clarity. Post these words and clarify them as the study of flight progresses.

  (For a BLM of a Sort and Predict think sheet, see *SYSTH*, Attachment 10.3, or *Success*, p. 6.100.)

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-02 Describe properties of fluids using air and water as examples, and identify manifestations of these properties in daily life.

Include: air and water flow and exert pressure; objects can flow through air and water; warm air and water rise.

GLO: B1, D3, E1

6-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7h Identify potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Accessing Prior Knowledge

As a class, brainstorm a list of "facts" about air. Record these "facts" on a class chart under the headings "What We Know" and "What We Think We Know" (for anything of which students may be unsure). Add to the chart as the study of flight progresses.

➢ Investigating Air Pressure

Provide students with a plastic pop bottle with several holes punched into the bottom. Ask students to lower the open bottle into a container of water and leave it there for one minute. Have them lift the bottle out of the water, noting what happens to the water in the bottle.

Ask students to predict what would happen if

- they covered the top of the bottle with their thumb before submerging it (only a small amount of water would enter the bottle)
- they left the bottle open in the water but covered the top of the bottle before taking it out of the water (water would not stream out of the bottle)

Have students investigate to determine whether their predictions are correct. Ask students whether they can explain the results.

➢ Fluid Dynamics

Ask students to describe what happens in a quickly moving stream when the water comes in contact with a large boulder. (The water flows around the boulder.) Students should recognize that the ability to flow around objects is a characteristic of water (fluids). Have students observe air (also a fluid) dynamics by conducting the following class demonstration.

Light a candle and place it about 5 cm behind a pop bottle. Have students try to blow out the candle with the pop bottle between them and the candle. Gradually move the candle further back from the bottle. Have students continue to try to blow out the candle. Have students discuss their observations and draw a diagram of what they think is taking place. (Air is flowing around the bottle.) Ask the following questions:

1. At what distance was it easiest to blow out the candle?
2. What effect would changing the size of the bottle have on the optimal distance for blowing out the candle? Explain.
3. How is air like water? (They both flow around objects.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Background Information

Fluids are gases and liquids that flow. Flowing air is called an *air stream*. Properties of air are as follows:

- expands in warm temperatures
- contracts in cold temperatures
- rises when warmed
- moves (flows), creating wind and weather
- takes up space
- is made up of particles we cannot see
- can exert pressure (enough pressure to support a heavy airplane)
- has mass, weight, and volume
- is made up of different gases
- is lighter than water

PRESCRIBED LEARNING OUTCOMES
Students will...
6-2-02 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Air and Water in Daily Life**

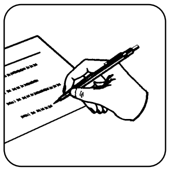
Use explicit instruction to introduce to students the concept that both liquids and solids are called *fluids* because of their ability to flow.

Have students provide examples of how fluids (e.g., air and water) demonstrate the following characteristics in daily life:

- they flow (e.g., orange juice flows out of a pitcher; air flows out of a balloon)
- they exert pressure (e.g., deep-sea divers experience the effects of water pressure when they dive deep into the ocean; a balloon-powered car moves when the balloon is opened up)
- they rise when warm (e.g., it is hotter near the ceiling than on the floor in the winter; water in a lake is colder down deep than it is near the surface)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Extended Response

Provide students with the following:

Properties of Fluids

What did you learn about the properties of fluids from the investigations and demonstrations? Refer to both *air* and *water* in your answer.

Look for:

- reference to *air* and *water*
- an indication that both air and water exert pressure
- an indication that both warm air and warm water rise
- an indication that objects can flow through both air and water

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-03 Identify adaptations that enable living things to propel themselves through air, water, or to be transported by the wind.

Examples: the streamlined shape of dolphins and barn swallows, the helicopter-like motion of the winged fruit of maple trees, the parachute-shaped fruit of dandelions...

GLO: D1, D4, E1

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Movement through Fluids**

Provide small groups of students with models or pictures (e.g., of animals) that illustrate movement through fluids. Include examples of adaptions for movements such as diving, gliding, spinning, hovering, and parachuting. Ask students to look at the models/pictures and decide what features or ways of moving can be grouped together. Subcategories should be agreed upon by group consensus. Once each group has sorted the features and recorded information, have students present their ideas to the class.

Have groups use a KWL Plus Map to categorize and sort the models/pictures and to record the characteristics of movement through fluids.

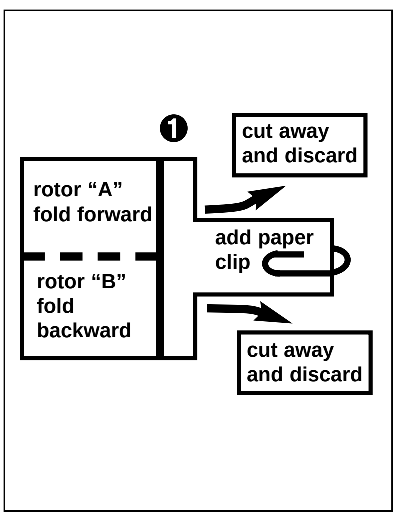
(For a BLM of a KWL Plus Map, see *5-8 ELA*, BLM-66.)

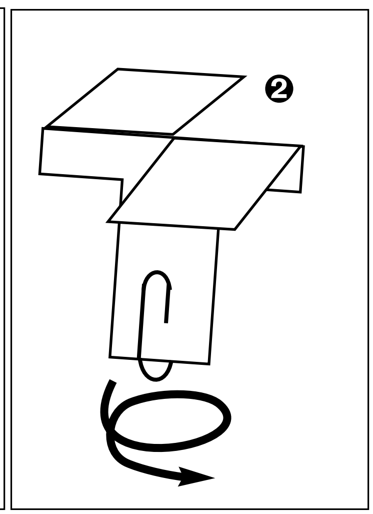
➢ **Maple Seed Travel**

Have students

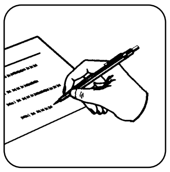
- look at maple tree seeds to determine how their design enables them to travel (flow through air)
- construct a spinner to represent a maple seed
- determine the effects of dropping the spinner from various heights
- attach a paper clip to the bottom of the rotor shaft to add weight for some stability during flight

Example:





SUGGESTIONS FOR ASSESSMENT

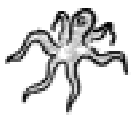


Extended Response

Provide students with the following:

Adaptations for Movement through Fluids

Look at the following pictures. Explain how each is adapted to propel itself through air or water, or to be transported by the wind. Be specific.



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octopus

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dolphin

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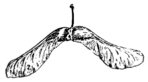
eagle



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tree seed

SUGGESTED LEARNING RESOURCES

Discover Flight (p. 65)

Prescribed Learning Outcomes

Students will...

6-2-04 Recognize that in order for devices or living things to fly they must have sufficient lift to overcome the downward force of gravity, and that the force of gravity increases as mass increases.

GLO: D4

6-0-1b Identify various methods for finding the answer to a specific question and select one to implement. *Examples: generating experimental data; accessing information from a variety of sources…* GLO: C2 (ELA Grade 6, 3.2.2; Math: SP-I.2.6, SP-II.1.6)

6-0-4a Carry out procedures that comprise a fair test. Include: controlling variables; repeating measurements to increase accuracy and reliability. GLO: C2

6-0-7b Base conclusions on evidence rather than pre-conceived ideas or hunches. GLO: C2, C4

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

Suggestions for Instruction

➢ **Demonstration: The Force of Gravity**

Bring to class two identical resealable plastic containers. Fill one with a light stuffing such as popcorn or cotton balls, and the other with a heavier stuffing such as marbles or small lead weights (the heavier the better). Challenge the class to come up with as many strategies as possible to prove that one container has more mass, and therefore has a greater force of gravity pulling on it. Possible strategies include: using a balance, using a spring scale, or dropping both containers from the same height into sand and measuring the depth of the crater formed.

> **Teacher Notes**
>
> This demonstration is linked to learning outcome 6-4-11 (from Cluster 4: Space) and can be used to reinforce or introduce the differentiation between mass and weight. Refer to Cluster 4 for background information on this concept.

➢ **Overcoming Gravity**

Use explicit instruction to introduce students to the concept of *lift* (the upward force used to overcome gravity and to achieve flight). Have students brainstorm ways in which different objects or living things achieve lift (or get off the ground).

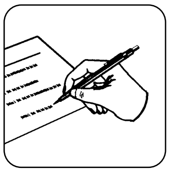
➢ **Investigating Lift**

Use air speed to demonstrate one way in which lift overcomes gravity to move an object upward. Provide students with a strip of paper (20 cm x 3 cm) and have them

- hold the strip at one end so that the other end hangs down
- predict what will happen when they blow across the top of the strip
- bring the held end close to their lips and gently blow straight ahead (this increases the speed of the air on top of the paper to create lift, and causes the paper to rise until it is parallel to the floor)
- describe the direction the other end of the paper moved and explain why
- investigate the effect that increasing the thickness or width of the paper will have on this investigation

> **Teacher Notes**
>
> The phenomenon demonstrated by this learning activity is part of Bernoulli's principle (see learning outcome 6-2-06).

Suggestions for Assessment



Restricted Response

Provide students with the following:

Lift and Gravity

Complete the following statements:

1. All objects within the Earth's atmosphere are pulled downward by _________.
2. The upward force that enables an object to fly is called __________.
3. In order to fly, objects must overcome __________ and attain __________.
4. The greater the mass of the object, the __________ the attraction of gravity.
5. The greater the mass of the object, the _________ the force of lift required.

Look for:

1. gravity
2. lift
3. gravity, lift
4. greater
5. greater

Suggested Learning Resources

Science Everywhere 6 (p. 228)

Discover Flight (p. 19)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-05 Describe how “lighter-than-air flying devices” are able to achieve lift.

Include: hot-air balloons, helium balloons.

GLO: D4

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ➲ Construct a prototype. GLO: C3

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

6-0-7e ➲ Identify new practical problems to solve. GLO: C3

6-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ Activating Prior Knowledge

To demonstrate that warm air rises, have students

- make a “spiral snake” by cutting a circle of paper into smaller and smaller continuous circles, creating a spiral
- attach a string to the head of the spiral
- hold the spiral over a light bulb or other heat source
- use what they know about air to explain what happens (Air around the light bulb is heated and then rises, creating drafts that cause the spiral snake to spin.)

➢ Making Hot-Air Balloons

Have students construct hot-air balloons using a large, lightweight plastic bag, a small plastic container or bag, tape, a hole punch, string, and a source of hot air such as a blow dryer. Have students follow these directions:

- Take one of the lightweight plastic bags, stand on a chair, hold the bag above your head and let it go. What happens to the bag? (It falls to the floor.)
- Have another student fill the lightweight plastic bag with hot air from a blow dryer. Then repeat step 1, using the bag filled with hot air. Observe what happens. (The bag rises.)
- Punch four evenly spaced holes close to the opening of the bag. Attach a piece of string to each hole. The strings should be the same length.
- Attach a small plastic container or bag to the four strings to act as a basket for the hot-air balloon.
- Fill the balloon with hot air. Observe what happens.
- Place small objects into the basket and observe what happens.
- In your science notebook, explain how the hot air balloon was able to achieve lift.

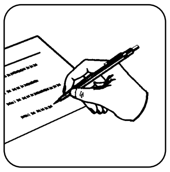
➢ Helium Balloons: Design Challenge

Have students plan, construct, and test a helium balloon prototype that meets identified criteria (developed by the teacher with the class). Sample criteria include:

- carries a specified passenger (an object of a particular mass)
- travels the width of the room using a propulsion method that doesn’t directly touch the balloon (e.g., blowing on the prototype, fanning it)

Refer to page 15 of this document for a description of the design process.

Suggestions for Assessment



Extended Response

Provide students with the following:

Balloons and Flight

In your science notebook, explain how hot-air balloons and helium balloons are able to achieve lift.

Look for:

- Hot-air balloons: The heated air in the balloon causes the balloon to become less dense (lighter) than the air around it. As a result, the balloon rises.
- Helium balloons: The helium gas in the balloon is less dense (lighter) than the air around the balloon. This causes the balloon to rise.

Teacher Notes

"Lighter-than-air flying devices" achieve lift through the use of a balloon containing a gas that is "lighter" or less dense that the air around it. This results in an upward buoyant force that is greater than the downward force of gravity. In a hot-air balloon, heating of the air inside the balloon causes it to be less dense than the air around it (warm air rises). Helium balloons are able to achieve lift because helium is less dense or "lighter" than air.

The learning activities suggested for learning outcome 6-2-05 allow students to explore the relationship between mass and lift, which applies to learning outcome 6-2-15.

Suggested Learning Resources

Science Everywhere 6 (p. 218)

Discover Flight (p. 82)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-06 Test models of aircraft to observe Bernoulli's principle.

Include: the shape of a wing affects the speed of airflow, creating lift in a "heavier-than-air flying device."

GLO: C2, C3, D3, D4

6-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Introducing Bernoulli: Part 1**

Place a ping-pong ball in a freshly washed funnel. Have students

- predict what will happen to the ping-pong ball if they blow into the bottom of the funnel (The ball will remain in the funnel.)
- blow into the bottom of the funnel and observe what happens (Blowing into the funnel speeds up the air directly under the ball and lowers the air pressure; therefore, the greater air pressure above the ping pong ball keeps it in the funnel. The harder the student blows, the more firmly the ball stays in the funnel.)
- discuss the results and develop an explanation using the terms *air speed* and *air pressure*
- think of a way to get the ping-pong ball out of the funnel, using their knowledge of air pressure (Blow over the top of the funnel. This will create an increase in air speed over the top of the ball and thus decrease the air pressure in that area, resulting in the ball being pushed out of the funnel by the higher air pressure coming from underneath.)

➢ **Introducing Bernoulli: Part 2**

As a class demonstration, hang two small empty plastic pop bottles (or two paper strips, or two ping-pong balls) about 5 cm apart. (String can be attached to the cap of the bottle with a glue gun or by making a small hole in the cap, threading it through, and tying it in the inside of the cap.) Have students

- predict what will happen if you blow hard between the two bottles
- test whether their predictions are correct (The bottles will come together. Blowing between the bottles lowers the air pressure between them. The pressure on the outside of the bottles is greater and forces the bottles to move together.)
- explain their results, including a diagram, in their science notebooks

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

Daniel Bernoulli, a Swiss scientist born in 1700, discovered that fast-moving air exerts less pressure than slow-moving air. This principle—Bernoulli's principle—is important in understanding flight.

Bird wings, for example, are relatively flat on the bottom and convex on the top. When a bird is moving forward, the air flowing over the wing has farther to go in a given amount of time than the air beneath the wing (the shortest distance between two points is a straight line). As a result, the air pressure is greater below the wing (slower-moving air) than it is above the wing (faster-moving air), and the bird is pushed up. This same principle allows airplanes and gliders to fly. The shape of airplane wings (called a cambered airfoil) is designed to make air flow faster over the top than under the bottom of the wing. The faster-moving air above the wing produces an area of low pressure; thus, the greater pressure below the wing exerts an upward force (lift) on the wing.

Suggested Learning Resources

Science Everywhere 6 (p. 240)

Discover Flight (p. 104)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION

Students will...

6-2-06 *(continued)*

(continued)

(continued)

➢ **Testing Airfoils**

Have students make and experiment with an airfoil using the following directions:

1. Take a 15 cm x 5 cm strip of paper and fold it in half widthwise.
2. Tape the top edge of the paper so that it is 1 cm shorter than the bottom edge, curving the top half of the paper like the top of a wing (see Fig. 1).

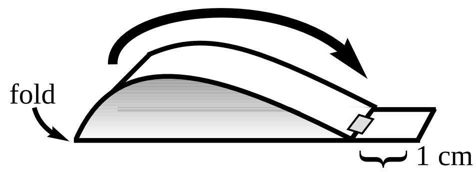


Fig. 1

3. Slide the “wing” over a pencil so that the curved side is facing up and the folded seam is facing you (see Fig. 2).

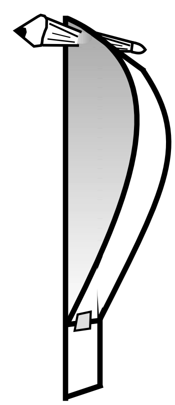


Fig. 2

4. Hold the wing in front of you (see Fig. 2) and blow straight at the folded seam and observe what happens (see Fig. 3). (The wing will lift up from its hanging, at-rest position.)

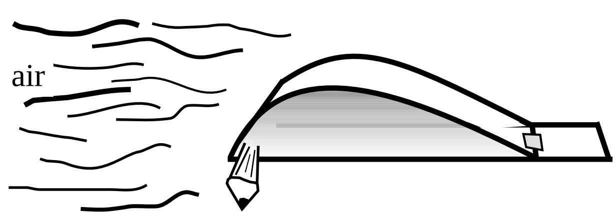


Fig. 3

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES
Students will...
6-2-06 *(continued)*

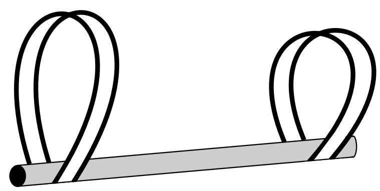
SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Making a Straw Flyer**

Have students use paper and a straw to construct a straw flyer, following these directions:

1. Cut two paper strips. One strip should be 2 cm x 24 cm and the other 1.5 cm x 18 cm.
2. Tape the ends of each strip together to form two loops or circular "wings" of different sizes.
3. Tape the straw ends to the inside of each loop to create a flier.



4. Launch the flier by throwing it into the air (the way you would throw a paper airplane). What happens when you throw it? Why does it fly? (Air moves faster above each circular wing than it does below the wing, thus creating lift.)
5. Experiment with different throwing methods, different sizes of circular wings, and different positions for the circular wings.

Suggestions for Assessment

Extended Response

Have students complete the following in their science notebooks:

Bernoulli's Principle

Think about the investigations, demonstrations, and experiments completed in this section. Based on your observations, explain Bernoulli's principle.

Look for:

- fast-moving air exerts less pressure than slow-moving air
- this principle can be applied in the design of objects/devices to create lift

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

6-2-07 Explain how Bernoulli's principle is applied in a device other than an aircraft.

Examples: paint sprayer, perfume mister...

GLO: A5, B1, D4

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7h Identify potential applications of investigation results. GLO: C4

Suggestions for Instruction

➢ Bernoulli's Principle in Action

Have students brainstorm a list of devices they have used or situations they have observed in everyday life where Bernoulli's principle applies.

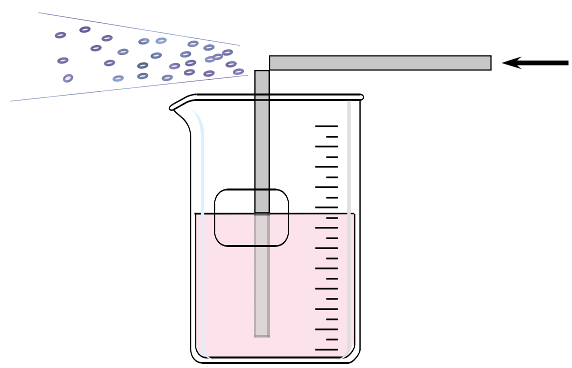
Examples:

- the flight of a concave plastic disc
- a shower curtain sticking to you when the water is turned on
- the flight of a kite
- the spin on a baseball or tennis ball
- the spray from an aerosol can
- hair sometimes blowing forward when a person is driving a car with the window open

➢ Creating a Simple Sprayer

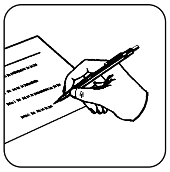
Have students investigate how a paint sprayer works by constructing a simple sprayer, following these directions:

1. Place a straw into a glass of water, holding it upright and keeping the bottom of the straw just off the bottom of the glass.
2. Blow a short, hard blast of air through a second straw, holding it so that it is perpendicular to the first straw and their ends are touching. Observe what happens. (A mist of water sprays out from the first straw.)



3. In your science notebook, explain how the sprayer works, using diagrams and a written explanation. (The normal air pressure pushing down on the water is decreased by the speed of the air flowing out of the horizontal straw. This decrease in normal air pressure forces some water up the tube and it gets blown out.)

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Bernoulli's Principle in Action

Give two examples of devices or situations in which you have observed Bernoulli's principle in action. Explain how the principle works in each case.

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 240)

Discover Flight (p. 101)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-08 Provide examples of design features or adaptations that enhance or reduce lift, and explain how they work.

Examples: race car spoilers reduce lift; bird wing shapes enhance lift...

GLO: A5, B1, D1, D4

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7h Identify potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ **Wind Tunnel Investigation**

Have students use a simple wind tunnel to test various wing and airplane designs and observe the features that reduce or enhance lift. A small electric fan with varying speeds and a cage for safety would be suitable as a source of air flow.

Have students test wing shapes by following these directions:

- Create three "wings" by folding paper (or use the airfoil from the Testing Airfoils learning activity in conjunction with learning outcome 6-2-07) to create airfoils with different cambers.
- Attach a thread to the top of each camber to act as an indicator.
- Hold each airfoil camber in front of a blowing fan and observe what happens to the string. Which design has more lift? Which design has more lift in slower airstream? in faster airstream?
- Use the information gathered in this investigation to determine how the shape of a bird's wing enables it to enhance or reduce lift.

➢ **Why Doesn't It Fly?**

Show students a model or picture of a racing car with spoilers. Have students brainstorm the reasons why, despite travelling at an enormous speed, the racing car will remain on the ground. (The spoilers divert the airflow, preventing the lowering of air pressure that would lift the rear end of the car.)

➢ **Investigating the Flight of Birds**

Have students work in small groups to match the wing shape of birds with the correct description of the type of flight (see "Wing Shapes," BLM 6-A).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Discover Flight (p. 25)

Prescribed Learning Outcomes

Students will...

6-2-09 Provide examples of design features or adaptations that enhance or reduce drag, and explain how they work.

Examples: pilots use flaps to increase drag when landing aircraft; birds tuck their wings to decrease drag when diving...

GLO: A5, B1, D1, D4

6-0-4c ⊂ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ⊂ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ⊂ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7h Identify potential applications of investigation results. GLO: C4

(continued)

Suggestions for Instruction

➢ **Investigating Drag**

Have students experience the effects of drag on various shapes and sizes of surface area by completing the following:

- Hold a large piece of cardboard outdoors on a windy day so that
  - — the wind blows against the flat side
  - — the edge is facing the wind
- Fold or cut the cardboard into different shapes.
- Experiment with shapes that are similar to airplanes and that provide the least resistance to the air flow (wind).
- Record findings in an appropriate format.

Have students answer the following questions, based on their investigations:

1. What shapes allow air to flow more efficiently? (streamlined shapes)
2. What is the relationship between the size of the surface area and the amount of drag that can be felt? (A larger surface area results in greater drag.)

➢ **Demonstrating Drag**

Have students observe drag caused by air turbulence through the following teacher demonstration (see Fig. 1):

- Hold a 5 cm square of cardboard about 5 cm in front of a burning candle.
- Blow in the direction of the flame from about 10 cm in front of the cardboard.
- Observe the movement of the flame.

Continue the demonstration by using pieces of cardboard of different sizes, various curved shapes (such as a bottle, an apple, toy cars or airplanes, a round ball, a football, or a box), and objects with different surface types (rough versus smooth, jagged versus rounded). (See Fig. 2.)

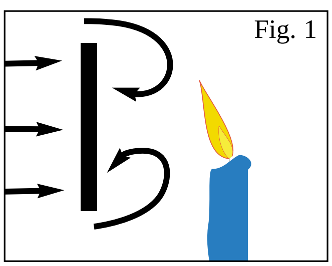


Fig. 1

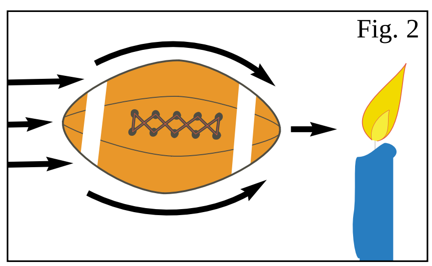


Fig. 2

(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Background Information

Drag can be increased or decreased by

- changing surface area
- changing shape
- changing surface type (smooth versus rough)

Drag is not always detrimental. It can be useful (e.g., for parachuting, airplane landings) but its effect must be reduced for efficient flight.

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 249)

Discover Flight (p. 105)

Prescribed Learning Outcomes	Suggestions for Instruction
Students will...	
6-2-09 *(continued)*	

(continued)

Have students diagram which shapes cause turbulence (drag) and which shapes are aerodynamic (i.e., the shapes that allow fluids to move freely past). Students should draw conclusions regarding the role that reducing or increasing drag plays in transportation (e.g., boats, planes), in safety (e.g., landings, slowing down), and in the flight of birds.

➢ Improving the Airfoil

Have students use print or multimedia resources to explore the role of flaps and slats in airplane wings to answer the following questions:

1. How do flaps and slats affect lift? (Flaps and slats help adjust the curvature of the wings to increase drag and reduce speed.)
2. When would a pilot use a flap or a slat? (A flap or a slat would be used in landing a plane.)

➢ Investigating Kites

Have students experiment with various kite designs to determine how differences in design affect performance. Kites can be purchased in kits, made from patterns in books or on the Internet, or designed by students. Have students investigate (in small groups or as a class) to answer the following questions:

1. Which design
   - was easiest to launch?
   - flew best in very windy conditions?
   - flew best in light wind conditions?
2. What can be done to produce lift when the kite drops?

Teacher Notes

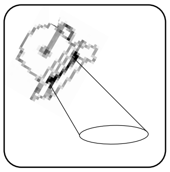
Kites may be used as part of a design process project in relation to learning outcome 6-2-15.

➢ Looking at Sports Equipment

Have students work in small groups to brainstorm a list of sports where drag is a factor, and to list the equipment associated with these sports (e.g., bicycle racing helmets, racing canoes, shuttlecocks). Have students identify the design adaptations of the equipment and determine whether the design enhances or reduces drag.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Demonstrating Drag

Provide students with a pre-made paper airplane. Instruct students to use the paper airplane to answer the following questions. **Note:** Let students know they may make modifications to the design of the paper airplane if necessary.

1. How can drag can be increased?
2. How can drag can be decreased?

Scoring Rubric	
Score	**Criteria**
3	The student understands the meaning of the term *drag*, and successfully demonstrates how drag can be both increased and decreased by changing surface area and/or shape.
2	The student understands the meaning of the term *drag*, and demonstrates either how drag can be increased or how it can be decreased by changing surface area and/or shape.
1	The student understands the meaning of the term *drag*, but does not demonstrate how drag can be increased or decreased.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-10 Identify and diagram the four forces that act on living things or devices that fly through the air.

Include: lift, gravity, thrust, drag.

GLO: C6, D4

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Four Forces**

Have students summarize and reflect on what they have learned about *lift, gravity, thrust,* and *drag* by completing a vocabulary think sheet such as the Three-Point Approach for Words and Concepts (Simons, 1991), including definitions, diagrams, and examples.

(For a BLM of a Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

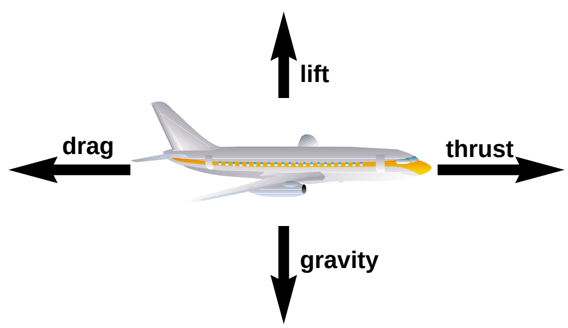
➢ **Diagramming Forces**

Ask students to collect pictures of living things or devices that fly. Have students work in pairs to select a picture and draw a diagram showing the four forces that act on the selected living thing or device. Have them present their diagrams to the class and explain how the forces work to enable the living thing or device to fly.

Teacher Notes

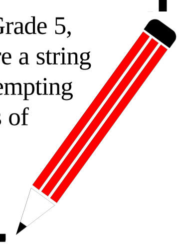
Background Information

Forces act in pairs. For flight, lift and gravity exert force in opposite directions, as do thrust and drag.

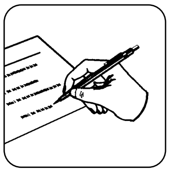


Planning Note

Students were introduced to the concept of force diagrams in Grade 5, Cluster 3: Forces and Simple Machines. Students should picture a string attached to the object pulling in a particular direction when attempting to illustrate forces acting on an object using force arrows. Pairs of forces are usually drawn, and their relative lengths indicate the strengths of the forces.



Suggestions for Assessment



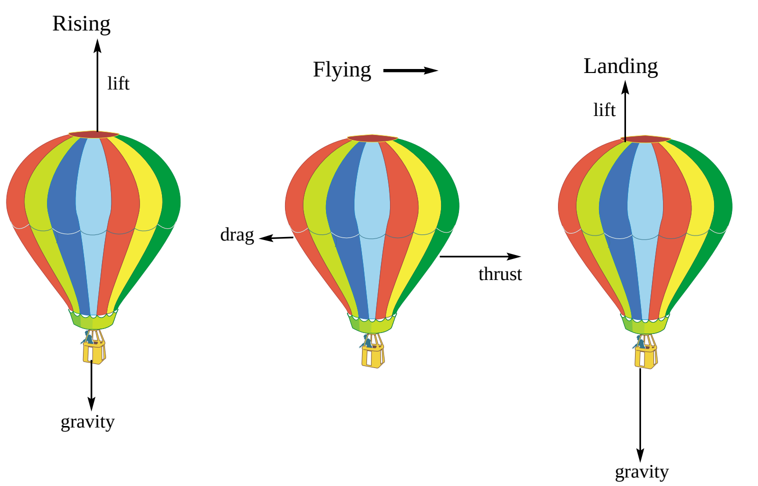
Restricted Response

Provide students with the following:

Forces and Lift

In your science notebook, list the forces acting on a hot-air balloon as it rises, flies, and lands. Draw and label a diagram to illustrate each of the three processes and the relative strengths of the forces as the balloon rises, flies, and lands.

Look for:



Suggested Learning Resources

Science Everywhere 6 (pp. 228, 249)

Discover Flight (p. 89)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-11 Compare a variety of propulsion methods that are used to produce thrust in animals and flying devices.

Examples: rockets for spacecraft, propellers, or jet engines for aircraft, wings for flying animals...

GLO: B1, D1, D4, E4

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7h Identify potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Rocket /Jet Engine Thrust**

To explore how thrust is produced, have students construct a model rocket/jet engine, following these steps:

- Inflate a long balloon and close the opening with a clothespin.
- Tape a straw to the side of the balloon.
- Thread a long string or fishing line through the straw.
- Tie the string to fixed objects on opposite sides of the room to create a taut “clothesline” across the room.
- Bring the balloon to one end of the string and release the clothespin.
- Observe and describe what happens.

Have students explain how the balloon is able to move and identify where this principle is used (e.g., in airplanes).

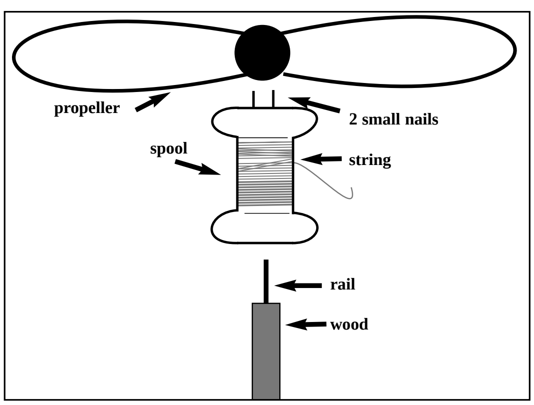
➢ **Whirlybird Flier**

Have students experiment with the upward thrust created by spinning rotor blades, following these directions:

- Make rotors by taping cardboard “wings” to a straw.
- Firmly tape the rotor blade to another straw that will act as a rotor shaft.
- Put the rotor shaft between your hands with your palms facing each other.
- Slide your palms in opposite directions to spin the shaft and release the flier.
- Observe what happens.
- Draw a diagram to explain the forces involved.

➢ **Investigating Propellers**

Have students assemble a propeller launcher (see diagram) to experiment with different sizes and designs of propellers.



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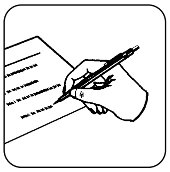
SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Propulsion

In your science notebook, give examples of three different methods of propulsion used to produce thrust in animals and flying devices. Explain how each method of propulsion works.

Look for:

- examples in living things, such as wings, birds running
- examples in flying devices, such as rockets, propellers, jet engines
- clear explanation for each example

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 246)

Discover Flight (p. 83)

Prescribed Learning Outcomes	**Suggestions for Instruction**

Students will...

6-2-11 *(continued)*

(continued)

- Purchase different propellers or make them from recycled thick plastic or balsa wood.
- Place each propeller (in turn) on the launcher and pull the string to rotate the propeller.
- Observe what happens.
- Record the size and design that creates the most lift.

➢ **How Do Birds Get off the Ground?**

Have students compile a list of various means of propulsion used by birds to get off the ground (e.g., they run along the water to obtain lift).

6-2-12 Describe how unbalanced forces are used to steer aircraft and spacecraft.

GLO: A5, D4, D6

6-0-2a ⊃ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-4b ⊃ Construct a prototype. GLO: C3

6-0-5b ⊃ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-6d ⊃ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7g ⊃ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

➢ **Experimenting with Paper Airplanes**

Have students modify a paper airplane/glider to move in different ways:

- fly straight and level
- turn to the right or left
- do a loop-the-loop (circle in a vertical loop)
- ascend or descend

> **Teacher Notes**
>
> The results of this learning experience may be important to the design process project suggested in relation to learning outcome 6-12-15.

Have students note the changes that were made to achieve the different motions. Ask them to explain what happened in relation to the forces involved. Have students brainstorm ways in which these motions are achieved in aircraft. (If students are unable to come up with ideas, present them with the terminology.)

➢ **Controlling Spacecraft**

Have students research how a spacecraft is controlled, with the purpose of identifying similarities and differences between a spacecraft and an aircraft. Have them present their findings to the class.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Teacher Notes

Background Information

An aircraft has the capacity to make the following types of motions:

- *Pitch:* the nose of an aircraft rises up or moves downward.
- *Roll:* one wing rises while the other wing moves downward.
- *Yaw:* the nose of an aircraft sways to the left or right while the tail moves in the opposite direction.

An aircraft has moveable parts that enable pilots to control these motions:

- *Ailerons* are located at the rear of the wings. They control the up and down motion of the wing tips. When one aileron goes up, the one on the opposite wing goes down. This either makes the aircraft roll over to the left or to the right, or holds the wings level.
- *Elevators* are located on the horizontal stabilizers on the tail. They control the up and down motion of the nose. If the tail is pulled up the aircraft dives; if it is pushed down the aircraft climbs.
- The *rudder* pushes the vertical tail to the left or the right to create yaw. The rudder enables the aircraft to turn.

Science Everywhere 6 (p. 235)

Discover Flight (p. 106)

Prescribed Learning Outcomes

Students will...

6-2-13 Explain why the design of aircraft and spacecraft differs.

GLO: B1, C3, D4, D6

6-0-2a ⟲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ⟲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

Suggestions for Instruction

Teacher Notes

Background Information

The forces acting on an aircraft and a spacecraft differ.

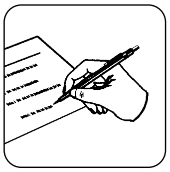
- An aircraft is affected by four forces: *drag*, *lift*, *thrust*, and *gravity*. A spacecraft (rocket) is affected by two forces: *thrust* and *gravity*.
- An aircraft requires wings to achieve lift and to maintain lift. A rocket design does not include wings since maintaining lift is not necessary. A space shuttle has wings to help it glide back to Earth.
- A spacecraft requires tremendous thrust and stability to escape from the Earth's gravitational field, whereas an aircraft only requires enough thrust to gain limited altitude. Special seating is needed in spacecrafts to allow astronauts to withstand high speeds and acceleration.
- A spacecraft needs to be made of specific materials that will allow the craft to withstand the heat caused by re-entering the Earth's atmosphere. An airplane needs to be made of specific materials to allow it to withstand a range of atmospheric temperatures including extreme cold.
- A retrorocket is necessary to slow a spacecraft's descent to Earth. Parachutes also assist with gentle, soft landings. An aircraft uses flaps and slats to control speed and lift. These features create drag to slow down the plane. Some planes have spoilers or air brakes to increase drag. Slower speeds cause the wings to begin to stall, which greatly decreases lift.

➢ Aircraft-Spacecraft Comparison

Have students complete a Venn diagram to compare an aircraft and a spacecraft. Students should consider: purpose, where it travels, how it creates thrust and lift, and the resulting design differences (e.g., in size, slope, materials). Students could research both types of craft using print resources, videos, CD-ROMs, and/or the Internet.

Have students share their findings with the class. (If students do not mention important points listed in the Teacher Notes above, introduce these points at this time.)

Suggestions for Assessment



Extended Response

Provide students with the following:

Comparing an Aircraft and a Spacecraft

Compare and contrast an aircraft and a spacecraft. Consider the following in your answer:

- design
- lift and thrust
- steering
- purpose

Scoring Rubric	
Score	**Criteria**
4	All four areas are discussed. The answer is thorough, clear, and accurate.
3	Three areas are discussed. The answer is thorough, clear, and accurate.
2	Two areas are discussed. The answer is thorough, clear, and accurate. Two or three areas are discussed. The answer is not well developed or is unclear.
1	One area is thoroughly and accurately discussed.

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-14 Identify milestones in the history of air travel and describe their impacts on daily life.

GLO: A4, B1, B2, D4

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-8c ➲ Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

6-0-8d ➲ Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

6-0-8g ➲ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

6-0-9b ➲ Show interest in the activities of individuals working in scientific and technological fields. GLO: B4

SUGGESTIONS FOR INSTRUCTION

➢ Milestones of Flight

Have students work in small groups to research milestones in the history of air travel. Have students use a W-5 Chart (Who? What? Where? When? Why?) to record and organize the research information. Students should use at least two sources of information. Alternatively, provide students with a timeline and ask them to select one of the events mentioned and research it. Have students present their findings in one of the following ways:

- a newspaper report, with students acting as interviewers
- a timeline
- a story about a specific milestone, which can be developed using a story map
- a biography of an inventor or aviator

➢ Impact of Air Travel

Have students use a T-chart, with the headings “Then” and “Now,” to look at the world-wide impact that air travel has had on human transportation, mail service, the shipment of goods and resources, warfare, space travel, and pollution.

SUGGESTIONS FOR ASSESSMENT

Milestones of Flight Project

When assessing students' Milestones of Flight projects, look for indications of the following:

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
The project					
• presents well-developed ideas, expressed in sentences and paragraphs	1	2	3	4	5
• answers to the 5 Ws (Who? What? Where? When? Why?)	1	2	3	4	5
• shows evidence that at least two different sources were used	1	2	3	4	5
• includes a bibliography	1	2	3	4	5
• is an informative and interesting presentation	1	2	3	4	5

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 255)

Discover Flight (p. 118)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-2-15 Use the design process to construct a prototype that can fly and meet specific performance criteria.

Examples: a glider that can loop; a hot-air balloon that can stay aloft for a given time...

GLO: C3, D4

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-1d ⊃ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ⊃ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ⊃ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ⊃ Construct a prototype. GLO: C3

6-0-5b ⊃ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-6d ⊃ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7d ⊃ Propose and justify a solution to the initial problem. GLO: C3

6-0-9d ⊃ Appreciate the importance of creativity, accuracy, honesty, and perseverance as scientific and technological habits of mind. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ Constructing Prototypes

This learning outcome (6-2-15) may be addressed in conjunction with other learning experiences such as Experimenting with Paper Airplanes (learning outcome 6-2-12) or Making Hot-Air Balloons (learning outcome 6-2-05).

OR

Have students use the design process to construct one of the following prototypes:

- Using only one piece of paper, design a plane that can fly the length of a gymnasium.
- Using only one piece of paper, design a plane that can remain aloft for a specified period of time.
- Design a plane that will perform a loop-the-loop.

In addition to devising criteria related to materials used and performance, have students suggest additional criteria such as reliability, aesthetics, etc. Have students present their prototypes to the class.

Note: The Helium Balloons—Design Challenge (learning outcome 6-2-05) is another example of a design process learning experience.

Students may use the “Design Project Report” (BLM 6-E) to record their work.

SUGGESTIONS FOR ASSESSMENT

When assessing student prototypes, refer to “Design Project Report: Assessment” (BLM 6-F).

Self-Assessment: Design Process

Provide students with the following self-assessment tool:

Self-Assessment of Flying Prototype

I chose to make ______________________________

1. One problem I had was ______________________________
2. One thing I did well was ______________________________
3. If I did this project again I would ______________________________
4. I would still like to learn more about______________________________
5. I think my design ______________________________

____

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 254)

Discover Flight (pp. 54-55, 97)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Notes

Grade 6

Cluster 3: Electricity

Overview

In this cluster, students explore current and static electricity and compare and contrast the characteristics of each. These explorations help students identify and appreciate the importance of electricity in everyday life and understand the need for safe practices when using electricity. Students have the opportunity to apply their knowledge of series and parallel circuits in the construction of a prototype that performs a specific function. They demonstrate how electricity can be transformed into motion, and motion into electricity. Students also identify other types of transformations that can take place. Students discuss advantages and disadvantages of various renewable and non-renewable sources of electrical energy, and recognize the importance of energy conservation. The creation of an action plan to help reduce electrical energy consumption helps students understand the impacts they can make.

Prescribed Learning Outcomes

Students will...

6-3-01 Use appropriate vocabulary related to their investigations of electricity.

Include: positive charge, negative charge, current electricity, static electricity, electrical circuit, insulator, conductor, switch, series circuit, parallel circuit, electromagnet, magnetic field, motor, generator, transformation, electrical energy, renewable, non-renewable, energy consumption.

GLO: C6, D4, E4

Suggestions for Instruction

Teacher Notes

Prior Knowledge:

Students have had previous experiences related to this cluster in Grade 3, Cluster 3: Forces That Attract or Repel.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Word Splash**

Introduce students to their study of electricity and activate prior knowledge by using a Word Splash (Saphier and Haley, 1993). Print words randomly on a large wall chart and provide smaller copies to each student. Read the words to students and have them discuss their meaning. Have students write sentences to make predictions about the upcoming learning experiences. Collect and save all predictions and review them at the end of the study.

(For a discussion of the Word Splash strategy, see *Success*, p. 6.28.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

6-3-02 Explain the attraction and repulsion of electrostatically charged materials.

Include: negatively and positively charged materials attract one another; materials of like charge repel one another.

GLO: D4

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-7h Identify potential applications of investigation results. GLO: C4

Suggestions for Instruction

Teacher Notes

Background Information

All matter is composed of *atoms*. All atoms are composed of *subatomic particles*. *Protons* and *electrons* are part of these particles. Protons carry a positive charge and electrons carry a negative charge. Normally, objects carry an equal number of electrons and protons and are said to have a neutral charge.

When two different materials come into close contact (e.g., rubbing wool on a balloon) electrons may be transferred from one material to the other. When this occurs, one material ends up with an excess of electrons and becomes negatively charged. The other material ends up with a deficiency of electrons and becomes positively charged. This accumulation of imbalanced charges on objects results in the phenomenon referred to as static electricity.

Note: At this level, students are not expected to know or use the terms “electrons” or “protons.” Instead, students are expected to use the terms *positive charges* and *negative charges*.

➢ Accessing Prior Knowledge

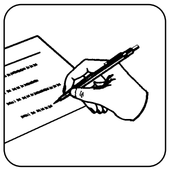
Ask students to rub a balloon in their hair or on another material such as felt or wool, then have students stick the balloon to a wall. Ask students to explain why the balloon stays on the wall. Record their ideas on a class chart.

➢ Static Electricity in the Environment

Use explicit instruction to introduce students to the concept of *positive charges* and *negative charges*. Add to the explanation of the balloon sticking to the wall using the terms *negatively charged, positively charged,* and *attract.* (Hair and wool are materials that readily give up negative charges so the balloon becomes negatively charged. When the negatively charged balloon is brought near the neutrally charged wall, the wall becomes positively charged and the two materials are attracted to one another.)

Have students brainstorm places in which they have experienced static electricity. (For example: lightning, getting shocked after walking across a carpet, clothes clinging after being in the dryer, combing hair in winter). Have them select one example and explain what causes the static electricity to happen. Their explanations should include the terms *repel, attract, static electricity, positive charge,* and *negative charge,* as well as a diagram.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

Electrostatics

Use words and diagrams to answer the following questions:

1. What happens when uncharged materials are placed together?
2. What happens when uncharged materials come in contact with a statically charged material?
3. What happens when two statically charged materials come together?

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 183)

Prescribed Learning Outcomes

Students will...

6-3-03 Explain current electricity, and compare the characteristics of current and static electricity by using a model.

GLO: A2, D4

6-0-4c ⊃ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ⊃ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ⊃ Make observations that are relevant to a specific question. GLO: A1, A2, C2

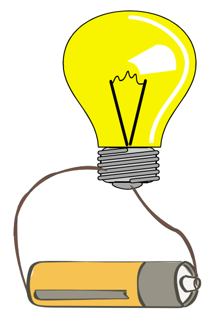
Suggestions for Instruction

➢ Current Electricity Demonstration

1. Have students hold hands while standing in a circle. Have each student squeeze the hand of the person next to him or her in turn until the circle is complete. Discuss what students observed.
2. Place 10 marbles side-by-side in a line. Roll a marble into the last marble in line and have students observe what happens. (The marble on the other end moves forward.)

Explain that the squeezing of hands and the moving of the force between the marbles is like the movement of negative charges along a circuit. This movement is continuous and orderly, not random.

➢ Making It Light Up



1. Provide small groups of students with a battery, two wires, and a light bulb (without the holder) and ask them to try to light the bulb. Have each small group pair with another group to share their solutions, looking at how they are similar. Have the groups share solutions with the class. Ask students what was required to light the bulb. (Wires need to come from both the positive and negative ends of the battery, with one wire touching the side of the bulb and the other wire touching the bottom of the bulb.)
2. Have students use their observations of the holding hands demonstration (from the Current Electricity Demonstration) to explain why the wires need to be touching both the side and the bottom of the bulb. (The current follows a path flowing from the negative pole to the positive pole on the battery.) Have students use their science notebooks to show/explain how they made the materials work.

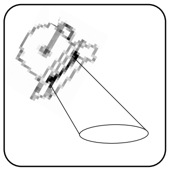
➢ Static and Current Electricity Comparison

Introduce students to the term *current electricity*.

Have students use a Compare and Contrast Frame (Matchullis and Mueller, 1994) to develop a class chart comparing static and current electricity. This chart can be started at this time and then added to as students gain new information about current electricity.

(For a BLM of a Compare and Contrast Frame, see *SYSTH*, Attachment 10.4, or *Success*, p. 6.103.)

Suggestions for Assessment



Lighting the Bulb

Provide students with the following:

Lighting the Bulb

You have been given a battery, some wire, and a light bulb. Draw a diagram to show how you would use these items to make the light bulb light up. Explain how you know it will work.

Teacher Notes

Electricity is the flow of electrons through a conductor. Current electricity is produced when negative charges (electrons) move along a path (circuit).

Both static and current electricity involve the movement of negative charges.

- In *static electricity*, the movement of negative charges is random, caused by friction or rubbing, and is not confined to a path.
- In *current electricity*, the movement of negative charges is orderly and requires a path in which to travel.

Suggested Learning Resources

Science Everywhere 6 (p. 183)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-04 Identify dangers associated with static and current electricity, and demonstrate and describe appropriate safety precautions.

GLO: C1, D4

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-7h Identify potential applications of investigation results. GLO: C4

6-0-9e ➲ Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment. GLO: B5

SUGGESTIONS FOR INSTRUCTION

➢ **Caution: Electricity!**

Have students brainstorm safety considerations regarding both current and static electricity. Have them give reasons for their suggestions. **Note:** There are important safety issues associated with static electricity that is manifested as lightning.

Examples:

Static Electricity (Lightning) Safety:

- Do not play outside during a thunderstorm. (Lightning often takes the easiest path from the clouds to the ground. It is easier for static electricity to go through a person than to take the long way around and go through the air. It is even easier for the electricity to travel through a large piece of metal [e.g., a golf club or baseball bat] and then channel through the person.)
- Do not take cover under a tall tree during a thunderstorm. (Lightning can hit the top of the tree, travel down the trunk, and then channel into a person standing under it.)
- Do not swim during a thunderstorm. (Lightning can hit the water and the electricity can channel into a person in the water.)

Current Electricity Safety:

- Do not use appliances/devices that have cords with exposed wires. (A short circuit can happen when the outer covering of wires is worn or when wires touch one another.)
- Do not overload an electric socket. (Heat is produced as electricity passes through wires. If too many wires are plugged into one outlet, the heat produced can cause a fire.)
- Do not play near power lines.
- Never put anything but a plug into a socket. (Other objects can conduct electricity and cause a shock.)
- Do not unplug an appliance by pulling the cord. Always use the plug. (The cord can become damaged and can cause an electrical shock.)
- Do not use electrical appliances when you are in or near water. (Water is a conductor of electricity and if in contact with an electrical appliance can conduct electricity.)

Have students create safety posters demonstrating some of these safety issues. Posters can be shared by having students do a Gallery Walk (Brownlie and Close, 1992) and/or by displaying the posters in the school for other students to see.

(For a discussion of a Gallery Walk, see *Success*, p. 6.80.)

Suggestions for Assessment

Safety Poster

Provide students with the following checklist for peer assessment of safety posters:

Peer Assessment of Safety Poster		
The poster	**Yes**	**No**
• clearly demonstrates safety issues		
• is presented in an appropriate format (pictures and text are easy to see from a distance)		
• is clear, colourful, and interesting		
Constructive comments:		

Teacher Notes

For related learning outcomes and teacher support, refer to General Learning Outcome 3—Safety, in *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* (2000).

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

6-3-05 List electrical devices used at home, at school, and in the community, and identify the human needs that they fulfill.

Examples: heat, light, communication, movement...

GLO: B1, B2, D4

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-8c ➲ Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

6-0-8d ➲ Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

Suggestions for Instruction

➢ Electricity Survey

Have students conduct a survey both in their homes and in their communities to identify devices that use electricity. Have them identify the human needs that these electrical devices fulfill.

Example:

Electricity Survey

Location	Electrical Device	Human Need Met
kitchens of homes/ school/restaurants	• microwave • refrigerator • dishwasher • stove	• heat food • removal of heat (cooling) • heat for washing and drying dishes • heat for cooking
backyard/window/ school	• air conditioner	• removal of heat (cooling)
living room	• telephone	• communication

Note: This chart is referred to again in an instructional strategy suggested for learning outcome 6-3-18.

➢ What Happened before Electricity?

Have students add another column to their “Electrical Survey” chart called “Before Electricity.” Ask students to indicate how humans met each need before there was electricity.

6-3-06 Develop a definition of an electrical circuit, based on classroom explorations.

Include: an electrical circuit is a continuous path for charges and must contain a power source and a conductor.

GLO: C2, D4

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

➢ Defining an Electrical Circuit

Have students refer to the learning experiences related to current electricity suggested for learning outcome 6-3-03 (and those suggested for learning outcome 6-3-07, if appropriate). Have them work in small groups to use this information to develop a definition of an *electrical circuit*. The definition should include the concept that an electrical circuit

- is a continuous path for charges
- must contain a power source
- must contain a conductor

Have small groups share their definitions with the class. Use these definitions to develop a class definition.

Teacher Notes

The instructional strategy suggested below could follow the learning experiences related to learning outcome 6-3-07 so that students can more fully understand what is meant by the term *conductor*.

Suggestions for Assessment

Journal Reflection

Have students use their science journals to reflect on how technology helps us meet our needs and how technology is constantly changing.

Suggested Learning Resources

Science Everywhere 6 (pp. 180, 183)

Prescribed Learning Outcomes

Students will...

6-3-07 Experiment to classify a variety of materials as insulators or conductors.

GLO: C2, D3, D4, E1

6-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)

6-0-3b Identify variables that might have an impact on their experiments, and variables to hold constant to ensure a fair test. GLO: A2, C22

6-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow. GLO: C1, C2 (ELA Grade 6, 3.1.4)

6-0-4a Carry out procedures that comprise a fair test. Include: controlling variables; repeating measurements to increase accuracy and reliability. GLO: C2

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-6c ➲ Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7b ➲ Base conclusions on evidence rather than preconceived ideas or hunches. GLO: C2, C4

6-0-7c Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 6, 3.3.4)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-7h Identify potential applications of investigation results. GLO: C4

6-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

Suggestions for Instruction

Teacher Notes

Background Information

- A *conductor* is a material that allows the free flow of electrons, creating electric current. (Examples: metal, water.)
- An *insulator* is a material that will not allow an electric current to flow through it. (Examples: wood, rubber, paper, plastic.)

➢ Insulator or Conductor?

Provide students with batteries, bulbs, copper wires, bulb-holders, and alligator clips (or metal paper clips). Have students plan and conduct an experiment to answer the following question: Which materials conduct electricity? Have students

- identify materials to test (e.g., metal penny, rubber band, glass, aluminum foil, metal nail, plastic spoon)
- predict whether each substance will be an insulator or a conductor prior to the experiment
- conduct the experiment and share their findings with the class
- develop a definition for the terms *insulator* and *conductor* based on their findings
- identify potential applications of their experimental findings (e.g., Which material would be best to insulate a wire? Which material would be best to conduct electricity in a switch?)

For a description of the stages involved in scientific inquiry, refer to page 12 in this document.

Students may use the “Experiment Report” (BLM 6-H) to record their work.

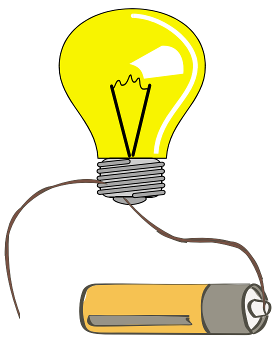
SUGGESTIONS FOR ASSESSMENT

Restricted Response

Provide students with the following:

Completing the Circuit

Pat wants to complete this circuit in order to light up the bulb.



Which of the following materials could Pat use to complete the circuit? Explain your choices.

- ❑ metal knife
- ❑ plastic spoon
- ❑ rubber band
- ❑ metal nail
- ❑ wooden toothpick
- ❑ string of metal paper clips

Refer to "Conducting a Fair Test: Observation Checklist" (BLM 6-G) to assess the student-designed experiments.

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 188)

Prescribed Learning Outcomes

Students will...

6-3-08 Demonstrate and describe the function of switches in electrical circuits.

GLO: D4

6-0-4b ➲ Construct a prototype. GLO: C3

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

Suggestions for Instruction

➢ Accessing Prior Knowledge

Discuss with students the fact that we generally do not want electrical devices to run all the time. Ask them to suggest possible reasons for not running them constantly (e.g., batteries would wear out too quickly; electricity bills would increase; devices could overheat and cause fires; appliances would break down; the environment could be affected; we sometimes require darkness, especially to sleep or view movies).

Provide students with a list of electrical devices. Ask them to explain how we control the use of these devices.

Example:

Controlling Electrical Devices

Electrical Device	Method of Control
kitchen lights	on/off switch
stove element	on/off switch
vacuum cleaner	on/off switch
hand-held video game	on/off switch

In their science notebooks, have students explain the importance of switches on electrical devices.

Teacher Notes

Background Information

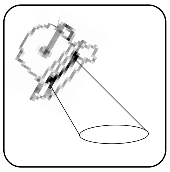
A switch allows us to control the flow of electricity without handling any wires. Switches allow us to close a circuit so that electricity can flow (on position) or open the circuit when we want to stop the flow of electricity (off position).

➢ Constructing Switches

Have students design and construct three different switches to control an electrical circuit. Students should select test materials used in other learning experiences or select new materials to test. Have students create a display of their switches, including a summary of the strengths and weaknesses of each.

Note: Students can also visit the Take-Apart Centre described in association with learning outcome 6-3-13 to examine switches used in different devices.

SUGGESTIONS FOR ASSESSMENT



Explaining Switches

Provide students with batteries, wire, light bulbs, light bulb holders, and switches (commercial or class-made). Ask them to imagine the following scenario:

The beaded cord that turns the table light on and off fascinates your young cousin. She asks you to explain how it works. Use the materials provided to demonstrate and explain how the light gets turned on and off.

Checklist:

The student

- ❑ connects the materials using a switch to control the electricity flow
- ❑ understands that closing the switch (on) allows the electricity to flow
- ❑ understands that opening the switch (off) stops the flow of electricity
- ❑ provides a clear explanation
- ❑ uses the correct terminology

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 196)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-09 Construct and diagram simple series circuits and simple parallel circuits.

GLO: C2, C6, D4, E1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

6-0-9d ➲ Appreciate the importance of creativity, accuracy, honesty, and perseverance as scientific and technological habits of mind. GLO: C5

(continued)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

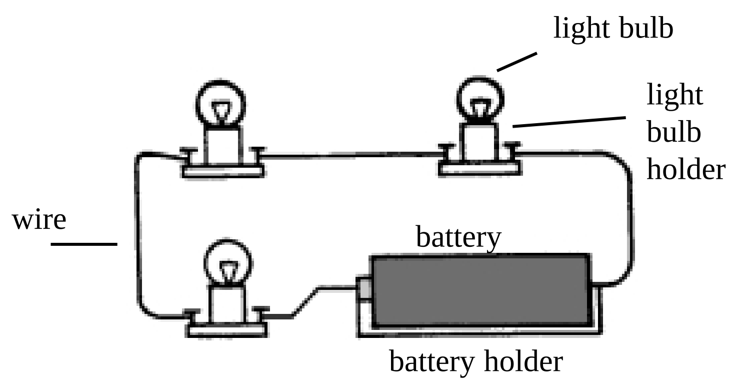
- A *series circuit* uses a single path to connect the electric source(s) to the output device(s).
- A *parallel circuit* provides more than one path for a current. It also provides the same voltage for every source and output device.

➢ Series and Parallel Circuits

Part A: Series Circuit

Have students draw and label a diagram of a simple circuit (similar to the ones they have constructed in previous learning activities) containing one battery and three light bulbs. Have students predict what will happen if one of the light bulbs is removed. Ask them to explain their thinking and then construct the circuit to test their prediction.

Example:



Part B: Parallel Circuits

Challenge students to create a circuit that will allow the two light bulbs to remain lit even when one light bulb is removed. Have them explain in their science notebooks how they designed their circuit and how it works. Their explanation should include a labelled diagram.

(continued)

SUGGESTIONS FOR ASSESSMENT

Refer to the assessment strategy suggested for learning outcome 6-3-10.

SUGGESTED LEARNING RESOURCES

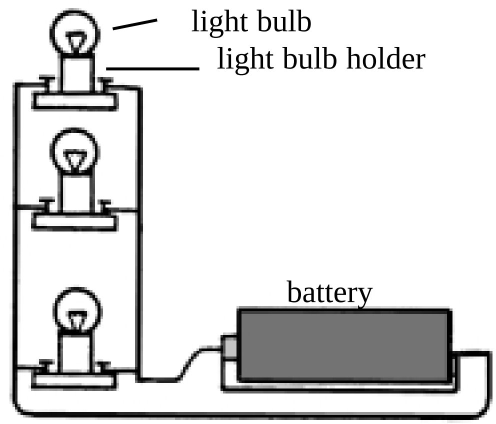
Science Everywhere 6 (p. 192)

PRESCRIBED LEARNING OUTCOMES
Students will...
6-3-09 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

Example:



Provide students with two titles for their diagrams—Series Circuit and Parallel Circuit—and ask them to decide which title goes with which diagram and explain why.

Have students identify examples in daily life where parallel circuits are used, and explain what would happen if parallel circuits were replaced with series circuits (e.g., if Christmas tree lights were on a series circuit, the string would not light up if one bulb burnt out).

➢ **Tree Climbing Analogy**

Have students compare series and parallel circuits using the analogy of climbing a tree with a rope or with a ladder.

Example:

- Climbing a tree with a rope is like using a series circuit. If the rope breaks, the climber will not be able to get to the top of the tree. In a series circuit, if one bulb/electrical device burns out the others will not work.
- Climbing a tree with a ladder is like using a parallel circuit. If one rung breaks, the climber can still use the others to reach the top. In a parallel circuit, if one bulb/electrical device burns out the rest will continue to work.

Ask students to think of other analogies. (Example: In a maze analogy, one end of the battery is the starting point with the wires serving as paths. A bulb acts as a bridge along a path. If the bulb is removed, a dead end is created along that path.)

Suggestions for Assessment

Suggested Learning Resources

Journal Reflection

In their science journals, have students reflect on how analogies are useful in understanding series and parallel circuits. Ask students to identify other areas where analogies are helpful.

Prescribed Learning Outcomes

Students will...

6-3-10 Explore to determine factors that affect bulb brightness in simple series and parallel circuits.

Include: number of bulbs, number of batteries, placement of bulbs and batteries.

GLO: C2, D4

6-0-1a Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6)

6-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship. GLO: A2, C2 (Math: SP-I.1.6)

6-0-3b Identify variables that might have an impact on their experiments, and variables to hold constant to ensure a fair test. GLO: A2, C22

6-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow. GLO: C1, C2 (ELA Grade 6, 3.1.4)

6-0-4a Carry out procedures that comprise a fair test. Include: controlling variables; repeating measurements to increase accuracy and reliability. GLO: C2

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-6c ➲ Identify and suggest explanations for patterns and discrepancies in data. GLO: A1, A2, C2, C5

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7b ➲ Base conclusions on evidence rather than preconceived ideas or hunches. GLO: C2, C4

6-0-7c Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 6, 3.3.4)

Suggestions for Instruction

➢ Exploring Bulb Brightness

For this experiment, have students use the series and parallel circuits made in conjunction with learning outcome 6-3-09. Provide students with additional batteries, light bulbs and holders, and wire.

Ask groups of students to experiment to determine what affects bulb brightness in both parallel and series circuits. Have students identify three factors that affect bulb brightness.

Note: Remind students to change **one** factor at a time to ensure a fair test.

Examples:

- increasing or decreasing the number of bulbs
- increasing or decreasing the number of batteries
- changing the placement of the bulbs
- changing the placement of the batteries

Ask students to record their observations, then write their conclusions indicating which factor(s) affected light bulb brightness. Students may use the “Experiment Report” BLM 6-H) to record their work. Have groups share their conclusions with the class.

Example:

Factors That Affect Bulb Brightness

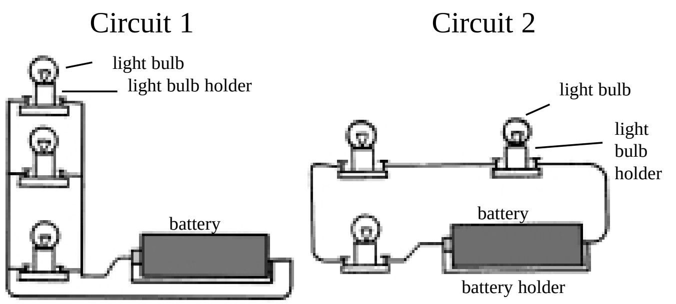
Change	Circuit Type	Effect
increasing the number of bulbs	series	dims the bulbs
	parallel	bulb brightness is not changed
increasing the number of batteries	series	increases the brightness
	parallel	bulb brightness is not changed

SUGGESTIONS FOR ASSESSMENT

Restricted Response

Provide students with the following:

Identify the Circuit



For each of the following statements, identify the circuit (circuit 1 or circuit 2) to which the statement refers.

a. If one light bulb burns out, the other will continue to work. ________
b. The light bulbs in this circuit will be brighter than the light bulbs in the other circuit. ________
c. This circuit is a parallel circuit. ________
d. Electricity has only one path to follow. ________

Look for:
a. 1
b. 1
c. 1
d. 2

When assessing the Exploring Bulb Brightness learning activity, refer to “Experiment Report: Assessment” (BLM 6-I).

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-11 Use the design process to construct an electrical circuit that performs a useful function.

Examples: doorbell, alarm, motorized toy, game...

GLO: C3, D4

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-1d ➲ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ➲ Construct a prototype. GLO: C3

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-6f ➲ Evaluate the methods used to answer a question or solve a problem. GLO: C2, C3 (ELA Grade 6, 3.3.4)

6-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

6-0-7e ➲ Identify new practical problems to solve. GLO: C3

6-0-8c ➲ Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

6-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ Designing a Security System

Ask students to construct a prototype to solve the following design challenge:

A construction company has hired you to develop a security system for new houses. They want a system that uses an electrical circuit either to set off an alarm, or to turn on lights if a house is entered illegally. Before you install the system, you are required to build a prototype to demonstrate how the system works.

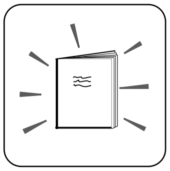
As a class, develop criteria that address the scientific components of the task (e.g., complete circuit, switch) and a variety of other criteria (e.g., appearance, durability). This learning experience allows students to apply their knowledge and skills related to electrical circuits from previous learning activities to a practical problem. It also provides an opportunity for teachers to identify and correct individual conceptual problems or misunderstandings related to circuits. Ensure that all students have an opportunity to take part in the planning and construction processes. Have each group present their prototype to the class, identifying problems they had in designing and building it, and explaining how these problems were overcome.

For a description of the stages of the design process, refer to page 16 of this document.

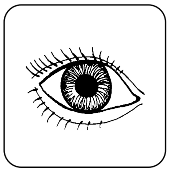
Students may use the “Design Project Report” (BLM 6-E) to record their work.

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Design Project Report: Assessment" (BLM 6-F)



"Constructing a Prototype: Observation Checklist" (BLM 6-D)

Suggested Learning Resources

Science Everywhere 6 (p. 207)

By Design: Technology Exploration & Integration

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-12 Demonstrate, using a simple electromagnet constructed in class, that an electric current can create a magnetic field.

GLO: C2, D4

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Making an Electromagnet**

Provide pairs of students with a large iron nail, a "D" cell battery, tape, and 90 cm of wire. Before constructing the electromagnet, have students try to use the nail to pick up objects such as paper clips, pins, keys, and/or coins. Ask them to record what they observed.

Have students construct a simple electromagnet by following these directions:

1. Hold the nail. Wrap the middle section of the wire tightly around the nail, starting from just below the head down to just above the point of the nail.
2. Tape one end of the wire to the negative end of the battery and the other to the positive end.
3. Try to pick up the objects with the nail. Record your observations.
4. Disconnect the wire from the battery and try to pick up objects. Record your observations.
5. In your science notebook, explain your results. Why do you think this happened? (Passing an electric current through certain types of metal objects creates a magnetic field. The magnetic field lasts only as long as the electric current is present.)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 6-3-13.

Suggested Learning Resources

Science Everywhere 6 (p. 202)

Prescribed Learning Outcomes

Students will...

6-3-13 Explore motors and generators to determine that electromagnets transform electricity into motion, and motion into electricity.

GLO: A5, D4, E2, E4

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

6-0-7h Identify potential applications of investigation results. GLO: C4

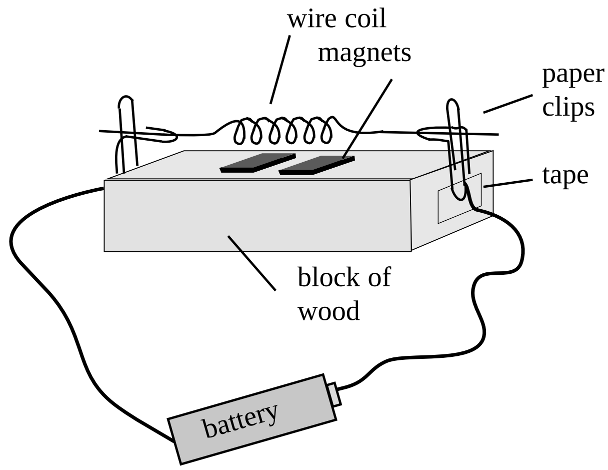
(continued)

Suggestions for Instruction

➢ **Constructing a Simple Motor**

Provide small groups of students with the following materials: two square magnets, wire, a 6-volt battery, masking tape, a pencil, paper clips, and a small block of wood (approximately 5 cm x 15 cm). Have students follow these directions to make a simple motor:

1. Wind the wire around a pencil to form a coil. Leave about 10 cm of wire at each end. Slide the coil off the pencil. To prevent the coil from unwinding, wrap a small piece of tape at two places on the coil.
2. Tape the magnets to the block of wood so that they are together in the middle of the board.



3. Attach a paper clip to opposite sides of the block so that half the clip is sticking up above the block. The top part of the paper clip should be bent downward in the middle so that it will support the wire from the coil.
4. Connect the paper clips to the battery with wires.
5. Put the ends of the coil into the paper clips.
6. Start the motor by spinning the coil.
7. Record your observations. What is causing the coil to turn? (The electric current running through the coil creates a magnetic field around it. The magnet alternately repels and attracts the coil, causing it to rotate. Motors change electricity into motion.)

(continued)

Suggestions for Assessment

Suggested Learning Resources

Teacher Notes

Background Information

- An *electric motor* contains two bar magnets and a rotating coil of wire called an armature. The coil becomes an electromagnet when it is charged with electricity. One end becomes the north pole; the other end becomes the south pole. The magnetized electromagnet rotates in the magnetic field of the bar magnets. Because like poles of magnets repel each other, and unlike poles attract each other, the coil spins on its axis. To prevent the armature from stopping its rotation, a commutator and brushes are used to change the direction of current flow. This reverses the magnetic polarity of the armature, keeping it turning.
- A *generator* is a device that produces electricity from mechanical energy. In a generator, a large coil of wires called an armature turns between the poles of many powerful magnets. This causes an electric current to flow in the coils of the armature.

Science Everywhere 6 (p. 205)

PRESCRIBED LEARNING OUTCOMES
Students will...
6-3-13 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Making a Simple Generator**

Provide groups of students with a piece of copper wire about two metres long, a bar magnet, and a compass. Have students follow these directions to make a simple generator:

1. Wrap one end of the wire around your hand about 10 times to make a coil. Slide the coil off your hand.
2. Wrap the other end of the wire around the compass about five times.
3. Twist the two ends of the wire together.
4. Slide the magnet quickly back and forth inside the coil.
5. Look at the compass. What is happening? (The moving needle in the compass shows that electricity is flowing through the wires.)
6. Record your findings in your science notebook.

➢ **Take-Apart Centre**

Have students bring to class old items that contain motors (e.g., record players, radio-controlled cars, fans). Make sure that these items are no longer needed. Have students take apart the items to observe the motors.

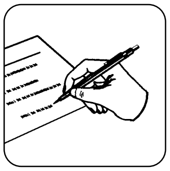
Safety Precaution:

Be sure to cut off the cords before letting students take the motors apart.

Advise students to wear safety goggles as they work.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Extended Response

Provide students with the following:

Electromagnets

In your science notebook, explain the purpose of electromagnets in generators and motors.

Look for:
- electromagnets transform electricity into motion (in motors)
- electromagnets transform motion into electricity (in generators)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-14 Identify forms of energy that may result from the transformation of electrical energy, and recognize that energy can only be changed from one form into another, not created or destroyed.

Include: light, heat, sound, motion.

GLO: D4, E4

6-0-5f ➲ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

The concept that energy cannot be created or destroyed will not be readily apparent to students. Introduce students to this concept.

➢ **Accessing Prior Knowledge**

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to identify forms of energy.

➢ **Transformation of Energy**

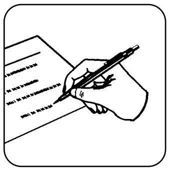
Present students with a list of electrical devices. Have them identify the form of energy that each device creates by transforming electrical energy.

Example:

Changing One Form of Energy to Another

Electrical Device	Changes Electrical Energy Into:
light bulb	light/heat
radio	sound
radio-controlled car	motion

Suggestions for Assessment



Restricted Response

Provide students with the following:

Energy Transformation

Complete the following sentences:

1. Electrical energy can be transformed into ____________ energy.
   A _____________ is an example.
2. Electrical energy can be transformed into ____________ energy.
   A _____________ is an example.
3. Electrical energy can be transformed into ____________ energy.
   A _____________ is an example.
4. Electrical energy can be transformed into ____________ energy.
   A _____________ is an example.

Suggested Learning Resources

Science Everywhere 6 (p. 207)

Prescribed Learning Outcomes

Students will...

6-3-15 Identify the two major sources of electrical energy, and provide examples of each.

Include: chemical sources such as batteries; electromagnetic sources such as turbine motion caused by wind, falling water, and steam.

GLO: B1, D4, E4

6-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

Suggestions for Instruction

Teacher Notes

Background Information

A battery changes chemical energy into electrical energy.

- A dry cell battery is made up of a zinc case with a carbon rod in the centre. The space between is filled with a chemical paste. Turning on the switch connects the zinc and the carbon. A chemical reaction takes place, creating a circuit through which electrical charges can move.
- A car battery is a wet cell battery made up of layers of lead. The case contains water and acid instead of chemical paste. The lead and the acid cause a chemical reaction that produces an electrical current.

Generators require a source of energy to create turbine motion, an electromagnetic source of electricity. Some generators use water (hydroelectric power) and others use steam or wind (windmills).

➢ Making a Simple Battery

Gather the following materials: two wires, two alligator clips, a glass beaker, a zinc electrode, a copper electrode, lemon juice, and an ammeter (used to measure the strength of an electrical current).

To demonstrate how a battery produces energy, construct a battery by following these directions:

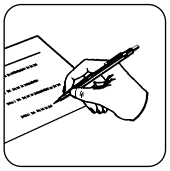
- Fill the beaker with lemon juice.
- Put the alligator clips on the ends of the wires and attach them to the ammeter.
- Put both electrodes in the beaker, moving them as close together as possible without touching.
- Connect one wire to each electrode.
- Observe what happens.

(Electrical energy is produced due to a chemical reaction between the zinc and the lemon juice.)

➢ Sources of Electrical Energy

Have students use videos, CD-ROMs, Internet resources, and/or print resources to research sources of electrical energy. If possible, have students visit a hydro plant. Ask students to share their findings with the class.

Suggestions for Assessment



Extended Response

Provide students with the following:

Sources of Electrical Energy

What are the two major sources of electrical energy? Give an example of each source.

Look for:

- chemical sources (e.g., batteries)
- electromagnetic sources (e.g., turbine motion caused by falling water, steam or wind)
- an example is given for each

Suggested Learning Resources

Science Everywhere 6 (p. 173)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-16 Identify renewable and non-renewable sources of electrical energy, and discuss advantages and disadvantages of each.

Examples: renewable sources such as hydroelectric, wind, geothermal, solar; non-renewable sources such as fossil fuels, nuclear fission...

GLO: B5, E4

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-7h Identify potential applications of investigation results. GLO: C4

6-0-8g ➲ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

6-0-9e ➲ Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment. GLO: B5

SUGGESTIONS FOR INSTRUCTION

➢ **Identifying Energy Resources**

Have students brainstorm sources of electrical energy. Have them sort their ideas into "renewable" and "non-renewable" categories. Ask students to share their ideas with the class and create a class chart.

➢ **Positive or Negative?**

Using the list of energy sources identified in the previous learning activity, have students identify the advantages and disadvantages of each energy source. Students may be divided into groups with each group researching one source of electrical energy and then presenting their findings to the class.

After all groups have shared their results, ask students to review the positive and negative points and indicate whom or what each source of electrical energy affects (e.g., the environment, people, the economy). Have students use their science notebooks to reflect on the challenges of making decisions related to electricity production that balance the three perspectives.

Example:

Energy Source	**Positive Points**	**Negative Points**
Hydroelectric energy	• Water is a renewable resource. • Water is readily available (at least in Canada). • It is cheap to produce. • It is relatively pollution free.	• Land has been flooded to create reservoirs for hydroelectric plants. As a result, habitats have been destroyed. • Long systems of transmission lines are needed to carry electricity to where it is needed, and these are expensive.
Coal	• Coal is cheap. • A large quantity is still available. • Other products can be created from coal.	• Coal causes air and water pollution. • Mining has an impact on the environment and is dangerous for miners. • Coal will eventually run out (is a non-renewable resource).

Suggestions for Assessment

Teacher Notes

Background Information

- *Renewable energy* resources can be used over and over again. They are not consumable and do not get used up. Hydroelectric, wind, geothermal, and solar energy are examples of renewable sources of electrical energy.
- *Non-renewable energy* resources are consumable and can only be used once. Fossils fuels such as coal and oil are non-renewable sources of electrical energy. Nuclear fission is also a non-renewable source of electrical energy.

For related teacher support, refer to *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* (2000).

Suggested Learning Resources

Science Everywhere 6 (p. 172)

Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators

Prescribed Learning Outcomes

Students will...

6-3-17 Evaluate an electrical device using the design process.

Examples: light bulbs, kitchen appliances...

GLO: B5, C4

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?...* GLO: C3

6-0-1d ➲ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-6e ➲ Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

6-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

Suggestions for Instruction

Teacher Notes

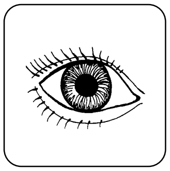
The following learning activity is an example of the design process. Students can choose to evaluate any electrical device to complete this learning activity.

➢ Looking at Light Bulbs

Have students follow the design process to evaluate electric light bulbs:

- Identify the problem to solve (e.g., What light bulb should I buy?).
- Identify ways to solve the problem and then select one to implement (e.g., testing light bulbs to see which one is best).
- Develop criteria to evaluate the light bulbs (e.g., reasonable cost, how long they last, environmental concerns).
- Create a written plan listing materials needed, the procedure to follow, and safety considerations.
- Test the product using the criteria established.
- Evaluate the strengths and weaknesses of the light bulbs based on the criteria.
- Propose possible modifications to the design of the light bulb.
- Propose and justify a solution to the initial problem.

Suggestions for Assessment



Looking at Light Bulbs

Look for indications of the following in student work:

Checklist:

The student

- ❑ identifies the problem
- ❑ identifies the criteria
- ❑ determines the method/procedure to conduct the test
- ❑ tests the product using predetermined criteria
- ❑ analyzes the data
- ❑ presents findings and arrives at a conclusion

Suggested Learning Resources

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-3-18 Describe factors that affect the consumption of electrical energy, and outline an action plan to reduce electrical energy consumption at home, at school, or in the community.

GLO: B5, C4, E4

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-8g ➲ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

6-0-9e ➲ Be sensitive to and develop a sense of responsibility for the welfare of other humans, other living things, and the environment. GLO: B5

6-0-9f ➲ Frequently and thoughtfully evaluate the potential consequences of their actions. GLO: B5, C4

SUGGESTIONS FOR INSTRUCTION

➢ **Reducing Energy Consumption**

Have students brainstorm reasons why it is important to reduce energy consumption, making links to their discussions related to learning outcome 6-3-16, regarding renewable and non-renewable sources of energy.

➢ **Consumption of Energy (Action Plan)**

Have students refer to the Electricity Survey they conducted in relation to learning outcome 6-3-05. Have them add a fourth column titled "Frequency of Use" or "When Used" and fill it in.

Example:

Electricity Survey

Location	Electrical Device	Human Need Met	Frequency of Use
kitchen	dishwasher	provides heated water and air to wash and dry dishes	twice a day

Have students select four electricity sources and develop a plan for reducing their electrical energy consumption. (For example: Use the dishwasher only when it is completely full. Turn off the heat for drying and let the dishes air-dry.)

Have students share their plans with the class. Action plans may be published in a class newspaper and sent home to parents/guardians.

6-3-19 Describe the ways in which electricity has had an impact on daily life.

GLO: B1, B2, B5

6-0-8c ➲ Recognize that technology is a way of solving problems in response to human needs. GLO: A3, B2

6-0-8g ➲ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

6-0-9f ➲ Frequently and thoughtfully evaluate the potential consequences of their actions. GLO: B5, C4

➢ **Electricity Use Journal**

Have students track the times that they use electricity over the course of an entire day. Ask students to reflect on their results in their science journals and comment on the potential consequences of individual overuse of electricity to society, the environment, and the economy.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 171)

Short Story

Provide students with the following:

A Day without Electricity

Imagine what your day would be like if there were no electricity. What impact would this have on communication, transportation, heat, and light? Write a short story called "A Day without Electricity" that discusses these impacts.

Look for:

- references to communication, transportation, heat, and light

Science Everywhere 6 (p. 168)

Notes

Grade 6

Cluster 4: Exploring the Solar System

Overview

In this cluster, students develop an understanding of the Earth in space, the solar system, and the role of space research programs in increasing scientific knowledge. Positive and negative impacts arising from space research programs are addressed, and the contributions of Canadians to these programs are highlighted. Students develop an appreciation for the nature of science by examining the changing conceptions of the Earth's position in space and by differentiating between astronomy and astrology. Students investigate the causes of phenomena such as the cycle of day and night, the yearly cycle of the seasons, moon phases, eclipses, and the reasons why the apparent movements of celestial bodies in the night sky are regular and predictable. An important distinction is made between weight and mass.

Prescribed Learning Outcomes

Students will...

6-4-01 Use appropriate vocabulary related to their investigations of Earth and space.

Include: astronauts, communication and remote sensing satellites, solar system, inner and outer planets, asteroid belt, mass, weight, points of reference, apparent movement, celestial objects, astrology, astronomy, rotation, revolution, axis, moon phases, eclipses.

GLO: C6, D6

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 3, Cluster 3: Forces That Attract and Repel, and in Grade 1, Cluster 4: Daily and Seasonal Changes.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **“I Wonder . . .” Chart**

Write the title “Learning about the Solar System” on chart paper and post the chart on a classroom wall. Invite students to record questions, words, or phrases related to this topic at any time throughout the study of this cluster. Review the chart to reinforce vocabulary and use the questions to focus inquiry and instruction.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-02 Identify technological developments that enable astronauts to meet their basic needs in space.

Examples: dehydrated foods, backpacks with an oxygen supply, hermetically sealed cabins with temperature and air controls...

GLO: B1, B2, D1, D6

6-0-1a Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6)

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

SUGGESTIONS FOR INSTRUCTION

➢ Human Needs

Provide students with the following scenario:

You have been chosen to take part in a television show dealing with how people survive in a wilderness area without modern conveniences. Work with a partner to identify your needs and determine what you would have to do to meet them.

Example:

Wilderness Survival

Need	What We Need to Do
water	Find a source of clean, fresh water within a reasonable distance.
shelter	Select a site, find suitable construction materials, and build a structure.

➢ Meeting Needs in Space

Have students complete the Know (K) and Want to Know (W) sections of a KWL Chart (Ogle, 1986) to deal with the topic of how astronauts meet their needs in space.

(For a BLM of a KWL Chart, see *SYSTH*, Attachment 9.1, or *Success*, p. 6.94.)

Divide the class into small groups. Have each group

- select one of the questions in the W section of the KWL Chart to research, including specific references to technological developments
- report research findings to the class (e.g., in the form of a poster or a multimedia presentation)

Possible questions:

- How/what do astronauts eat in space?
- How do astronauts breathe in space?
- How do astronauts control temperature while on a space mission?
- How do astronauts sleep in space?
- How does technology help solve problems in space?

Suggestions for Assessment

Extended Response

Provide students with the following:

Space Travel and Technological Developments

Space travel has resulted in the development of new technological devices.

Do you agree or disagree with this statement? Give reasons to support your answer.

Look for:

- technological developments related to basic human needs:
  - — water and food
  - — shelter
  - — breathing
  - — temperature control
  - — sleep
- answer is logical and well supported with examples

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 14)

Science Everywhere 6 (p. 117)

Prescribed Learning Outcomes

Students will...

6-4-03 Identify Canadians who have contributed to space science or space technology, and describe their achievements.

GLO: A4, A5, B1, B4

6-0-2a ⊃ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-5f ⊃ Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

6-0-7a Draw a conclusion that explains investigation results. Include: explaining patterns in data; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 6, 3.3.4)

Suggestions for Instruction

Teacher Notes

Learning activities related to learning outcomes 6-4-03 and 6-4-04 could be carried out at the same time as part of a major class research project. For example, have groups of students select projects related either to Canadian contributions to space science or space technology/space research programs, ensuring that both topics are well represented.

➢ **Canadian Contributions**

Have students use The Canadian Space Agency Internet site, available online at <http://www.space.gc.ca>, or another resource to find the names of Canadians who have contributed to space science or space technology. Have pairs of students select one of the people identified and write a newspaper article on this person’s contributions, answering the 5 Ws (Who? What? When? Where? Why?)

Students may choose to present their findings in the form of a mock interview or combine the articles into a class newspaper. All students are responsible for the information provided by each group and should use an appropriate format (e.g., summary table, paragraph, labelled illustration) to record key facts about each person studied by the class.

Suggestions for Assessment

Using Resources

Provide students with the following self-assessment tool:

Self-Assessment: Canadian Contributions			
	Yes	No	Comment
• Did I/we find answers to all or most of my/our questions? • Do I/we have information on the most important areas? • Do I/we have enough information in each area?			
What I/we did well:			

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 11, 13)

Science Everywhere 6 (p. 94)

World of Invention (Teacher Reference)

Science and Technology Breakthroughs (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES
Students will...
6-4-04 Investigate past and present space research programs involving astronauts, and explain the contributions to scientific knowledge. *Examples: Apollo, Mir, International Space Station...* GLO: A1, A2, A5, D6
6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1) **6-0-2b** ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3) **6-0-2c** Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ **Space Mission Research**

Brainstorm the names of space missions/projects such as the Mir Space Station and/or the National Aeronautics and Space Administration (NASA) Space Shuttle or Apollo missions. Have students work in groups to research one of the space research programs and prepare a report that includes the following:

- name of the mission
- date and length of the mission
- countries involved
- schematic drawing of the spacecraft
- names of people on the mission
- role of each crew member
- purpose of and contributions made by the mission (This is the main focus of the report.)

Have students create their reports in written form or deliver them to the class as an oral presentation. All students are responsible for the information provided by each group and should use an appropriate format (e.g., summary table, paragraph, labelled illustration) to record key facts about each space research program studied by the class.

(For strategies to aid students in using a variety of information sources, making sense of information, and recording and evaluating information, refer to *5-8 ELA*, learning outcomes 3.2.2-3.2.5 and 3.3.2-3.3.3.)

Suggestions for Assessment

Research Report

Look for indications of the following in student work:

Checklist:

The student (or group)

- ❑ introduces the topic
- ❑ presents the main ideas
- ❑ provides elaboration and detail
- ❑ stays on topic
- ❑ maintains sequence
- ❑ provides an effective conclusion

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 13, 14)

Science Everywhere 6 (p. 121)

Science and Technology Breakthroughs (Teacher Reference)

Prescribed Learning Outcomes

Students will...

6-4-05 Describe positive and negative impacts arising from space research programs.

Examples: advantages—increased knowledge about space and medicine, the development of technologies such as orange drink crystals and pocket calculators; disadvantages—space pollution and the high cost of research projects...

GLO: A1, B1, B5, D6

6-0-8g ➲ Describe positive and negative effects of scientific and technological endeavours. Include: effects on themselves, society, the environment, and the economy. GLO: A1, B1, B3, B5

Suggestions for Instruction

➢ Positive Impacts of Space Research

Bring to class a variety of items (e.g., orange drink crystals, canned orange juice, a pocket calculator, freeze-dried food, a map of the world, a detailed map of a global region, a crystal). Ask students to identify the items they think are the result of space research.

Example:

Products Resulting from Space Research

Item	Product of Space Research?
orange drink crystals	Yes. This product was initially produced for use in space missions.
canned orange juice	No.
pocket calculator	Yes. This product was initially produced for use in space missions.
freeze-dried food	Yes. This product was initially produced for use in space missions.
maps	Maps of the world have existed since the 1400s. Detailed maps of a global region are, however, produced by remote sensing satellites that use microwave instruments to send and receive signals through darkness, cloud, smoke, or fog. They are a product of space research.
crystals	In her micro-gravity research, Roberta Bondar discovered that crystals grown in zero gravity have a purer and better structure then those grown in the Earth’s gravity. These zero-gravity crystals are used in power lasers, high-resolution video cameras, and microwave broadcast devices.

➢ Negative Impacts of Space Research

Ask students what happens to rockets, satellites, and space probes once they have been used. Discuss the implications of all the “junk” that is left in space. In addition, discuss the cost of space research missions. Data can be gathered using the Internet (e.g., websites of organizations such as The Canadian Space Agency at <www.space.gc.ca> and the National Aeronautics and Space Administration at <www.nasa.gov>.)

SUGGESTIONS FOR ASSESSMENT

Impacts of Space Research Programs

Provide students with the following:

Impacts of Space Research Programs

Answer the following questions in your science notebook:

1. What do you think is the greatest positive impact of space research programs? Explain your thinking.
2. What do you think is the greatest negative impact? Explain your thinking.

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 6: *Space* (Chapter 13)

Science Everywhere 6 (p. 124)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-06 Identify technological devices placed in space that help humans learn more about the Earth and communicate more efficiently.

Include: communication and remote sensing satellites.

GLO: B1, B2, D6

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-1a Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 6, 3.1.2; Math: SP-I.1.6)

6-0-7h Identify potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Canadian Tour**

Take students on a satellite image tour of Canada through the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada website, available online at <www.ccrs.nrcan.gc.ca>. If it is not possible to use the Internet, obtain satellite pictures to show students.

➢ **Guest Interviews: Satellite Communications**

Invite guest speakers to class to discuss satellite communications (e.g., how a cell phone works, how satellite TV works). Have students work in small groups to develop a list of questions prior to the guest visits/interviews. If it is not possible to obtain a speaker to discuss the topic, show students a video, use a CD-ROM, or visit an "ask an expert" site on the Internet.

➢ **Weather Information from Satellites**

Have students view a weather broadcast to see how satellite images are used to provide information about the weather.

➢ **Global Positioning System**

A Global Positioning System (GPS) uses a satellite to locate the position of people and/or objects on the Earth. Have students share what they know about the uses of this system. As a class, discuss how this system could be helpful (e.g., It may be used for locating cars, boats, airplanes, or people. Mountain climbers on Mount Everest have used the system to enable rescuers to find them more easily, should they experience problems.)

➢ **Remote Sensing**

Use explicit instruction to provide students with information on remote sensing. The Canadian Centre for Remote Sensing <http://www.ccrs.nrcan.gc.ca> provides readily accessible information on remote sensing, including a teaching kit appropriate for Grade 6.

Provide students with the following discussion questions:

1. How can remote sensing information help with
   a. identifying and responding to natural and human-made disasters such as forest fires, oil spills on the ocean, and floods? (Remote sensing provides information on the size and movement of a forest fire to aid in fighting it, allows the tracking of oil spills for clean-up purposes, and tracks the spread of a flood to help in damage prevention.)

(continued)

Suggestions for Assessment

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 13)

Science Everywhere 6 (p. 112)

Prescribed Learning Outcomes

Students will...

6-4-06 *(continued)*

Suggestions for Instruction

(continued)

b. prospecting for mineral deposits? (Geologists can use remote sensing information to identify different types of rock formations, some of which are likely to contain rich minerals. This helps direct prospecting activities and saves time and money.)

c. navigating through ice packs in the Arctic? (Up-to-the-minute remote sensing information on the location of constantly moving ice floes can help captains plot their path.)

d. farming? (Remote sensing information enables farmers to track how their crops are growing and whether they have been affected by disease, flood, and so on.)

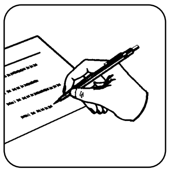
2. What else can remote sensing information be used for?

Teacher Notes

Background Information

In its simplest terms, *remote sensing* means observing the Earth with sensors from high above its surface. These sensors, usually contained in satellites, are like cameras except that they use not only visible light but also other bands of the electromagnetic spectrum, such as infrared, radar, and ultraviolet. Because they are so high up, these sensors can make images of a very large area, sometimes an entire province. Many countries, including Canada, have remote sensing satellites in space. Hundreds of images are sent every day from the satellites to receiving stations on Earth. The Earth's entire surface is imaged every week or so, making it possible to obtain current images of what is happening on the Earth's surface.

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

1. Identify two technological devices placed in space that have enabled us to learn more about the Earth and communicate more effectively.
2. Briefly describe what these devices do.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-07 Describe how the conception of the Earth and its position in space have been continuously questioned and how our understanding has evolved over time.

Include: from a flat Earth, to an Earth-centred system, to a Sun-centred system.

GLO: A1, A2, B2, C5

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

6-0-8a ➲ Recognize that science is a way of answering questions about the world, and that there are questions that science cannot answer. GLO: A1, A3

6-0-8b ➲ Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

SUGGESTIONS FOR INSTRUCTION

➢ How Would You See It?

In an outdoor setting, ask students to look up at the sky and think about how they would explain the position and motion of the Earth and the stars and planets if they had no technology available to assist them. Challenge students to provide "proof" with all their proposed explanations and eliminate any that require technology to prove their validity. Make a class list of their suggestions.

➢ Finding Evidence

Divide the class into small groups and provide each group with one of the four descriptions presented in "Changing Conceptions of the Earth and Its Position in Space" (see BLM 6-B).

Have each group

- read the description provided
- discuss it to ensure they understand it and answer the following question: What evidence did each person use to arrive at his or her explanation?
- select a group member to retell the description or story, using diagrams if necessary
- provide a summary of the evidence that was used to come up with the explanation for the shape of the Earth

As a class, discuss why it is so difficult to change what people believe. Ask students how they would feel if they were told that new discoveries could prove the Earth was really flat.

➢ Timeline of Changing Views

As a class, develop a timeline of the changing views of the Earth and its position in space. (Reference terms identified in the "include" part of learning outcome 6-4-07.) Students can use CD-ROMs, videos, print resources, and the Internet to find the information needed.

➢ Dramatization

Ask students to form small groups and have each student select one of the persons mentioned on the timeline created in the previous learning activity. Have students prepare a speech introducing the selected person and explaining his or her belief about the Earth's position in space and the evidence on which this is based. Students could dress in costumes of the time. Have students present their dramatizations to the class. If possible, invite another class as well.

Suggestions for Assessment

Nature of Science

Provide students with the following:

Thinking about Science

Write your own definition of what science is and how it works. (Use examples from recent learning activities to support your answer.)

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 4)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-08 Recognize that the Sun is the centre of the solar system and it is the source of energy for all life on Earth.

GLO: D6, E2, E4

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **The Day the Sun Disappeared**

Ask students to write a story about what would happen to the Earth and other planets if the Sun disappeared. Have them include the following concepts:

- all life on Earth would be destroyed
- planets would not remain in their orbits
- planets would cool dramatically

6-4-09 Identify the planets in the solar system and describe their size relative to the Earth and their position relative to the Sun.

GLO: D6, E1, E2

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5d ➲ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)

(continued)

➢ **Ordering the Planets**

Bring to class a variety of spheres (e.g., marbles, peas, golf balls, tennis balls, volleyballs, basketballs, beach balls) in a range of sizes. Have small groups of students

- arrange the spheres according to the relative size and order of the Sun and the planets in the solar system
- label their models
- share their models with the class and justify their placement choices

➢ **Great Distances**

Provide students with the "Planet Facts" data presented in the Teacher Notes on the following page. Have students use a large ball of string to plot the location of the planets in relation to the Sun on a school hallway wall. Start with the Sun (attach a label) and then, 58 cm further, add the label for Mercury, and so on. Students will need to calculate how many more centimetres of string to add after each planet. A chart such as the following may be helpful.

(continued)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 6-4-10.

Teacher Notes

The learning experiences suggested for learning outcome 6-4-09 refer to the following data:

Planet Facts

Planet	Distance from the Sun	Average Diameter
Mercury	58 million km	5 000 km
Venus	108 million km	12 000 km
Earth	150 million km	13 000 km
Mars	228 million km	7 000 km
Jupiter	778 million km	143 000 km
Saturn	1 427 million km	120 000 km
Uranus	2 870 million km	52 000 km
Neptune	4 497 million km	50 000 km
Pluto	5 900 million km	3 000 km

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 3)

Science Everywhere 6 (p. 99)

Addison Wesley Science & Technology 6: *Space* (Chapter 11)

Science Everywhere 6 (p. 82)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-09 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

Example:

Relative Distances

Planet	Distance from the Sun	Additional cm Needed
Mercury	58 million km	
Venus	108 million km	50 cm
Earth	150 million km	42 cm
Mars	228 million km	78 cm
Jupiter	778 million km	550 cm
Saturn	1 427 million km	
Uranus	2 870 million km	
Neptune	4 497 million km	
Pluto	5 900 million km	

➢ **How Big Are the Planets?**

Ask students whether they think the spheres they used in their models (see Ordering the Planets learning activity associated with learning outcome 6-4-09) accurately represent the relative sizes of the planets. Have them make a "sizing up the planets" model. This can be done outdoors using sidewalk chalk or indoors (e.g., in the gymnasium) on large pieces of paper.

Using the "Average Diameters" data from the chart presented in the Teacher Notes for learning outcome 6-4-09, have students calculate the radius of each planet. They can use a scale of 1000 km = 1 cm (if done indoors) or 1000 km = 10 cm (if done outdoors). To draw the circles, students can use a compass or create a push-pin string/pencil system. Once the drawings are complete, have students take a cutout model of the Earth and compare its size to that of the other planets.

SUGGESTIONS FOR ASSESSMENT

Refer to the assessment strategy suggested for learning outcome 6-4-10.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-10 Classify planets as inner or outer planets, based on their position relative to the asteroid belt, and describe characteristics of each type.

Include: inner planets are small and rocky; outer planets (except Pluto) are giant balls of gas.

GLO: D6, E1

6-0-7f Reflect on prior knowledge and experiences to construct new understanding, and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 6, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ Inner or Outer Planets

Have students complete a chart listing all the planets in our solar system, briefly describing their composition and classifying them as inner or outer planets.

Example:

The Composition and Classification of Planets

Planet	Composition	Inner or Outer Planet
Mercury	rocky, small	inner
Pluto	rocky, small	outer

➢ Word Splash

Give students a Word Splash (Saphier and Haley, 1993) such as the one presented below. Have them work in groups to make connections between the words, based on their prior knowledge, and then use the words to create a descriptive paragraph. Have groups share their paragraphs and compare the similarities and differences. Identify and correct any inaccuracies and misconceptions.

(For a discussion of the Word Splash strategy, see *Success*, p. 6.28.)

Example:

Word Splash

Sun	**rocky**	**gaseous**	**inner**
large	**Earth**	**centre**	**Saturn**
solar system	**Mercury**	**Jupiter**	**small**
Venus	**Uranus**	**Mars**	
outer	**energy**	**orbit**	**Neptune**
Pluto			

Suggestions for Assessment

Extended Response

Provide students with the following:

The Solar System

Make a labelled diagram of the solar system. In your diagram, include the following: the Sun, the planets (inner and outer), and the asteroid belt.

Look for:
- the Sun
- nine planets in the correct order
- the asteroid belt
- inner and outer planets (labelled)
- a neatly and accurately completed diagram

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 11)

Science Everywhere 6 (pp. 84-85)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-11 Recognize that mass is the amount of matter in an object, that weight is the force of gravity on the mass of an object, and that the force of gravity varies from planet to planet.

GLO: D3

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5d ➲ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)

6-0-5e Estimate and measure accurately using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-I.1.5)

SUGGESTIONS FOR INSTRUCTION

➢ **Measuring Weight and Mass**

To demonstrate the difference between weight and mass, have students do the following:

- Measure the weight of a collection of pennies using a *spring scale*. (A spring scale measures the gravitational pull on the pennies or their weight.)
- Measure the mass of the collection of pennies by using a *balance scale.* The scale can be balanced by adding any type of object such as paper clips, cubes, or beans. (A balance scale is an instrument that compares the masses of two objects. The unknown mass is placed on one side of the balance and known masses are added to the opposite side until the instrument balances. When the instrument balances, the unknown mass equals the sum of the known masses.)
- Discuss the difference between the two measurements of the pennies.

➢ **How Much Would I Weigh?**

Provide students with the following task:

Student A weighs 30 kg on Earth. Use the following chart to calculate student A's weight on each planet/moon. (Multiply student A's Earth weight by the gravity factor.)

Calculating Weight on Planets/Moon

Planet/Moon	Gravity Factor	Student A's Weight
Mercury	0.284	
Venus	0.907	
Earth's moon	0.166	
Mars	0.380	
Jupiter	2.340	
Saturn	0.925	
Uranus	0.795	
Neptune	1.125	
Pluto	0.041	

Have students look at the above chart and answer the following questions:

- On which planet(s) would you weigh about the same as you do on Earth?
- On which planet would you weigh the least?
- On which planet would you weigh the most?
- How would your mass be affected on the other planets? (Mass would not change.)

SUGGESTIONS FOR ASSESSMENT

Extended Response

Provide students with the following:

Mass Versus Weight

In your science notebook, explain the difference between *mass* and *weight*. Provide examples to support your answer.

Look for:

- an understanding of *mass*
- an understanding of *weight*
- examples to support the answer
- a clear and complete explanation

Teacher Notes

Background Information

- On Earth, *weight* is the term used to measure the force of attraction between an object and the Earth. This force is called a *gravitational attraction.* An object's weight would change if it were measured on another celestial body that had a gravitational force different from that of the Earth.
- The amount of weight depends on the *mass* (the amount of matter present). Unlike weight, the mass of an object would not change regardless of where it were measured. The object would have the same mass on the moon as it would on the Earth because mass is the measure of the amount of particles present. An object would weigh less on the moon than on the Earth, but its size would not change because its mass would not change. Regardless of what planet an object is on, the object can gain weight only if more particles (mass) are added to it.

SUGGESTED LEARNING RESOURCES

Science Everywhere 6 (p. 85)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-12 Explain, using models and simulations, how the Earth's rotation causes the cycle of day and night, and how the Earth's tilt of axis and revolution cause the yearly cycle of seasons.

GLO: A2, D6, E2, E4

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 6, 4.4.1; TFS: 3.2.2, 3.2.3)

(continued)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

The Earth rotates around a tilted axis (23.5 degrees). The north end of the axis always points toward the North Star as the Earth circles the Sun. The tilted axis of the Earth and the yearly orbit of the Earth around the Sun cause variations in the amount of heat at different locations on Earth at different times of the year, which cause seasonal changes. Summers in Canada are warmer than winters, not because the Earth is closer to the Sun at that time of year (a common misconception) but because the Sun shines more directly on the Earth in summer than it does in winter. At noon in summer the Sun is directly overhead, whereas in winter it is not. Places nearer the equator do not experience the extremes in climate caused by the tilt of the Earth's axis.

➢ Exploring the Earth's Rotation

1. On a sunny day take students outdoors. Push a long stick into level ground so that it is upright, perpendicular to the ground. Mark the tip of the stick's shadow using a stone or other marker. Have students mark the tip of the shadow every 10 minutes for half an hour. Ask students how the shadow is moving and why. (The Earth has a large diameter, about 13 000 km. It makes one complete rotation in 24 hours.)
2. Provide students with a flashlight and a globe. Ask students to mark their location on the globe. Have one student stand still with the flashlight as another student slowly rotates the globe. Ask students to note the change in the amount of light (day and night) at the location that they marked.
3. Read the following excerpt from *The Missing Sun*, a book exploring the Inuit and Western scientific explanations for day and night in the Arctic:

   "Emily's mother had told her that it would be different living in Inuvik but not that much different than living in Regina.

   Because her mother was a meteorologist, Emily believed her when she said it could be just as cold and just as windy in Inuvik as it was in Regina. But when Emily's mother told her that in Inuvik the sun wouldn't come up for many, many days and that even on Christmas Day, it was going to be night all day long, Emily could not believe her."*

   Have students write a letter to Emily explaining why her mother is correct.

(continued)

* Excerpt reproduced from *The Missing Sun*. Copyright © 1993 by Peter Eyvindson. Reproduced by permission of Pemmican Publications, Inc.

Suggestions for Assessment

Teacher Notes

Given the difficulty of the concepts associated with learning outcome 6-4-12 and the prevalence of strongly held misconceptions through to adulthood, provide students with opportunities to explore these concepts in a variety of ways. In addition to participating in the suggested learning experiences, students should have opportunities to view computer models or videos illustrating the causes of day and night and the seasons. If possible, visit a planetarium.

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 5)

Science Everywhere 6 (pp. 96, 102)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-12 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Exploring Seasons**

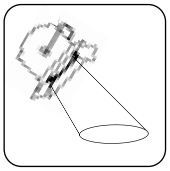
Assemble the following items: a globe that rotates around a tilted axis, a small lamp, a small nail with a large head, and adhesive tape. Create the following simulations to explore the yearly cycle of seasons:

- Place the lamp (without a shade) in the middle of the floor to represent the Sun.
- Label north (winter).
- Use the small nail to mark the school's location on the globe by taping it head down.
- Place the globe on the ground about 1.5 m away from the lamp on the side opposite north. The light bulb should be at the same height as the middle of the globe. The globe should tilt toward north.
- Centre the nail in the light and note the length of the shadow.
- Repeat the process for each direction: east (fall), west (spring), and south (summer), noting the shadow length. (A short shadow indicates strong, direct sunlight; a long shadow indicates weaker sunlight coming toward a direction at an angle.)

Ask students in what season we receive the most sunlight (where the nail's head is in the light the longest) and in what season we receive the same amount of daylight and darkness.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Is It True?

Provide students with the following:

Is the Sun Closest to the Earth in Summer?

At the ball diamond, you overhear a conversation between two young children.

Is the child's answer correct? Explain your thinking. Use both words and diagrams in your answer.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-13 Use the design process to construct a prototype that tells the time of day or measures a time span.

GLO: C3, D6

6-0-1c Identify practical problems to solve. *Examples: How can I make a hot-air balloon? Which type of light bulb should I buy?…* GLO: C3

6-0-1d ➲ Identify various methods to solve a practical problem, and select and justify one to implement. *Examples: constructing and testing a prototype; evaluating consumer products; accessing information from a variety of sources...* GLO: C3 (Math: SP-I.2.6, SP-II.1.6)

6-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, use of recycled materials, cost, reliability. GLO: C3

6-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, labelled diagrams of top and side views, steps to follow. GLO: C1, C3, C6

6-0-4b ➲ Construct a prototype. GLO: C3

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4d Assume various roles to achieve group goals. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

6-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

6-0-5c Select and use tools and instruments to observe, measure, and construct. *Examples: hand lens, telescope, binoculars…* GLO: C2, C3, C5

6-0-5d ➲ Evaluate the appropriateness of units and measuring tools in practical contexts. GLO: C2, C5 (Math: SS-I.1.6)

6-0-5e Estimate and measure accurately using SI and other standard units. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-I.1.5)

6-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

6-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

6-0-7e ➲ Identify new practical problems to solve. GLO: C3

SUGGESTIONS FOR INSTRUCTION

➢ **Design Scenario**

Present students with one of the following scenarios:

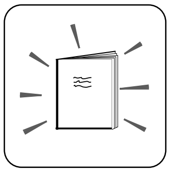
1. You have been selected to design a prototype that tells the time of day for your classmates in a wilderness survival course (e.g., an hour glass, a sun dial, a pendulum).
2. The timer on your stove has broken. You want to bake cookies but you need to time them as accurately as possible for 12 minutes. Design a prototype that will tell you when to remove the cookies from the oven (e.g., an hour glass, a pendulum).

Possible criteria:

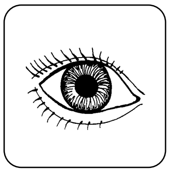
- the cost falls within a given budget
- the prototype works in repeated trials
- it is aesthetically pleasing
- it is portable (small enough to carry around)

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Project Report: Assessment" (BLM 6-F)



"Constructing a Prototype: Observation Checklist" (BLM 6-D)

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 1)

Science Everywhere 6 (p. 97)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-14 Explain how the relative positions of the Earth, moon, and Sun are responsible for moon phases and eclipses.

GLO: D6, E2

6-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

6-0-5f Record and organize observations in a variety of ways. *Examples: point-form notes, sentences, labelled diagrams, charts, ordered lists of data, frequency diagrams, spread sheets…* GLO: C2, C6 (ELA Grade 6, 3.3.1; Math: SP-III.2.6)

(continued)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

The moon revolves around Earth once every 27.3 days. It appears to rise in the east and set in the west due to the Earth's rotation from west to east. The moon does not generate its own light, but is visible due to reflected light from the Sun.

➢ Moon Phases

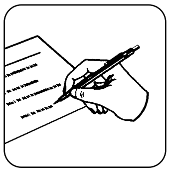
Provide students with a flashlight (or a projector with a strong focused beam supported by a stand) and a large basketball. Assign students to specific roles: Have one student hold the flashlight (representing the Sun) in the centre of the room. Have another student represent the Earth and walk around the Sun while slowly spinning. Have another student represent the moon by holding the ball slightly above his or her head. The moon circles the Earth and faces the Earth at all times. The person representing the Earth looks at the moon continuously in order to see its phases. Ensure that students have opportunities to try the different roles and to explain what they saw happening.

➢ Charting the Phases of the Moon

Have students observe the moon each night (for one lunar phase) and chart what they see. Have them compare the phases of the moon observed in the previous learning activity with their actual observations. (Phases of the moon are also reported in newspapers. On nights when the moon is not visible or at times of the year when the moon appears late at night, newspaper reports would provide an alternative source of data.)

(continued)

SUGGESTIONS FOR ASSESSMENT



Extended Response

Provide students with the following:

The Moon and the Sun

Answer the following questions in your science notebook:

1. Why does the moon appear to change shape over the course of a month?
2. Why do we have eclipses of the moon and the Sun?

Look for:

- the moon revolves around the Earth once every 28 days
- the Earth rotates on its axis
- the moon is visible due to reflected light from the Sun
- the phases of the moon are caused by the partial blocking of the Sun's light
- an eclipse occurs when one heavenly body obscures another
- a lunar eclipse occurs when the Earth is directly between the Sun and the moon
- a solar eclipse occurs when the moon is between the Earth and the Sun

SUGGESTED LEARNING RESOURCES

Addison Wesley Science & Technology 6: *Space* (Chapters 6, 7, 10)

Science Everywhere 6 (p. 92)

PRESCRIBED LEARNING OUTCOMES
Students will...
6-4-14 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Total Solar Eclipse**

To demonstrate what happens in a total solar eclipse, have students follow these steps:

- Close one eye and then hold out one index finger (representing the Sun) at arm's length.
- Keep one eye open and look at the index finger.
- Slowly move a finger from your other hand (representing the moon) across in front of your open eye until both fingers line up and the farther finger is completely blocked from view.

➢ **Lunar Eclipse**

Use a flashlight, a large ball, and a small ball to represent the Sun, the Earth, and the moon respectively. Hold the large ball in front of the flashlight and the small ball on the side of the large ball opposite the flashlight. Ask students: What do you observe?

Safety Precaution: Lunar eclipses are safe to view at any time. Solar eclipses must be viewed indirectly or with a proper filter. The Sun's light is strong enough to cause serious eye damage. Instant blindness could result from unsafe viewing of the Sun with binoculars or a telescope.

➢ **Solar Eclipse Safety**

Have students make safety posters demonstrating safe practices for viewing a solar eclipse. Put up the posters and have students take a Gallery Walk (Brownlie and Close, 1992) to observe them.

Suggestions for Assessment

Suggested Learning Resources

Teacher Notes

Background Information

- An *eclipse* occurs when one heavenly body obscures another.
- A *lunar eclipse* occurs when the Earth is directly between the Sun and the moon. The moon cannot be seen because the Earth blocks the Sun's light from being reflected off the moon.
- A *solar eclipse* occurs when the moon is between the Earth and the Sun. The moon blocks the Sun's light and creates a shadow on the Earth.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-15 Identify points of reference in the night sky and recognize that the apparent movement of celestial objects is regular, predictable, and related to the Earth's rotation and revolution.

Examples: planets, constellations...

GLO: D6, E2, E3

6-0-4c ➲ Work cooperatively with group members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 6, 5.2.2)

6-0-4e ➲ Use tools and materials in a manner that ensures personal safety and the safety of others. Include: keeping an uncluttered workspace; putting equipment away after its use; handling glassware with care. GLO: C1

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Creating an Umbrella Planetarium**

Demonstration:

- Use chalk or a white pencil to draw stars onto a black umbrella.
- Put the North Star (Polaris) at the centre of the inside of the umbrella. The North Star is at the end of the handle of the Little Dipper.
- Mark the positions of the remaining stars of the Little Dipper, as well as the stars of the Big Dipper and other constellations such as Cepheus, Draco, and Cassiopeia.
- Draw lines to connect the stars in each constellation.
- Turn the umbrella counter-clockwise to show how the stars appear to move through the night sky.

Ask students to demonstrate what really happens. (A student could pretend to be the Earth and rotate under a stationary umbrella.)

As a link to the learning experiences related to changing conceptions of the Earth and its position in space (see learning outcome 6-4-07), ask students to explain why people long ago believed that the stars moved and the Earth was stationary. (From any location on Earth, it seems as though we are standing still while the stars are moving.)

➢ **Shoebox Constellations**

To create a simulated planetarium, have students follow these steps:

1. Bring to class a shoebox and cut a rectangle out of one end of it, leaving a 2 to 3 cm border of cardboard.
2. Cut a hole in the opposite end of the shoebox just large enough to look through.
3. Cut a narrow slit in the lid of the box approximately 2 cm from one end and slightly less than the entire width of the lid, ensuring that the slit is just wide enough to allow a thin cardboard card to be inserted but not so wide as to allow excess light into the box.
4. Paint the inside of the box black, or cover it with black construction paper.

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

The stars appear to be moving because of the Earth's movement. The constellations shown in the umbrella are always visible above the horizon. Constellations further from the North Star rise and set each day as the Earth turns. The ribs of the umbrella represent celestial meridians. Astronomers determine the celestial longitude of stars in the same way that longitude is used on Earth.

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapter 12)

Science Everywhere 6 (p. 79)

Native Studies: Middle Years (Grades 5 to 8) (Teacher Reference)

Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

Native Science: Natural Laws of Interdependence (Teacher Reference)

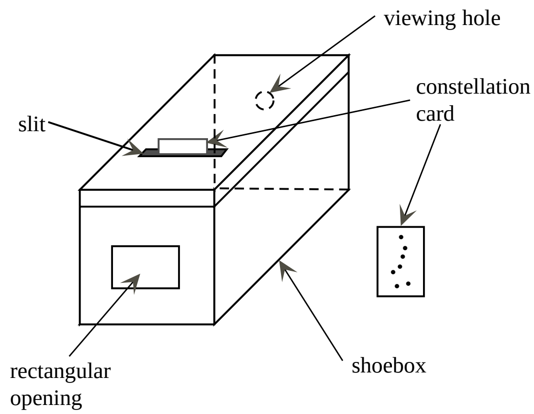
Prescribed Learning Outcomes	Suggestions for Instruction

Students will...

6-4-15 *(continued)*

(continued)

5. Create constellation cards by cutting pieces of light cardboard/heavy paper that fit the width of the slot in the lid of the shoebox but are slightly taller than the box. Then, using a sharp pencil, punch holes in each card to represent a different constellation (leave a 2 to 3 cm border without holes).
6. Place a constellation card in the slot, hold the box toward a light source, and look through the eyehole to observe the constellation. (An alternative is to enlarge the eyehole to fit the end of a flashlight and shine the light through the box so that the constellation can be projected onto a screen or light-coloured wall.)



Have students share their constellations with other students and challenge them to identify the constellations depicted.

➢ **Constellations from an Aboriginal Perspective**

Provide students with information regarding Aboriginal perspectives on some of the planets, constellations, and stars according to the Cree and Ojibway people of Manitoba. (See *Native Studies: Middle Years [Grades 5 to 8]*, 1997.) Have students use the blank Star Map (see BLM 6-C) and label the constellations using the Cree and/or Ojibway names.

Students could also research oral and written traditions for legends about each constellation or star.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Refer to the assessment strategy suggested for learning outcome 6-4-15.

PRESCRIBED LEARNING OUTCOMES

Students will...

6-4-16 Identify and describe how people from various cultures, past and present, apply astronomy in daily life.

Examples: using celestial bodies to navigate; knowing when to plant crops...

GLO: A4, A5, B1, B2

6-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 6, 3.2.2; Math: SP-II.1.6; TFS 2.2.1)

6-0-2b ➲ Review information to determine its usefulness, using predetermined criteria. GLO: C6, C8 (ELA Grade 6, 3.2.3)

6-0-2c Make notes on a topic, combining information from more than one source and referencing sources appropriately. GLO: C6 (ELA Grade 6, 3.3.2)

6-0-8b ➲ Identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence. GLO: A2

6-0-8d ➲ Provide examples of technologies from the past and describe how they have evolved over time. GLO: B1

6-0-9a ➲ Appreciate that women and men of diverse cultural backgrounds can contribute equally to science. GLO: A4

SUGGESTIONS FOR INSTRUCTION

➢ **Literature Connection**

Have students look in fiction texts for references to navigation using the stars. This literature may be related to a social studies or an English language arts classroom theme. There are many stories that tell how different groups of people used the constellations as a guide when travelling (e.g., stories of the Underground Railroad often make reference to the constellations).

➢ **Astronomy Timeline**

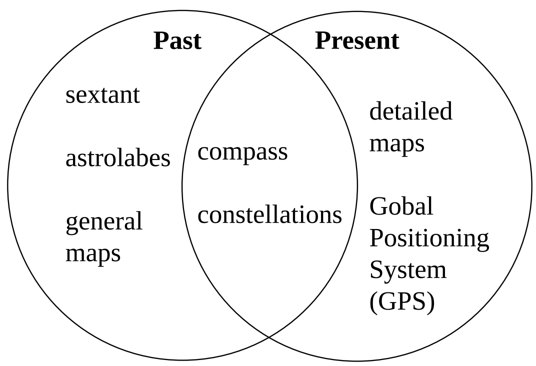
Have students make a timeline to illustrate how astronomy has been used throughout history by different cultures and continues to be used today. Information can be found on the Internet, or CD-ROMs, in print resources from elders, on videos, and so on.

➢ **Past-Present Comparison**

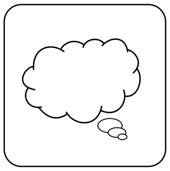
Have students use a Venn diagram to compare navigational devices from the past to those of the present.

Example:

Navigational Devices



Suggestions for Assessment



Astronomy

Have students reflect in their science journals on why astronomy has been so important to people in the past and continues to fascinate people today.

Suggested Learning Resources

Addison Wesley Science & Technology 6: *Space* (Chapters 1, 3)

Science Everywhere 6 (p. 79)

Native Studies: Middle Years (Grades 5 to 8) (Teacher Reference)

Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

Native Science: Natural Laws of Interdependence (Teacher Reference)

Prescribed Learning Outcomes

Students will...

6-4-17 Differentiate between astrology and astronomy, and explain why astrology is considered unscientific.

GLO: A1, A2, C5, C8

6-0-8a ⊃ Recognize that science is a way of answering questions about the world, and that there are questions that science cannot answer.
GLO: A1, A3

Suggestions for Instruction

Teacher Notes

Background Information

Both astronomy and astrology are concerned with the study of the heavenly bodies and with pinpointing the location of the planets and stars.

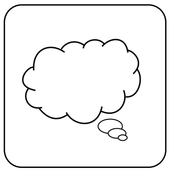
- *Astrology* involves personal viewpoints and predictions that are open to interpretation and are not based on tested facts and are difficult to verify. For example, some people believe that the sign of the zodiac in which the Sun, moon, and planets appeared on the day you were born influences your personality. This belief is called astrology.
- *Astronomy* involves explanations based on repeated observation and testing and has a readily proven predictive capacity. For example, scientists can predict when the next lunar eclipse will take place. If it does not take place as expected, scientists will revise their model/understanding until they can accurately predict this event again and again.

➢ How Is Your Horoscope?

Determine the astrological sign for all students based on their birth dates. Refer to a horoscope that is several days old and tell students that you will read out the horoscope prediction for the day before (yesterday). Ask students to think about the day they had yesterday and to list what part of the horoscope prediction actually happened. Once the lists are complete, tell students that the horoscope was not for yesterday but was for an earlier date. Ask students the following questions:

- Why were you able to find things that actually happened (that corresponded with the horoscope prediction) even though the date was incorrect? (Horoscopes are so general that most people would be able to find a word or a phrase that would be true for them.)
- Do you believe that astrology can be called a science? Is it based on fact? Is it testable? Is it observable? Give reasons for your answers.

Suggestions for Assessment



Cluster Reflection

Provide students with the following sentence stems:

Reflection

1. I found it interesting . . .
2. I was surprised . . .
3. I still have questions about . . .

Suggested Learning Resources

Science Everywhere 6 (p. 80)

Notes

Grade 6

Blackline Masters

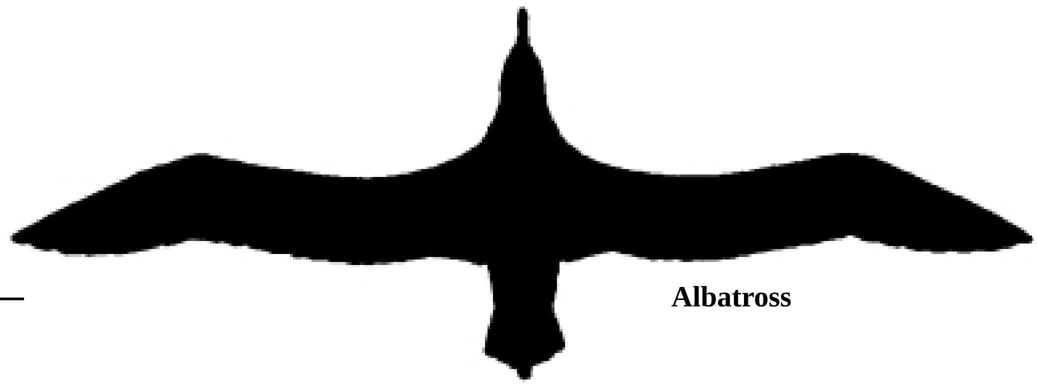
- Wing Shapes (BLM 6-A)
- Changing Conceptions of the Earth and Its Position in Space (BLM 6-B)
- Star Map (BLM 6-C)
- Constructing a Prototype: Observation Checklists (BLM 6-D)
- Design Project Report (BLM 6-E)
- Design Project Report: Assessment (BLM 6-F)
- Conducting a Fair Test: Observation Checklist (BLM 6-G)
- Experiment Report (BLM 6-H)
- Experiment Report: Assessment (BLM 6-I)

Wing Shapes

Match-up each description with the appropriate wing shape of the following birds. Write the name of each bird in the space provided.

a. short wings, allowing quick acceleration over a short distance

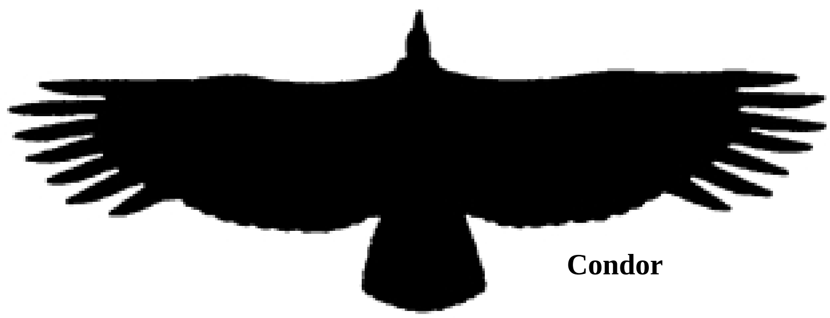
____



Albatross

b. long, slender, powerful wings for flying in strong winds on the open ocean

____



Condor

c. long, broad, flat wings soar at great heights and make powerful dives

____

Swift

d. small, stiff, narrow wings, which are like helicopter rotors for excellent control

____

Quail

e. long, slender wings, for fast flight

____

Hummingbird

Changing Conceptions of the Earth and Its Position in Space

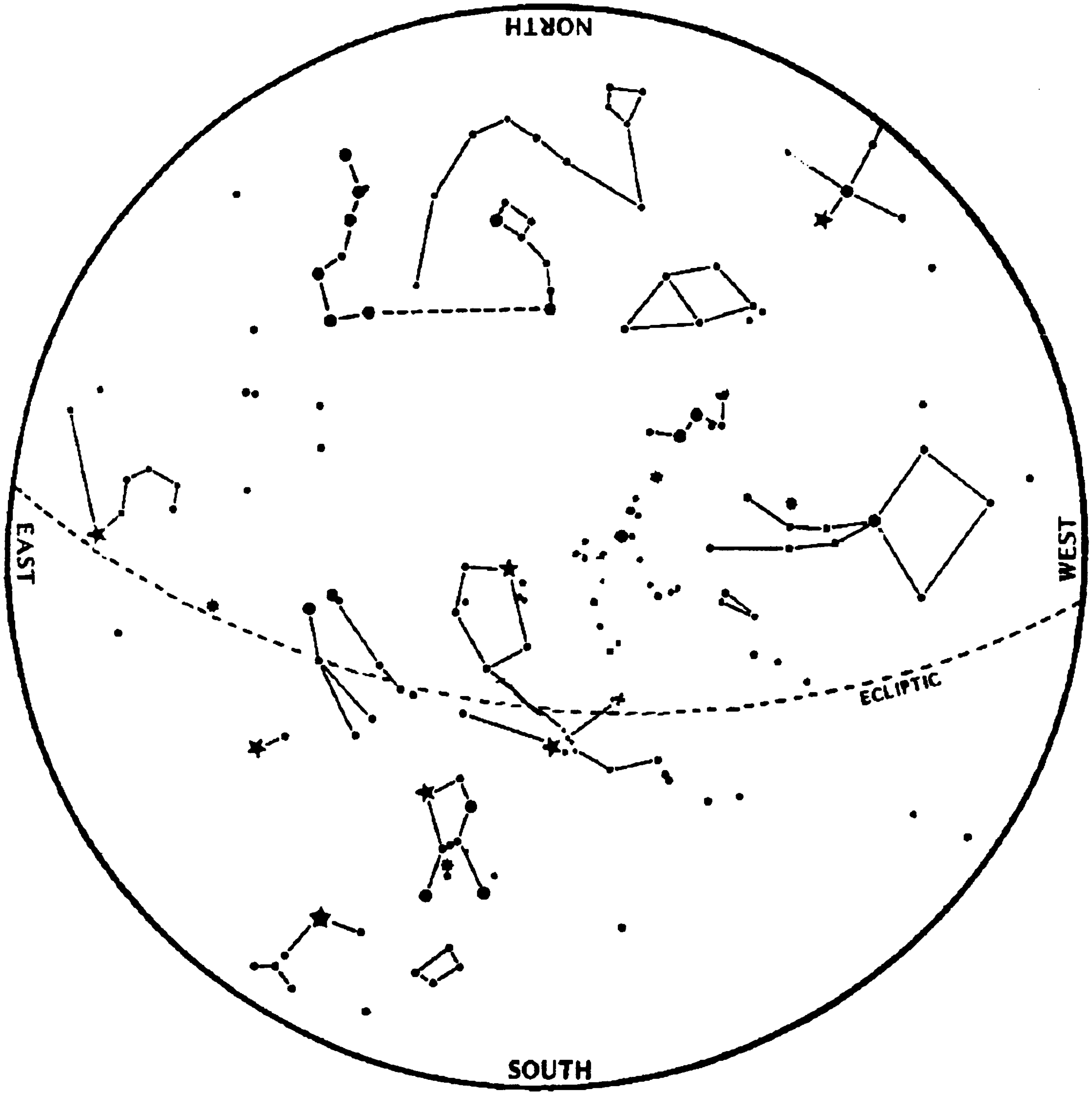
1. In 530 B.C. while teaching in southern Italy, Pythagoras, a Greek mathematician, suggested the idea of the spherical Earth. He got his idea from watching ships sail out to sea. He observed that as ships moved further from shore, they became smaller and smaller until they eventually disappeared from sight, first the hull and then the mast. Pythagoras realized that if the Earth was flat, then the whole boat would disappear at once. He surmised that if the Sun and moon are spherical, then the Earth must be too.

2. In Athens, Greece, around 450 B.C., Greek philosopher Anaxagoras thought that the Earth was a sphere. He also thought that the moon shone because of reflected light from the Sun. He enjoyed watching the moon. He concluded that eclipses occur when the Earth moves between the Sun and the moon. He saw that the dark area on the moon was curved and realized that, since it was the Earth's shadow, the Earth must be curved as well.

3. Around 225 B.C., Greek astronomer Eratosthenes was a librarian in Alexandria, Egypt. He was inspired by a book stating that in southern Egypt at noon on the longest day of the year when the Sun was at the highest point in the sky a vertical stick did not cast a shadow. Eratosthenes thought that if the Earth was flat, then he too should not get a shadow at that time in northern Egypt. He tried the same thing, and there was a shadow. He inferred that the Earth must be round because the Sun created a noon shadow at one location but not at another.

4. In 1543, Polish astronomer Copernicus suggested that the Earth spins around an axis like a top and also revolves around the Sun once a year. The church at the time rejected his theory and threw him into prison. His theory eventually was proven to be true.

Star Map



Star Map: Reproduced from *Native Studies: Middle Years (Grades 5 to 8): A Teacher's Resource Book*. Winnipeg, MB: Manitoba Education and Training, 1997. p. 3.18.

Constructing a Prototype: Observation Checklist

Date: ________________________________ Problem/Challenge: _______________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Constructing a Prototype: Observation Checklist *(continued)*

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Design Project Report

Name: ____________________________________ Date: ___________________________________

Problem/Design Challenge:

Criteria:

Brainstorming (What are all the different ways . . .):

Planning:

Steps to Follow:

Materials:

Safety Considerations:

.

(continued)

Design Project Report *(continued)*

Testing:

Criteria	Test Used

Test Results: Attach Data Summary

Evaluating and Improving:

- Justification of changes to original design:

- Strengths and weaknesses of final design:

- Comment/reflection (Next time . . . , A new problem . . . .):

(continued)

Design Project Report *(continued)*

Prototype Sketch 1 (Plan):

Top View

Side View

Prototype Sketch 2 (Final):

Top View

Side View

Design Project Report: Assessment

Prototype: ____________________________ Date: ____________________________

Team Members: ____

<table>
<tr><th>Criteria</th><th>Possible Points*</th><th>Self-Assessment</th><th>Teacher Assessment</th></tr>
<tr><td>Identifying the Practical Problem and Criteria for Success
• the problem is clearly stated
• class and/or group criteria are identified
• criteria address all or some of the following: function, aesthetics, environmental considerations, cost, reliability</td><td></td><td></td><td></td></tr>
<tr><td>Planning
• all steps are included and clearly described in a logical sequence
• all required materials/tools are identified
• safety considerations are addressed
• a labelled top- and side-view sketch of the prototype is included (Sketch 1)</td><td></td><td></td><td></td></tr>
<tr><td>Testing the Prototype
• tests are described and align with criteria (e.g., each criterion has been tested)
• test results are presented in an appropriate format (data sheet is attached)</td><td></td><td></td><td></td></tr>
<tr><td>Evaluating and Improving the Design
• a final sketch of the prototype is included (Sketch 2)
• changes to the original plan are justified
• strengths and weaknesses of the final prototype are presented
• suggestions for “next time” are included and/or “new problems” are identified</td><td></td><td></td><td></td></tr>
<tr><td align="right">Total Points</td><td></td><td></td><td></td></tr>
<tr><td colspan="4">Comments:</td></tr>
</table>

*__Note:__ The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Conducting a Fair Test: Observation Checklist

Experiment: ______________________________________ Date: ________________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (workspace, handling equipment)	Ensures Accuracy/ Reliability (e.g., repeats measurements)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Conducting a Fair Test: Observation Checklist *(continued)*

Names	Has Safe Work Habits (workspace, handling equipment)	Ensures Accuracy/ Reliability (e.g., repeats measurements)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Experiment Report

Name: ______________________________ Date: ______________________________

Experiment: ____

Question:

Prediction/Hypothesis: (Identify a cause and effect relationship.)

Planning for a Fair Test

- **Apparatus/Materials:**

- **Variables to Hold Constant:**

- **Method:** (Include steps to follow and safety considerations.)

(continued)

Experiment Report *(continued)*

Observations:

Analysis of Data: (Identify patterns and discrepancies.)

Note: Attach graph on a separate page, if required.

(continued)

Experiment Report *(continued)*

Strengths and Weaknesses of Approach: (State what went well and what needs to be done differently next time.)

Conclusion: (Support or reject prediction/hypothesis; pose new question(s).)

Applications/Implications: (Link to daily life or area of study.)

Experiment Report: Assessment

Experiment Title: ______________________________ Date: ____________________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Making a Prediction/Hypothesis • the prediction/hypothesis clearly identifies a cause and effect relationship			
Planning for a Fair Test • required apparatus/materials are identified • major variables to hold constant are identified • steps to follow are included • safety considerations are addressed			
Conducting a Fair Test/Making and Recording Observations • detailed data are recorded, appropriate units are used • data are recorded in a clear/well-structured/appropriate format			
Analyzing and Interpreting • graphs are included (where appropriate) • patterns/trends/discrepancies are identified • strengths and weaknesses of approach are identified			
Drawing a Conclusion • prediction/hypothesis is supported or rejected • new question(s) are identified			
Making Connections • potential applications to or implications for daily life are identified and/or links to area of study are made			
Total Points			
Comments:			

*__Note:__ The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the experiment.

Grade 7 Science

Grade 7

Cluster 1: Interactions within Ecosystems

Overview

In this cluster, students investigate the complex interactions between organisms and their environment. Students identify biotic and abiotic components of ecosystems, and analyze the cycling of matter that takes place within them. This includes an investigation of the transfer of energy that occurs at various consumer levels, the implications of the loss of producers and consumers to the transfer of energy, and the potential for bio-accumulation within an ecosystem. Students explore ecological succession and assess the positive and negative impacts of human interventions on this natural process. Students discuss environmental, social, and economic factors that should be considered in the management and preservation of ecosystems. They propose a course of action that would help protect the habitat of a particular organism. Students observe micro-organisms with microscopes and discuss their beneficial and harmful roles. Students consider how knowledge of micro-organisms has improved food production and preservation techniques.

Prescribed Learning Outcomes

Students will...

7-1-01 Use appropriate vocabulary related to their investigations of interactions within ecosystems.

Include: ecosystem, biosphere, abiotic, biotic, organisms, ecological succession, photosynthesis, cellular respiration, ecological pyramid, bioaccumulation, scavengers, decomposers, micro-organisms.

GLO: C6, D2

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 4, Cluster 1: Habitats and Communities; in Grade 4, Cluster 4: Rocks, Minerals, and Erosion; and in Grade 3, Cluster 1: Growth and Changes in Plants.

- Introduce, explain, use, and reinforce vocabulary throughout this cluster.

- **Word Cycle**

  Have students use the Word Cycle (Szabos, 1984) strategy to develop an understanding of a term by seeing how it is related to other terms. Students select one term from a list provided and place it on the word cycle. They then select a second term to place in an adjacent spot, indicating the relationship between the terms on a connecting band. This process continues until all spots have been filled. Students can then pair up to discuss their cycles and defend the choices they made.

  (For a BLM of a Word Cycle, see *SYSTH*, Attachment 10.1, or *Success*, p. 6.99.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

7-1-02 Define ecosystem, and describe various examples that range from the microscopic to the entire biosphere.

Include: a place on Earth where living things interact with other living things as well as non-living things.

GLO: D2, E2

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…*
GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts.
GLO: A2, C4 (ELA Grade 7, 1.2.1)

Suggestions for Instruction

➢ **Defining an Ecosystem**

Provide small groups of students with pictures of various ecosystems (e.g., a forest, a pond, a prairie). Have students use a Concept Frame (Matchullis and Mueller, 1994) to

- list the characteristics common to all the pictures (e.g., they all contain living and non-living components)
- name the ecosystem each picture represents (students may need to use references) and list them in the “examples” portion of the frame
- write their own definition of an ecosystem
- describe what ecosystems are like and unlike

Have students share their results with the class. Discuss and revise these results with students as necessary to create a class definition that contains essential elements from the “include” portion of learning outcome 7-1-02.

(For a BLM of a Concept Frame, see *SYSTH*, Attachment 11.2, or *Success*, p. 6.111.)

➢ **Ecosystem Awareness**

Have students work in small groups to determine which of the following are examples of ecosystems:

- puddle
- rain barrel of water
- vacant lot
- Spirit Sands (Carberry Desert)
- field of wheat
- Canadian Shield
- North America
- Earth

Have two groups come together to discuss their conclusions and then work to reach consensus on the list. Students should continue this process until they reach a class consensus.

(Students should find that all items on the list meet the definition of an ecosystem. Not all the examples listed are stable or long-term, but they all include an interaction of living and non-living components.)

Suggestions for Assessment

Journal Reflection

Have students reflect on their experiences related to ecosystems using the following sentence stems:

1. I was surprised to learn . . .
2. I found it interesting that . . .
3. I wonder . . .

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.2)

Sciencepower 7 (Section 1.2)

Addison Wesley Science & Technology 7 (Chapter 1, Section 1.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-03 Identify abiotic and biotic components of ecosystems that allow particular organisms to survive.

GLO: D1, D2, E2

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

SUGGESTIONS FOR INSTRUCTION

➢ Biotic or Abiotic

Use explicit instruction to introduce the terms *biotic* and *abiotic* as the scientific way of referring to living and non-living components of an ecosystem. Have students brainstorm the needs of living things (addressed extensively from Grades 1-6) and categorize them according to whether they are obtained from biotic or abiotic components of the ecosystem.

Example:

A human needs

- air/oxygen (abiotic)
- water (abiotic)
- food (biotic—from plants and animals)
- shelter (abiotic)

➢ Observing Ecosystems

Have students observe an ecosystem (e.g., aquarium, schoolyard, forest, pond) and identify its biotic and abiotic components. If viewing an actual ecosystem is not possible, students can use the pictures of ecosystems from the Defining Ecosystems learning activity (see learning outcome 7-1-02). Ask students to draw a diagram of the ecosystem being studied, label its biotic and abiotic components, and write a brief paragraph describing how the components interact.

Note: The Ducks Unlimited Canada website <http://www.ducks.ca> has an online teacher resource containing student learning activities and support materials on the topic of wetland ecosystems.

Teacher Notes

In conjunction with this cluster, initiate an outdoor learning experience or field trip that allows students to collect a wide range of information on one or several ecosystems for use throughout the study of this cluster. Refer to *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* (1997) for guidelines and sample forms related to field trips. This document was distributed to all Manitoba schools. Additional copies can be obtained from the Manitoba Text Book Bureau at <http://www.edu.gov.mb.ca/metks4/curricul/learnres/mtbb/index.html>.

Note: The terms *living* and *non-living* are problematic for some cultural groups, particularly Aboriginal groups. These groups use different criteria than Western scientists to determine whether an object is animate. Teachers should be sensitive to the potential conflict between Western science and other views and indicate that students can hold multiple views at the same time, recognizing the value of each.

Suggestions for Assessment

Extended Response

Provide students with the following:

Components of an Ecosystem

List and label the abiotic and biotic components in the ecosystem pictured below. Include things that are obvious to the unaided eye as well as those things you can't see but feel certain are present.

Look for:
- trees—biotic
- grass/plants—biotic
- rocks—abiotic
- squirrel/bird—biotic
- soil—abiotic
- etc.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.2)

Sciencepower 7 (Section 1.2)

Addison Wesley Science & Technology 7 (Chapter 1, Sections 2.0-2.1)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

Prescribed Learning Outcomes

Students will...

7-1-04 Describe ecological succession and identify signs of succession in a variety of ecosystems.

Include: the natural process whereby some species are replaced by other species in a predictable pattern.

GLO: D2, E2, E3

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

(continued)

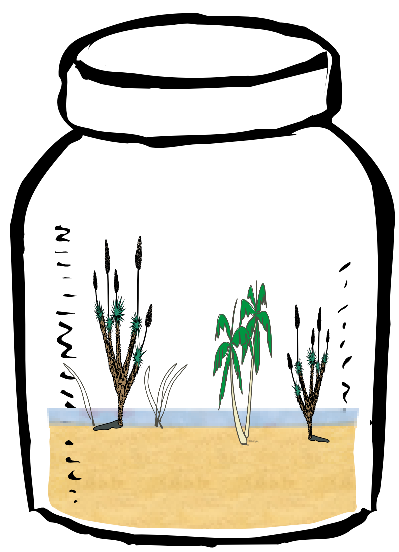
Suggestions for Instruction

➢ **Changes within an Ecosystem**

Have students create a small pond ecosystem, following these steps:

- Place 5 cm of soil and 7.5 cm of water in a large jar.
- Place the jar near a window or grow light and let the water settle overnight.
- The following day, place an aquatic plant in the water. Draw an illustration of the ecosystem and label its biotic and abiotic components.
- Add three or four birdseeds to the jar every couple of days for a week (initially they will germinate and rot).
- Continue to add birdseeds when the water has evaporated (the seeds will begin to grow and the aquatic plant will die).
- Draw an illustration of the ecosystem and label its biotic and abiotic components.

Example:



Have students answer the following questions in their science notebooks:

1. What type of ecosystem does your first illustration represent? (pond) What other types of biotic and abiotic components would you find in the real ecosystem? (fish, insects, rocks)
2. What type of ecosystem does your second illustration represent? (wetland) What other types of biotic and abiotic components would you find in the real ecosystem? (birds, moose, rocks, cattails, reedy grasses)

(continued)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 7-1-05.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.20)

Sciencepower 7 (Section 2.4)

Addison Wesley Science & Technology 7 (Chapter 1, Sections 5.0, 5.3-5.5)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-1-04 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

3. What type of ecosystem would be present after the model had thoroughly dried out? (grassland)
4. Do the changes that took place in this model ecosystem mirror what happens in a real ecosystem? Why or why not? (Ecosystems are constantly changing, with biotic and abiotic components being added or replaced.)
5. What are some examples of changing ecosystems that you have observed? (trees starting to grow along the edges of grassy fields, grasses starting to fill in a pond)

Have students share their answers with the class.

➢ **Ecological Succession**

In a class discussion, introduce *succession* as the term used to describe the natural process whereby some species are replaced by other species in a predictable pattern.

Have students view information from print or multimedia sources to observe examples of succession in a variety of ecosystems, and select one to represent with a series of illustrations showing the major changes.

Have students answer the following questions in their science notebooks:

1. What are some ways in which new plants move to an area? (Seeds are carried by wind, birds, and/or animals.)
2. What are some reasons animals move to a new area? (Animals may move to a new area to find food, mates, and/or shelter.)
3. What naturally occurring event can start the process of succession all over again? (Natural fires burn off some of the accumulated debris on the forest floor and allow some plants/trees to re-establish themselves.) What happens if this event is prevented from taking place? (There is a build-up of debris on the forest floor. When a fire starts it burns very hot and causes major damage.)
4. What are some ways in which humans prevent or accelerate the process of succession? **Note:** This question will also be addressed in conjunction with learning outcome 7-1-05.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-05 Identify and describe positive and negative examples of human interventions that have an impact on ecological succession or the makeup of ecosystems.

Examples: positive—protecting habitats, reintroducing species; negative—preventing natural fires, introducing non-indigenous species, draining wetlands for agriculture or housing...

GLO: B5, D2, E2, E3

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

7-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

7-0-9f Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

SUGGESTIONS FOR INSTRUCTION

➢ **Word Splash**

Have students use a Word Splash (Sophier and Haley, 1993) to obtain information about the effects that humans can have on natural succession. To develop a Word Splash, collect newspaper or magazine articles that feature either a positive or a negative example of human intervention on an ecosystem.

(The Manitoba Clean Water Guide, produced by Manitoba Environment, includes a section entitled “Invasion of Exotic Species” which would be useful for a Word Splash. The guide can be obtained from: <http://www.gov.mb.ca/environ/pages/publs97/cwgtext/cover.html>.)

Identify 10 to 15 key words from an article and place them on a sheet. Ask students to make thought/concept connections between the words, and then read the article and discuss the similarities and differences between their connections and the connections made in the article.

Have students summarize the information they gathered from the article using the following format:

Word Splash Summary

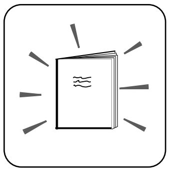
Title of article:

Type of ecosystem being affected:

Causes of change within the ecosystem:

Does the change to the ecosystem have a positive or negative impact? Support your answer with points from the article.

SUGGESTIONS FOR ASSESSMENT



Word Splash

Look for indications of the following in student work:

Checklist			
Criteria	**Yes**	**No**	**Needs Improvement**
• the ecosystem is identified			
• the causes of change are identified			
• the effects of change are identified			
• the conclusion states whether the change had a positive or negative impact on the ecosystem and is supported by points from the article			

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 5.21)

Sciencepower 7 (Section 3.2)

Addison Wesley Science & Technology 7 (Chapter 1, Section 6.0)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-06 Identify environmental, social, and economic factors that should be considered in the management and preservation of ecosystems.

Examples: habitat preservation, recreation, employment, industrial growth, resource development...

GLO: B1, B5, D2, E2

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

7-0-9a Appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds. GLO: A4

7-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

7-0-9f Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

SUGGESTIONS FOR INSTRUCTION

➢ **Sustainable Development**

Use explicit instruction to introduce the concept of *sustainable development. Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators* is a useful resource available on the Manitoba Education and Training website at: <http://www.edu.gov.mb.ca/metks4>. Have students discuss examples of situations where different perspectives and priorities must be balanced in the decision-making process (e.g., environmental, economic, and social factors).

Teacher Notes

Background Information

Sustainable development is an approach to daily decisions that integrates probable consequences to the environment, the economy, and human health and well-being. It is a way of making decisions that balances the needs of today without sacrificing the ability of future generations to meet their own needs.

Manitoba Conservation, 1999

➢ **Aboriginal Perspectives**

Have students read “Aboriginal Perspectives” (BLM 7-A) and discuss the following questions:

1. What can Aboriginal perspectives contribute to society’s goal of sustainability?
2. How can environmental knowledge from Aboriginal people be accessed and included in a decision-making process?

SUGGESTIONS FOR ASSESSMENT

Journal Reflection

Have students reflect on the following question in their science journals:

The Role of Science

What contribution can science make to the overall goal of a sustainable society that balances the needs of society, the environment, and the economy? Explain your thinking.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 5.13-5.17)

Sciencepower 7 (Section 3.5)

Addison Wesley Science & Technology 7 (Chapter 1, Section 6.0)

Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators (Teacher Reference)

Native Science: Natural Laws of Interdependence (Teacher Reference)

A People's Ecology: Explorations in Sustainable Living: Health, Environment, Agriculture, Native Traditions (Teacher Reference)

Look to the Mountain: *An Ecology of Indigenous Education* (Teacher Reference)

Native Studies: Middle Years (Grades 5 to 8) (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-07 Propose a course of action to protect the habitat of a particular organism within an ecosystem.

Examples: protect the nesting habitat of a given bird in a local wetland...

GLO: B5, C3, D2, E2

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

7-0-9b Express interest in a broad scope of science and technology related fields and issues. GLO: B4

7-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

7-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

7-0-9f Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

SUGGESTIONS FOR INSTRUCTION

➢ **What Is Your Opinion?**

Locate articles or videos that discuss a current environmental issue. Place statements about the issue on an Anticipation Guide (Readence, Bean, and Baldwin, 1981) and have students list their opinions about the issue before they view the videos or read the articles provided. Ask students to complete the last portion of the Anticipation Guide after they have viewed the videos or read the articles.

(For a BLM of an Anticipation Guide, see *SYSTH*, Attachment 9.3, or *Success*, p. 6.98.)

➢ **Habitat Protection**

As a class, or in groups, identify an issue related to an endangered organism and/or habitat (e.g., preserving wetlands, creating prairie tall-grass sites) for class exploration. Design a course of action to become involved in the issue, while recognizing that the principles of sustainable development need to come into play (refer to learning outcome 7-1-07). Some possible activities:

- Identify existing groups that work toward protecting habitats (Living Prairie Museum, Fort Whyte Centre, Ducks Unlimited, and Oak Hammock Marsh). Find information about the groups and then choose one group to support (e.g., assist with the general clean-up of litter, or the set-up of educational materials or tours).
- Create pamphlets to inform the public of the threats to a habitat and the ways in which the public can ensure its well-being.
- Create a video that describes the plight of a habitat and the organisms that depend on it. Suggest ways to ensure the well-being of the habitat.
- Write a letter to Members of Parliament, Members of the Legislature, and/or local government officials citing concerns about an endangered organism or habitat and possible ways to alleviate the problems.

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.20)

Sciencepower 7 (Section 1.5)

Addison Wesley Science & Technology 7 (Chapter 1, Section 6.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-08 Compare photosynthesis to cellular respiration, and explain how both are part of the cycling of matter and the transfer of energy in ecosystems.

Include: photosynthesis: water + carbon dioxide + light energy = sugar + oxygen in the presence of chlorophyll; cellular respiration: sugar + oxygen = water + carbon dioxide + energy.

GLO: A2, C6, D2, E4

7-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 7, 3.1.2; Math: SP-I.1.7)

7-0-1b Select and justify a method to be used in finding the answer to a specific question. GLO: C2 (ELA Grade 7, 3.2.3; Math: SP-II.1.7)

7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7)

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4)

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-4f Identify WHMIS hazard symbols that provide information on the safety of substances. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Activating Prior Knowledge

To activate students' prior knowledge of plants, have them fill out a Knowledge Chart (Matchullis and Mueller, 1994) on the topic.

(Plant parts, functions, and needs were studied in Grade 3, Cluster 1: Growth and Changes in Plants. For a BLM of a Knowledge Chart, see *SYSTH*, Attachment 9.2, or *Success*, p. 6.95.)

➢ Photosynthesis

In the following learning experiences students investigate the products that plants produce and recognize how these products are part of the process called *photosynthesis*.

As a class, review work habits to ensure personal safety, the safety of others, and consideration for the environment prior to carrying out the following learning experiences. Students should also be made familiar with the Workplace Hazardous Materials Information System (WHMIS) safety symbols. *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* (available online at <http://www2.edu.gov.mb.ca/metks4/curricul/k-s4curr/science> or for purchase from the Manitoba Text Book Bureau) contains important information on safety practices, equipment, and WHMIS safety symbols, and provides student lessons in these areas.

Part A: Plants Provide Oxygen

Read the following to students.

Joseph Priestly was an English clergyman and scientist. He noticed that if he put a burning candle in a jar, the candle went out after a few minutes and when he put a mouse in the jar, the mouse died. When Priestly added a green plant to the jar the candle did not go out as quickly and the mouse survived.

Ask students: What substance was given off by the plant? (Plants provide oxygen, a substance that is essential for the survival of animals and necessary for a fire to burn.)

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

All living things require food, which provides the energy and matter for all life processes.

- Green plants make their own food through *photosynthesis*, the process by which water, carbon dioxide, and light energy are transformed into sugar (stored energy) and oxygen (a by-product). For this process to take place, chlorophyll must be present (found in green plants). Almost all other forms of life depend on green plants for their own food needs. Plants also resupply the environment with oxygen which is important for living things.
- Living things release the energy that is stored in their food (in the form of sugars) through a process called *cellular respiration.* The sugars (stored energy) are combined with oxygen to release the energy and give off carbon dioxide as a by-product. Photosynthesis and cellular respiration are part of the cycling of matter and the transfer of energy in ecosystems.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.18)

Sciencepower 7 (Section 3.1)

Addison Wesley Science & Technology 7 (Chapter 1, Sections 3.2, 4.2)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum: K-9 (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-08 *(continued)*

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6b Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

7-0-6c Identify strengths and weaknesses of different methods of collecting and displaying data, and potential sources of error. GLO: A1, A2, C2, C5 (ELA Grade 7, 3.3.3)

7-0-6f Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 7, 3.3.4)

7-0-7b Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

7-0-7c ➲ Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 7, 3.3.4)

(continued)

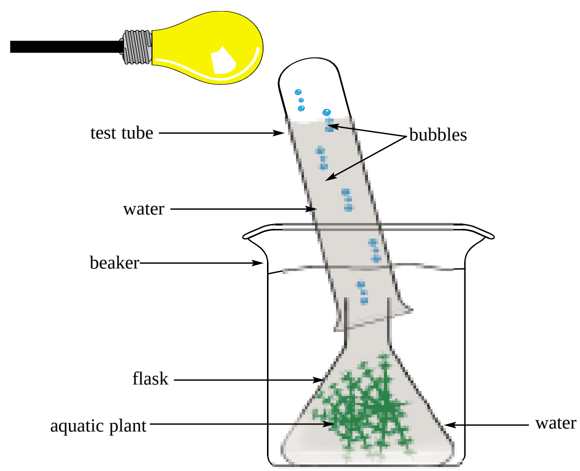
SUGGESTIONS FOR INSTRUCTION

(continued)

Part B: Effect of Light on Oxygen Production

Have students plan and conduct an experiment to determine whether light affects the production of oxygen in a green plant. Prior to the experiment, discuss with students the importance of fair testing and the need for several trials to take place. Students may need to be introduced to the use of a glowing splint to test for the presence of oxygen. (It will burst into flame in the presence of oxygen.) As an alternative to individual student experiments, have students plan an experiment and then select one (or more) as a class to be conducted as a teacher demonstration.

Possible setup:



Part C: Sugar Production

Provide students with the following information about chemical indicators:

Indicators are chemicals that change appearance in the presence of specific substances.

- Benedict's solution is an indicator of the presence of sugar and undergoes a series of colour changes when heated in the presence of sugar (ending up as a reddish-orange).
- Glucose indicator strips go through colour changes in the presence of sugar.
- Starch turns blue/black when it comes in contact with iodine.
- Brown wrapping paper becomes translucent when it comes in contact with oil or fat.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.18)

Sciencepower 7 (Section 3.1)

Addison Wesley Science & Technology 7 (Chapter 1, Sections 3.2, 4.2)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum: K-9 (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-1-08 *(continued)*
(continued)

SUGGESTIONS FOR INSTRUCTION

(continued)

Have students test different parts of plants to determine where sugars, starches, and oils are stored. Recommended plants include potatoes (when testing for starch), apples/bean seeds (when testing for sugar); peanuts (when testing for oils). Crush seeds with a mortar and pestle and add water to use a glucose test strip, and crush peanuts before applying the brown paper. The Benedict's test may be conducted as a teacher demonstration.

> **Safety Precaution:** Remind students to wear goggles when heating solutions and to point test tubes away from people. Iodine is a corrosive substance when used in higher concentrations.
>
> Check for allergies before bringing peanuts into the school.

Part D: Word Equations

Use explicit instruction to summarize what students have learned in investigations regarding what plants need to survive and what products they produce. Use the term *photosynthesis* to describe the overall input and output processes and to develop the following word equation:

$$\text{Water + carbon dioxide +light energy} \xrightarrow{\text{Chlorophyll}} \text{sugar + oxygen}$$

Ask students to answer the following questions about photosynthesis:

1. What are the inputs? (water, carbon dioxide, light energy)
2. What are the outputs? (sugar, oxygen)
3. Where does the water and carbon dioxide come from? (the environment)
4. What happens to the sugar and oxygen? (The oxygen is given off as a by-product and the sugar is stored in the plant and used as energy for life processes.)
5. What is important about chlorophyll? (Chlorophyll must be present for photosynthesis to take place. Photosynthesis takes place only in plants that contain chlorophyll, i.e., green plants.)

(continued)

SUGGESTIONS FOR ASSESSMENT

Refer to “Photosynthesis and Cellular Respiration” (BLM 7-B) for an assessment suggestion.

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES
Students will...
7-1-08 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Cellular Respiration**

Explain to students that the process by which cells release the energy stored in sugars (obtained from food) is called *cellular respiration*. Provide students with the following word equation:

sugar + oxygen ⟶ carbon dioxide + water + energy

Ask students to answer the following questions about cellular respiration:

1. What are the inputs? (sugar, oxygen)
2. What are the outputs? (carbon dioxide, water, energy)
3. Where does the sugar come from? (food that has been transformed into stored energy in the form of sugar)
4. Where does the oxygen come from? (the environment)
5. What happens to the carbon dioxide, water, and energy? (The carbon dioxide and water are given off as by-products and the energy is used for life processes.)

➢ **Bean Seeds and Cellular Respiration**

Have students complete "Bean Seeds and Cellular Respiration" (BLM 7-C) to observe how it can be proven that bean seeds undergo cellular respiration.

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-09 Analyze food webs, using ecological pyramids, to show energy gained or lost at various consumer levels.

Include: producers; primary, secondary, and tertiary consumers.

GLO: C2, C8, D2, E4

7-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ **Ecological Pyramids**

Part A

Have students create a four-link food chain beginning with a specific producer using a local plant. Have students label the three consumers they have included as

- primary consumers (those that eat producers)
- secondary consumers (those that eat primary consumers)
- tertiary consumers (those that eat secondary consumers)

Example:

Food Chain

wheat (producer)	→	mouse (primary consumer)	→	snake (secondary consumer)	→	hawk (teritary consumer)

Part B

Present students with the following example of an ecological pyramid and food chain:

Ecological Pyramid

1 hawk (tertiary consumer)
3 snakes (secondary consumer)
20 mice (primary consumer)
200 grains of wheat (producer)

Have students answer the following questions in their science notebooks:

1. Compare and contrast the information provided by the ecological pyramid above and the food chain (from Part A). (Both describe the relationship between the elements of the food chain; however, the pyramid provides additional information related to numerical relationships.)
2. What reason might explain the pyramid shape in the ecological pyramid? (Energy is lost at each level of the pyramid, so the numbers of organisms that are supported become smaller as you move up the food chain.)
3. How much grain is needed to support a hawk (tertiary consumer), assuming it is only eating snakes? Why? (200 grains are needed to support the 20 mice to support the three snakes that the hawk needs to eat.)

Suggestions for Assessment

Journal Reflection

Provide students with the following:

What to Eat?

Four hectares of corn will support 1000 people for one day. If those same hectares of corn were fed to cattle and then the cattle were eaten by people, there would only be enough beef to feed 50 people for one day.

What are the implications of this knowledge to North America? What are the implications to countries where food is in short supply?

Teacher Notes

Background Information

An *ecological pyramid* is a graphic representation of the relationships among the different components of a food chain. It can illustrate

- the number of organisms at each level (pyramid of numbers)
- the amount of biomass (pyramid of biomass) at each level
- the energy lost at each level (pyramid of energy)

Only a small percentage (approximately 10 percent) of the food energy is available to the next level of a food chain.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.10)

Sciencepower 7 (Sections 2.1, 2.3)

Addison Wesley Science & Technology 7 (Chapter 1, Sections 4.3-4.4)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-10 Analyze, using ecological pyramids, the implications of the loss of producers and consumers to the transfer of energy within an ecosystem.

GLO: C2, C8, D2, E4

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

7-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

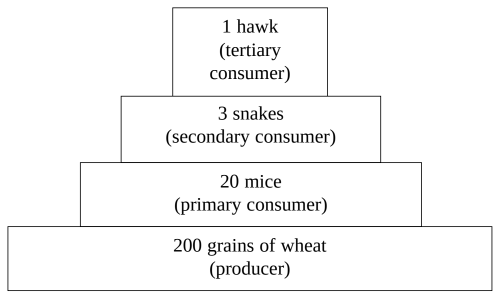
7-0-9f Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

SUGGESTIONS FOR INSTRUCTION

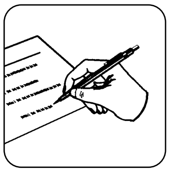
➢ **Transfer of Energy in an Ecosystem**

Have students use the ecological pyramid from the learning experience suggested for learning outcome 7-1-09 to answer the following questions in their science notebooks:

1. What would happen to the food chain if only 100 grains of wheat were available instead of 200?
2. What might cause a reduction in the amount of wheat available?
3. What other natural or human-caused events could take place, and what effect would they have on the ecological pyramid?



Suggestions for Assessment



Extended Response

Provide students with the following:

What Are the Implications?

1. What other food sources exist for mice, snakes, and hawks?
2. Why might it be useful to have more than one food source?
3. What statement can you make regarding the transfer of energy within an ecosystem and the implications of the loss of producers and consumers to this transfer?

Look for:

1. Answers may vary.
2. If one food source is eliminated or reduced, an alternative food source will ensure survival.
3. The loss of producers or consumers disrupts the flow of energy in an ecosystem.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.10)

Sciencepower 7 (Section 2.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-11 Explain, using ecological pyramids, the potential for bioaccumulation within an ecosystem.

GLO: D2, E2, E4

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Deadly Links***

Use pylons, chairs, or flagged sticks to stake out a habitat (indoors or outdoors) in which students will be gathering food. Spread white pipe cleaners and coloured pipe cleaners, or white popcorn mixed with coloured popcorn (two-thirds white, one-third coloured) throughout the habitat area. (Any white and coloured substances that students can easily pick up would work, but popcorn is recommended for outdoor use because it is biodegradable.)

Tell students they will be taking part in a food chain learning activity. Assign them roles as primary, secondary, and tertiary consumers (e.g., grasshoppers, shrews, and hawks). There should be approximately three times as many primary as secondary consumers, and three times as many secondary as tertiary consumers.

Conduct the following learning activity:

- Give each of the primary consumers an empty lunch bag (representing their stomachs) and have those students go into the designated habitat area to gather food (allow a 30-second time limit).
- Send in the secondary consumers. These students must capture food bags from the primary consumers (within a 15- to 60-second time limit, depending on size of area). Any captured primary consumer moves to the sidelines.
- Send in the tertiary consumers. These students capture food bags from the primary and secondary consumers, and the remaining secondary consumers continue capturing bags from the primary consumers (allow a 15- to 60-second time limit). Any captured consumer moves to the sidelines.

Ask all students to come together, bringing any food bags they have. Ask those students who have been "consumed" to identify what animal they are and who "ate" them. Ask the remaining consumers to count the number of white and coloured food pieces they each have. Inform students that a pesticide was sprayed on the food supply and that the coloured pieces are poison.

(continued)

***Deadly Links:** Adapted with permission: "Deadly Links", *Project WILD Activity Guide.* Ottawa: Canadian Wildlife Federation, 1999, pp. 299-301. Project WILD is part of the WILD Education family of environmental education programs that emphasize wildlife and other natural resources. For information about workshops and resources, contact <www.wildeducation.org>.

Suggestions for Assessment

Suggested Learning Resources

Teacher Notes

Background Information

People have developed *pesticides* to control organisms, *herbicides* to control unwanted plants, *insecticides* to control unwanted insects, and so on. When pesticides involve the use of poisons, the poisons frequently end up going where they are not wanted. Many toxic chemicals have a way of persisting in the environment and often become concentrated in unexpected and undesirable places. *Bioaccumulation* or *biological amplification* is the process that results in increasing concentrations of a harmful chemical at each higher level of a food chain.

Nelson Science & Technology 7 (Section 5.11)

Further readings and activities may be found at the following websites:

<http://www.schoolnet.ca/learning/teacher/classroom/index_en.html> (Toxic Fish)

<http://www.ec.gc.ca/science/sandemay00/article4_e.html> (Polar Bears at the Top of POPs)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-11 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

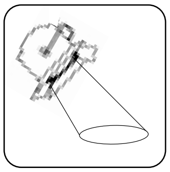
The following consumers are now “dead:” any primary consumer with coloured pieces of food; any secondary consumer with half or more of the food supply composed of coloured pieces; and the tertiary consumer with the highest proportion of coloured food.

Introduce the term *bioaccumulation* and have students use it to explain how the pesticide got into the food chain and how it could affect animals that did not consume the poison directly. Have students discuss the pros and cons of using toxic chemicals, identifying the perspectives of the various groups involved (e.g., farmers want to prevent grasshoppers from eating part of a crop and ensure a supply of the crop for consumers and livestock. Customers at a store do not want to pay more for particular kinds of foods because the supply has become limited, nor do they want to consume food containing large amounts of chemicals. Environmentalists want to ensure the survival of a particular species of animal that is dying because of chemical poisoning.).

Further reference material and learning activities can be found on the following web sites:

- Learning for a Sustainable Future, “Toxic Fish,” <http://www.schoolnet.ca/learning/teacher/classroom/index_en.html>
- Environment Canada, “Polar Bears at the Top of POPs,” http://www.ec.gc.ca/science/sandemay00/article4_e.html

Suggestions for Assessment



Extended Response

Provide students with the following:

Mercury Bioaccumulation

Mercury is a poisonous substance that can affect the functioning of body systems. Mercury levels in water have fluctuated in the past years. In the 1970s, there were high levels of mercury found in some areas due to discharges from pulp and paper mills. Laws have since been implemented to monitor and regulate the amount of mercury that can enter water systems. In addition, quotas have been imposed by the government on the number and type of fish that can be caught. These quotas are placed on large predatory fish only, and do not apply to small fish. Why do you think this is?

Look for:

Mercury accumulates in the larger fish because they eat many smaller fish also containing mercury. This accumulation makes it dangerous for people to eat the large fish.

Scoring Rubric

Score	Criteria
4	The response is correct, complete, and detailed. It contains examples and/or elaboration to support the answer. It includes evidence of higher-order thinking.
3	The response is correct and complete. It contains examples and/or elaboration to support the answer.
2	The response is generally correct and complete. It may contain minor errors. It contains examples and/or elaboration to support the answer.
1	The response is partially correct but is incomplete and/or contains major errors. No examples and/or elaboration to support the answer.

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-12 Provide examples of scavengers and decomposers, and describe their role in cycling matter in an ecosystem.

Include: micro-organisms.

GLO: D2, E1, E2, E3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-2c Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ **Scavengers and Decomposers**

Have students read or view videos, CD-ROMS, and other research materials to identify examples of scavengers and decomposers and write a description of the roles they play in the cycling of matter in an ecosystem.

(For a BLM of "A Viewer's Discussion Guide for Informational Films/Videos," refer to *5-8 ELA*, BLM-73.)

7-1-13 Demonstrate proper use and care of the microscope to observe micro-organisms.

Include: preparing wet mounts beginning with the least powerful lens; focussing; drawing specimens; indicating magnification.

GLO: C1, C2, C7

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

➢ **Using a Microscope**

Have students identify parts of a microscope on a diagram and list as many points related to the proper use and care of a microscope as possible. Then, as a class, identify all the parts and review information about proper use and care information. (Refer to "The Compound Microscope," BLM 7-D.) As a class, review the basic skills of diagramming what students observe through a microscope and discuss how to determine the power of magnification when viewing a slide.

➢ **Observing Micro-organisms**

Have students use prepared slides of micro-organisms, as well as a self-prepared wet mount slide of pond water, to observe various types of micro-organisms. Ask students to draw and label diagrams of what they see and indicate the magnification used. Students may also use simple identification guides to identify the organisms they see.

Safety Precaution:

Pond water, especially water from a fish or turtle tank, may contain harmful bacteria and/or protists. Discuss with students the importance of keeping hands and writing utensils away from their mouths when dealing with pond water. Ensure that students wash their hands with soap and warm water after handling water samples.

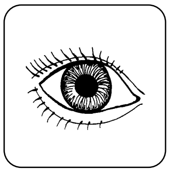
SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 5.4)

Sciencepower 7 (Section 2.1)

Addison Wesley Science & Technology 7 (Chapter 1, Section 3.4)



Proper Care and Use of a Microscope

When observing and assessing students' use of microscopes, look for indications of the following:

Checklist:

The student

- ❑ carries the microscope by the arm and base
- ❑ cleans the objective and ocular lenses with lens paper only
- ❑ places the slide on the stage and lowers the objective carefully (watches from the side of the microscope to ensure that the objective does not crush the slide) and focuses while looking through the ocular lens and raising the objective lens
- ❑ lowers the stage before changing from a lower objective lens to a higher objective lens, then watches from the side of the microscope to ensure that the objective does not hit the stage

Nelson Science & Technology 7 (Section 5A)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-1-14 Identify beneficial and harmful roles played by micro-organisms.

Examples: beneficial—aid in digestion, composting, food and vaccine production; harmful—cause disease, food spoilage...

GLO: B3, C2, D2

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ The Role of Yeast: Baking Bread

Have students form groups to observe the effect of yeast (a micro-organism) in baking bread.

- Have all groups use the same bread recipe, with half the groups using yeast and half the groups leaving out yeast.
- Ensure that all students view the yeast before and after adding water and sugar. Ask them to write their observations in their science notebooks, noting what yeast needs to grow (i.e., sugar as a food source, water, and warmth).
- Have students bake and compare the two breads, recording their observations in their science notebooks. (The bread containing yeast should be higher, fluffier, and have more bubble holes than the yeastless bread.)

  Extension: Have students view a prepared slide of yeast through a microscope.

➢ Bread Mould

Mould is also a micro-organism. In the previous learning activity students found that yeast needs a food source, water, and warmth to grow and reproduce. Have the class devise a set of experiments to determine what bread mould needs to grow. Discuss the importance of testing only one variable at a time. Using the bread baked in the previous learning activity, have different groups test specific variables such as dry versus slightly moist bread and cold versus warm bread (one kept in the fridge and the other in a warm spot). Have students share their results with the class. Have students answer the following questions in their science notebooks:

1. Knowing what mould needs to grow could assist scientists in growing moulds for medicinal purposes, but mould can also cause food spoilage. How would knowing what mould needs to grow assist people in preventing food spoilage? (They would know what not to provide for mould to grow, such as warmth, water, and air.)
2. What are some things people do to prevent food from moulding? (Keep food dry, cool, and covered.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 5.11)

Sciencepower 7 (Section 2.1)

Addison Wesley Science & Technology 7 (Chapter 1, Section 3.4)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum: K-9 (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-1-14 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Beneficial and Harmful Roles of Micro-organisms**

Have students view films/videos and/or research the beneficial and harmful roles that micro-organisms play in both natural ecosystems and in humans. Have students share their findings and compile them on a class chart.

Example:

Roles of Micro-organisms

Beneficial Roles	Harmful Roles
Micro-organisms aid in • digestion • composting • vaccine production • food production (e.g., yogurt)	Micro-organisms cause • disease • food to spoil

Have students

- select one of the items from the chart to research
- use their research findings to prepare an information poster, to be posted on a class bulletin board

Encourage students to present their information in an innovative way (e.g., in a newspaper article titled “Mould Gets a Bad Rap,” or using digital photographs of food spoilage caused by micro-organisms).

Suggestions for Assessment

Suggested Learning Resources

When assessing students' bread mould experiments, refer to "Experiment Report: Assessment" (BLM 7-R).

Prescribed Learning Outcomes
Students will...
7-1-15 Research and describe human food production or preservation techniques that apply a knowledge of micro-organisms. *Examples: bread and yogourt making, food drying, sterilization, refrigeration...* GLO: A5, B2, B3, D1
7-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 7, 3.1.2; Math: SP-I.1.7) **7-0-2a** ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1) **7-0-2b** Evaluate the usefulness, currency, and reliability of information, using predetermined criteria. GLO: C6, C8 (ELA Grade 7, 3.2.3; TFS 2.2.2) **7-0-2c** Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2) **7-0-7a** Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4) **7-0-7g** ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

Suggestions for Instruction

➢ Food Preservation Techniques

Have students refer to cookbooks, and/or interview their parents/guardians, grandparents, extended family, and/or family friends to identify past and present methods of preserving foods. Students may work in groups or by themselves to collect information. Have students list the different food preservation techniques and indicate which of a micro-organism's basic needs is affected by each preservation technique. Have students record their information in chart form and share it with the class. Create a large class poster with the information collected.

Example:

Effects of Food Preservation Techniques

Food Preservation Technique	Affects Micro-organism's Need for
• freezing	• warmth
• salting	• water
• drying	• water
• pasteurizing	• only moderate warmth
• adding sugar	• water

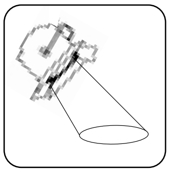
➢ Micro-organisms in the Production of Food

Have students conduct research to identify ways in which micro-organisms are used in large-scale food or beverage production. Have them create cartoon strips describing the process and product.

➢ Food Preparation Safety

Invite a guest speaker from a restaurant or food inspection office to talk to students about safety precautions taken in the preparation of foods. Before the speaker's visit, have each student submit three questions to a class pool of questions to be addressed by the speaker.

Suggestions for Assessment



Case Scenario

Have students read and complete "The Barbeque," BLM 7-E.

Look for:

The food poisoning from the potato salad caused the illnesses. The food poisoning occurred because the potato salad was not kept in the cooler, and it contained a mayonnaise-based dressing (made from eggs). Harry was extremely ill because he ate two helpings of the potato salad; Alice was not ill because she did not eat any.

Food Practice	**Safe/Unsafe Practice**
hot dogs kept in the cooler	safe
hamburgers put in the cooler	safe
potato salad not put in the cooler	unsafe
hamburgers and hot dogs well-cooked	safe
cooked meat put on clean plate	safe
salad and fruit not refrigerated (no mayonnaise-based dressing)	safe

Scoring Rubric

Score	Criteria
4	The conclusion is correct. All of the food practices have been correctly identified and categorized. The response is clear, supports the conclusion, and includes evidence of higher-order thinking.
3	The conclusion is correct. The majority of the food practices have been correctly identified and categorized. The response is clear and includes evidence to support the conclusion. Minor errors in reasoning may be present.
2	The conclusion is correct. The majority of the food practices have been correctly identified and categorized. The response includes limited evidence to support the conclusion, errors in reasoning are present, and/or response is unclear.
1	The conclusion is correct. The food practices have not been identified or categorized. The response includes limited evidence to support the conclusion. Errors in reasoning are present and/or an explanation is lacking.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 5.7)

Sciencepower 7 (Section 2.1)

Addison Wesley Science & Technology 7 (Chapter 1, Section 3.4)

Notes

Grade 7

Cluster 2: Particle Theory of Matter

Overview

In this cluster, students explore the nature of science by examining the development of scientific theories. One theory, the particle theory of matter, is investigated in detail. Students use the particle theory to describe changes of state, to differentiate between pure substances and mixtures, and to describe characteristics of solutions. An important distinction is made between heat and temperature. Students demonstrate how heat is transmitted by way of conduction, convection, and radiation. They plan and conduct experiments to identify substances that are good insulators and conductors of heat. They apply this knowledge through the design and construction of a prototype that controls the transfer of heat energy. Students also identify different forms of energy that can be transformed into heat energy, and recognize that heat is the most common by-product of other energy transformations. Students classify substances used in daily life as pure substances, mechanical mixtures, and solutions. They demonstrate different methods of separating the components of mixtures. Students experiment to determine factors that affect solubility. They describe the concentration of solutions in qualitative and quantitative terms, and demonstrate the differences between saturated and unsaturated solutions. The potential harmful effects of some substances on the environment are discussed, and methods to ensure safe use and disposal are identified.

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-01 Use appropriate vocabulary related to their investigations of the particle theory of matter.

Include: boiling and melting points, pure substance, scientific theory, particle theory of matter, temperature, heat, conduction, convection, radiation, mixture, solution, mechanical mixture, homogeneous, heterogeneous, solutes, solvents, solubility, concentration, dilute, concentrated, saturated, unsaturated, terms related to forms of energy.

GLO: C6, D3, E4

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 5, Cluster 2: Properties of and Changes in Substances.

➢ Introduce, explain, use, and reinforce vocabulary throughout the cluster.

➢ **Word Game**

Use word games to help students become familiar with a definition, either at the knowledge level or at the comprehension level. Word games (e.g., crosswords, puzzles, and word searches) can be student-generated, teacher-generated, or purchased.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

7-2-02 Evaluate different types of thermometers using the design process.

Examples: materials used, range, sensitivity, durability, scale, cost...

GLO: C1, C3

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-4c Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6e Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

Suggestions for Instruction

Teacher Notes

Science supply catalogues list and describe a wide range of thermometers. Ensure that students research a variety of thermometers, including digital probes, thermocouples, and thermograms.

➢ Which Thermometer?

Divide students into groups. Have each group use the design process to determine which type of thermometer would be best suited in each of the following facilities:

- school
- hospital
- restaurant
- research station in the Antarctica
- research lab

Have students

- identify criteria for the type of thermometer that would best suit their given facility
- use science supply catalogues to research and evaluate different types of thermometers in relation to the predetermined criteria, taking into consideration the type of materials used for the construction of the thermometer, range, sensitivity, durability, scale, safety issues, and cost
- record their findings on a chart
- make recommendations based on their findings, substantiating their recommendations with data from their chart

For a description of the design process, refer to page 16 in this document.

Safety Precaution: Use mercury thermometers with extreme care and only with appropriate clean-up procedures in place. (Some schools are choosing to remove mercury thermometers rather than having to deal with the difficulties of effectively cleaning up a mercury spill.) Mercury thermometers should be replaced with non-mercury thermometers over time.

Suggestions for Assessment

Extended Response

Provide students with the following:

Alcohol or Mercury: Which Thermometer to Use?

Property	Alcohol	Mercury
Range (temperatures at which it works best)	–80°C to 110°C	–39°C to 375°C
Materials	Easy to clean if there is a spill.	Difficult to clean if there is a spill. If it is absorbed through the skin it can endanger one’s health.

1. Which thermometer would be best to use in very cold conditions, such as below –40°C?
2. Which thermometer would be best to measure the boiling point of a liquid above 100°C?
3. Which thermometer would be best to use in school situations? Why?

Look for:

1. alcohol thermometer
2. mercury thermometer
3. An alcohol thermometer would be best in school situations. If a mercury thermometer breaks and people touch the mercury while trying to clean up the spill, the mercury could be absorbed through their skin and endanger their health. Mercury is difficult to clean up because it is not absorbed by average cleaning materials.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 2.3)

Sciencepower 7 (Section 7.1)

Addison Wesley Science & Technology 7 (Chapter 3, Section 1.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-03 Demonstrate the effects of heating and cooling on the volume of solids, liquids, and gases, and give examples from daily life.

GLO: A2, C1, D3, E4

7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7)

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Effect of Heating on Volume

Have students perform or observe the following experiments. Ask students to identify the independent variable (heating/cooling) and the dependent variable (volume of matter), make relevant observations, and draw conclusions. Have students list everyday situations where this knowledge is applied, and some inventions that use this concept. Students may work in groups that rotate between stations, or they may view teacher demonstrations if equipment is limited.

Safety Precaution:
In conducting the following experiments:

- Make sure the glass tubing is inserted into the stoppers.
- Use glycerine or soapy water to insert tubing and wear gloves.
- Ensure that balloons will stretch over necks of containers.
- Blow up balloons to stretch them and let them deflate several times before using them.

Experiments

Solids

1. Using a ball and ring apparatus, pass the ball through the ring. Heat the ball over a candle for three minutes and then try to pass it through the ring again. (The ball should not be able to fit through.) Let the ball cool by placing it in cold water for a few minutes, and then try to pass it through the ring again.
2. Heat one side of a bimetallic strip over a burning candle and then cool it in water. Heat the other side of the strip (which has a different metal) and then cool it in water as well. What happens? (The metal curls because the two different metals have different heating and expansion rates.)
3. Connect copper wire to a ring stand and place a 25 g weight at the end of the wire. Measure the length of the wire before and after it is heated with a candle or a burner.

Liquids

1. Place coloured water in a one-holed stoppered flask with 40-60 cm of glass tubing in the stopper. (Ensure one end of the glass tubing is in the coloured water.) Heat the flask slowly and observe the liquid as it rises up the tube.
2. Observe the liquid in a glass thermometer when it is placed in hot water and when it is placed in ice water.

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

Heating causes matter to expand in volume. Cooling causes a decrease in volume.* Everyday applications include

- putting a jar lid under hot water to cause it to expand away from the glass jar and to open more easily
- filling the joints between sidewalk blocks with tar to prevent the blocks from buckling in the summer heat
- leaving enough slack in hydro lines so that they sag a little in summer but do not snap when they contract in the winter cold
- building bridges with jagged metal grid gaps at either end of the span so that they do not buckle in the summer heat
- designing thermostats from bimetallic strips so that they can turn a furnace on/off depending on temperature
- putting liquid in glass thermometers
- leaving air space or a small air hole at the top of filled plastic gas containers

***Note:** Water is an exception. It expands when it freezes.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 2.2)

Sciencepower 7 (Section 8.1)

Addison Wesley Science & Technology 7 (Chapter 3, Sections 1.1-1.4, 2.2)

Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum: K-9 (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-2-03 *(continued)*

SUGGESTIONS FOR INSTRUCTION

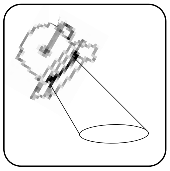
(continued)

Gases

1. Run a bead of water around the mouth of a one-litre plastic bottle to create a seal. Place a dime over the opening of the bottle. Pour warm water over the sides of the bottle. (The air inside will expand as it warms and it will move the dime.)
2. Attach a previously inflated balloon over the top of a one-litre plastic bottle. Pour hot water over the sides of the bottle. Observe the balloon. (It should inflate as air in the bottle expands.) Then place the bottle in a container of ice and water. Observe the balloon.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Case Study

Provide students with the following:

The "Challenger" Disaster

Florida is the home of hot, humid weather, the NASA space program, and the space shuttle. Space shuttle launches seem like routine events now, with little possibility of disasters like those associated with the initial rocket launches of the 1960s. But a disaster did occur on January 28, 1986, when the "Challenger" space shuttle blew up with seven astronauts on board.

Investigators had to study pictures, videos, data from computers, design specifications, and weather conditions to piece together the cause of the explosion of the fuel tanks. Investigations led scientists to believe that the tragic event was due to a leak through an "O" ring (similar to those found in water faucets to prevent leakage/dripping of water) in the booster rockets. It was also noted that weather for that day had been uncharacteristically cold.

What caused the normally tight fitting "O" rings to leak and the subsequent explosion of the fuel tanks? Explain your thinking.

Look for:

- references to the uncharacteristically cold weather and the fact that particles of matter slow down and move closer together in the cold
- inference explaining that the "O" rings might have contracted in the cold, causing them to be ill-fitting and allowing fuel to leak out and ignite upon the rockets' firing

Scoring Rubric

Score	Criteria
4	The response is correct, complete, and clearly stated. It includes references to previous learning experiences to support the answer. It provides evidence of higher-level thinking.
3	The response is correct, complete, and clearly stated. It includes references to previous learning experiences to support the answer.
2	The response is generally correct but it contains minor errors and/or omissions. It includes some examples to support the answer.
1	The response is partially correct but is incomplete and/or contains major errors. It gives no examples to support the answer.

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-04 Compare the boiling and melting points of a variety of substances and recognize that boiling and melting points are properties of pure substances.

Include: water.

GLO: C2, D3, E3, E4

7-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ Activating Prior Knowledge

Show students a cube of ice and a cube of paraffin wax on a tray. Have them list in their science notebooks the visible physical properties that both share (they are both translucent and have a cubed shape). Then, using the Think-Pair-Share strategy (McTighe and Lyman, 1992), have students brainstorm a method to identify which object is not the ice, without touching either object. (Wait a few minutes to see which object melts at room temperature.)

Have students identify what property allows this method to work. Ask them whether this method would work outdoors if the temperature were –5°C. Why or why not? (It would not work at –5°C because water freezes at 0°C, and the ice would not melt.)

➢ Boiling and Melting Points

Boiling and melting points are properties of pure substances. Have students

- research to identify the boiling and melting points of several pure substances (two of which should have similar boiling or melting points)
- organize their information in a chart form
- answer the following questions:
  1. Would you be able to identify a substance by only its boiling or melting point? Why or why not? (You would not, because several substances have similar boiling and melting points. Other tests would be needed to see whether a given substance had all the other properties of the substance to which you were comparing it.)
  2. When might it be important to know the boiling or melting point of a substance?

Teacher Notes

The emphasis of learning outcome 7-2-04 is on having students become familiar with boiling and melting points of a range of substances and recognizing these as properties of pure substances. Students are not required to measure boiling points themselves.

Suggestions for Assessment

Case Study

Provide students with the following:

Bars of Gold?

A chest is located at the bottom of the Gulf of Mexico and some metal bars are found inside. Legend has it that ships that travelled in the area carried gold bars and jewels. Often captains of the ships would substitute fake bars in the chests so that if the ships were boarded by pirates, the real gold would not be stolen as it would be hidden elsewhere on the ships.

A lab heats up the bars to 955°C before they begin to melt. The scientist working in the lab consults the chart below to determine whether the bars are gold. Are the bars gold? How do you know?

Substance	Melting Point (°C)	Boiling Point (°C)
Gold	1063°	2600°

Look for:
The bars are not gold. They melted before reaching gold's melting point.

Manitoba Winters

Provide students with the following:

Manitoba Winters

In Manitoba would it be advisable to leave water in a car's radiator all year round? Why or why not?

Look for:
It would not be advisable, because in winter the temperature of the air goes below water's freezing point. Water would freeze, expand, and break the radiator. It may even be advisable to use a different substance (such as antifreeze) in the summer if the temperatures are very high.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 2.7)

Sciencepower 7 (Section 8.3)

Addison Wesley Science & Technology 7 (Chapter 3, Section 1.1)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-05 Explain what scientific theories are, and provide some examples.

Include: a scientific theory helps to explain an observation; when this explanation has been repeatedly tested and shown to be consistent it is generally accepted in the scientific world.

GLO: A1, A2

7-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 7, 3.1.2; Math: SP-I.1.7)

7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7)

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4)

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5e Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-III.1.6, SS-I.1.5)

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Importance of Testing**

Have students record, in their science notebooks, whether the following statement is true or false: Heavier objects fall faster than lighter objects.

Read the following story to students:

Aristotle was a famous ancient Greek scholar. He was so well-known, and his thoughts so highly respected, that often his ideas were accepted without question. One such idea was that the mass of an object would determine how fast it fell. Aristotle never tested his hypothesis and for many years it seemed quite logical. Approximately 350 years ago, Galileo, an Italian physicist, questioned Aristotle's hypothesis and decided to test its validity.

Have students plan and conduct an experiment to test Aristotle's hypothesis. Ensure that they design experiments that test one variable at a time (e.g., they could drop objects of the same shape and size but different mass from a specified point, then drop objects of different shapes but the same mass from a specified point, and compare the results). Plastic containers work well for this experiment (e.g., one filled with water and one empty). Students will find that the heavier containers do not land first. Students can record their experiment results on the "Experiment Report" (BLM 7-Q).

➢ **Scientific Theory**

Have students work in groups to answer the following questions:

1. What would have to be done before a person could consider a statement to be accurate? (Numerous tests would need to be conducted, controls would have to be in place when testing occurs, and accurate data would have to be collected and analyzed.)
2. Someone develops a new cream for acne. What would have to happen before you would feel confident enough to use it on your skin? (Tests would need to be performed and data would have to be collected and analyzed.)
3. Why would a product need to be tested many times? (A product could be dangerous to a person's health, it could be faulty, or it might not work at all.)

(continued)

Suggestions for Assessment

Extended Response

Provide students with the following:

Examining the Findings

Four groups of students tested Aristotle's hypothesis (that the mass of an object determines how fast it falls). Based on the statements below, are the groups' results reliable? Why or why not?

1. In group A, two students of different heights each dropped an identical object from their respective shoulder heights.
2. In group B, students dropped objects with different masses and different shapes (a ball and a rectangular-shaped box) from the same height.
3. In group C, students used a stopwatch to time how long it took objects of identical shapes, but different masses, to travel a set distance. They performed their test once.
4. In group D, students used the same apparatus and method as group C, but repeated the test several times.

Look for:

1. No. The distance each object travelled was not held constant, which would affect the outcome.
2. No. Neither the shape of the objects nor their masses were controlled. Therefore, it is impossible to determine whether the results were caused by different shapes, different masses, or both.
3. No. The test was only performed once and may have been affected by some unknown variable or inaccurate measurements. The results may not be reproducible.
4. Yes. Students were precise in their method and their collection of data (the stopwatch), kept certain variables controlled (the shape of container, the distance the objects would travel), and repeated their test several times to ensure that the result did not happen by chance.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 2.5)

Sciencepower 7 (Section 1.2)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 4.2-4.3)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-2-05 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

Teacher Notes

Background Information

The distinction between a *theory* and a *law* is often unclear. While a *hypothesis* is clearly a preliminary explanation for an observed phenomenon, the condition required for an explanation to move from something that has gained general acceptance within the scientific community (theory) to something that has been demonstrated to be true without exception (law) is not readily apparent.

➢ **Scientific Theory: Yesterday/Today/Tomorrow**

Have students answer the following questions:

1. Christopher Columbus helped to disprove one theory that was held during his time. What was it? (The world is flat.)
2. At one time people believed that all things were made of earth, fire, and water, but the current scientific theory is that all living things are made of cells. What type of technology may have enabled people to discover this theory? (microscopes)
3. Presently there is a scientific theory that all things are made of tiny particles that vibrate (the particle theory of matter). Will this theory still be considered true in the year 3000? Why or why not? (It may or may not be considered true because technology may change and allow us new insights.)

Ask students to complete a Concept Frame (Matchullis and Mueller, 1994) for the concept of scientific theory, using

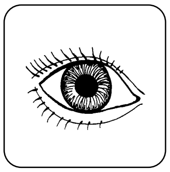
- their responses to the above questions
- the findings of their experiment testing Aristotle's hypothesis that the mass of an object determines how fast it falls
- further research

(For a BLM of a Concept Frame, see *SYSTH*, Attachment 11.2, or *Success*, p. 6.111.)

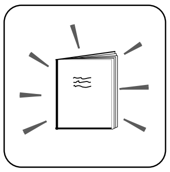
Suggestions for Assessment

Suggested Learning Resources

Refer to the following BLMs for assessment suggestions related to student-designed experiments for the Importance of Testing learning activity:



“Conducting a Fair Test: Observation Checklist (BLM 7-P)



“Experiment Report: Assessment” (BLM 7-R)

Prescribed Learning Outcomes

Students will...

7-2-06 Describe the particle theory of matter and use it to explain changes of state.

GLO: A2, C6, D3, D4

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5e Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-III.1.6, SS-I.1.5)

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots…* GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)

7-0-6b Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

(continued)

Suggestions for Instruction

➢ Particle Theory of Matter

Use explicit instruction to introduce students to the *particle theory of matter* and have them organize the information presented using a Concept Overview (Matchullis and Mueller, 1994) organizer. Have students share their questions and analogies with the class.

(For a BLM of a Concept Overview, see *SYSTH*, Attachment 11.3 or *Success*, p. 6.112.)

➢ Safe Practices

Review with students safe practices for the science lab. The emphasis should be on preventing accidents. Working with heat sources requires students to follow strict safety procedures. *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions* provides important information as well as student lesson plans related to safe practices.

➢ Heating Curve

Part A: Solid to Liquid

- Have students collect a beaker of snow or crushed ice and record its temperature. Leave the beaker at room temperature, causing the snow/ice to melt (change state).
- Have students record the temperature of the beaker's contents at regular intervals (once every minute or two) until the snow/ice has completely melted.

Safety Precaution: A hot plate could be used to speed up this process, but there is the risk of the glassware cracking because of the close contact of hot and cold materials. This faster method also results in a smaller plateau at the melting point stage. If you are using a hot plate (here or in Part B), hold the thermometer by its plastic grip or clamp it to a ring stand. It should not touch the bottom of the beaker and a stir stick should be used to stir the liquid regularly.

(continued)

Suggestions for Assessment

Teacher Notes

Review with students the proper use of thermometers and safety procedures when heating substances. Students may have numerous questions such as: Why does snow have different temperatures? Is 0°C the melting and freezing point of water? Why is melting occurring but the temperature is below 0°C? What affects the boiling point of a substance? You may wish to guide students into further inquiries/investigations to answer these questions.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 2.7)

Sciencepower 7 (Sections 4.3, 8.4)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 4.2, 4.3, and Chapter 3, Sections 2.0-2.3)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

Be Safe! Canadian Edition: A Health and Safety Reference for Science and Technology Curriculum: K-9 (Teacher Reference)

Prescribed Learning Outcomes	Suggestions for Instruction
Students will...	

7-2-06 *(continued)*

(continued)

Part B: Liquid to Gas

Note: This portion of the experiment may take place in combination with Part A over the class period (if a hot plate is used), or in the next class if more time is required. Note that burners do not provide a constant, even source of heat. If hot plates are unavailable, be sure to place the beaker well above the burner to avoid breakage of glass or skewed results. Keep the flame low.

- Have students measure and record the temperature of the water every minute until only half the liquid remains. (Refer to the safety precaution outlined for Part A.)
- Introduce/review with students the procedure for constructing a line graph and have them graph their data. Students may also create a computer-generated graph instead of, or in addition to, the hand-drawn graph.

(For instructional suggestions, refer to *5–8 Math*, learning outcomes SP-III.2.6-2.7; Appendix: Teacher Information, and Graphs, Tables, and Lists.)

Have students analyze their graphs and answer the following questions in their science notebooks:

1. What was the temperature of the snow at the beginning of the experiment? (Answers may vary according to the temperature outdoors.)
2. What temperature was recorded at the first plateau? (several similar readings in a row) What change of state was occurring? (melting)
3. What temperature was recorded at the second plateau? (Although the boiling point of water is 100°C at sea level, the plateau may be around 98°C because of impurities in the water, height above sea level, and air pressure.)
4. What change of state was occurring at the second plateau? (vaporization)
5. Even though you were adding the same amount of heat throughout the period of a plateau, the temperature of the substance did not rise. Using the particle theory of matter, explain what the heat energy was being used for. (The heat energy was used to lessen the attraction of the particles for each other, thus allow them to move more freely.)

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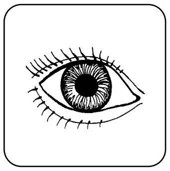
SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Following Safe Lab Procedures

When observing and assessing students' lab procedures, look for indications of the following:

Checklist:

The student

- ❑ uses the thermometer properly
- ❑ wears safety goggles during the heating of water
- ❑ uses proper equipment to handle heated liquids and containers
- ❑ ensures clothing and hair are appropriate (long hair is tied back, no baggy long-sleeved shirts or sandals are worn)
- ❑ keeps workplace uncluttered
- ❑ puts equipment away after use
- ❑ handles glassware with care

Prescribed Learning Outcomes	Suggestions for Instruction
Students will...	

7-2-06 *(continued)*

(continued)

6. Melting points and boiling points are characteristics of pure substances. What is the boiling point of water at sea level? (100°C)
7. What is the melting/freezing point of water? (0°C)

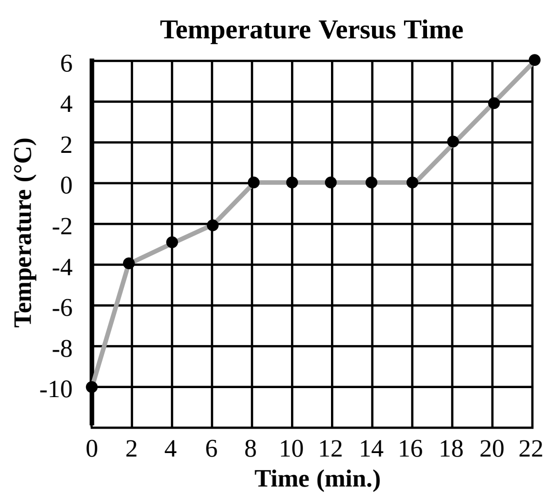
➢ **Making Line Graphs**

Refer to *5-8 Math* for support on the development of graphing skills.

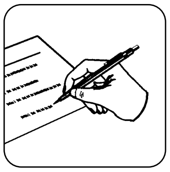
Examples (Part 1):

Data Chart

Time (min.)	Temperature (°C)
0	-10
2	-4
4	-3
6	-2
8	0
10	0
12	0
14	0
16	0
18	2
20	4
22	6



Suggestions for Assessment



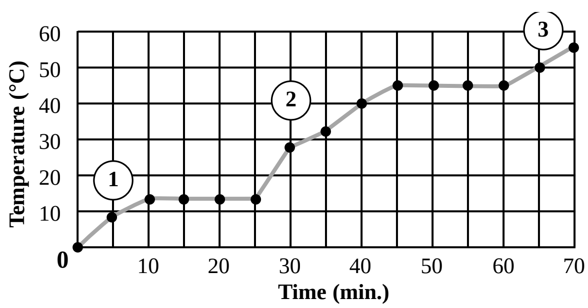
Restricted Response

Provide students with the following:

Identifying Melting and Boiling Points

1. Using the graph below, identify
   a. the boiling point of substance A. Justify your response.
   b. the melting point of substance A. Justify your response.
2. Indicate the state of matter of substance A at
   a. point #1
   b. point #2
   c. point #3

Substance A: Temperature Versus Time



Look for:

1. a. The boiling point of substance A is 45°C. That is the second plateau observed.
   b. The melting point of substance A is 15°C. That is the first plateau observed.
2. a. solid
   b. liquid
   c. gas

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-07 Differentiate between the concept of temperature and the concept of heat.

GLO: D3, D4, E4

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5e Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-III.1.6, SS-I.1.5)

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots…* GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)

7-0-6b Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Heat or Temperature

Use explicit instruction to introduce students to the distinction between *heat* and *temperature*. Use examples such as the following to model the appropriate use of the two terms:

- The heat from the burning fire was unbearable.
- The temperature of the hot tub was over 40°C.

➢ Temperature Versus Heat Experiment

Have students perform the following experiment to determine whether the volume of a substance affects the relationship between the amount of heat added and a substance's temperature. Have students use a Think-Pair-Share strategy (McTighe and Lyman, 1992) to determine the independent and dependent variables, and to identify what variables need to be controlled to ensure a fair test (e.g., have two ring stands set up and use the same burner). Have students graph the results of the experiment and then answer the questions provided.

Experiment:

1. Fill one beaker with 100 mL of water and another with 200 mL of water. (Use more water if students are using a burner.) Both beakers should have the same water temperature.
2. Heat the beakers for five minutes, recording the temperatures on a chart every 30 seconds. (**Note:** Attach the thermometers to a stand.)
3. Graph the results. (This graph will include the comparison of two separate lines, one representing 100 mL of water and the second representing 200 mL of water.)

Questions:

1. Was the amount of heat applied equal? (yes)
2. Which beaker of water had the higher temperature after one minute? After two minutes? (100 mL beaker) Using the particle theory of matter, explain your answer.
3. Using the following graph, determine which sample had more heat energy when both beakers had reached 100°C. Explain your answer using the particle theory of matter. (The 200 mL beaker. It had more particles that were vibrating due to the added heat energy.)

(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Use safety precautions when heating and handling hot liquids/containers. Ensure that students use the terms *heat* and *temperature* correctly.

- *Temperature* measures how hot or cold something is and depends on how fast its particles are moving. Materials that have fast-moving particles have higher kinetic energy, and therefore, a higher temperature.
- *Heat* energy is the energy that is transferred from materials with a high temperature to materials with a low temperature.

Heat energy is a difficult concept to comprehend, even for scholars. The emphasis of learning outcome 7-2-07 is not on providing students with precise definitions but on having students use the terms *heat* and *temperature* appropriately.

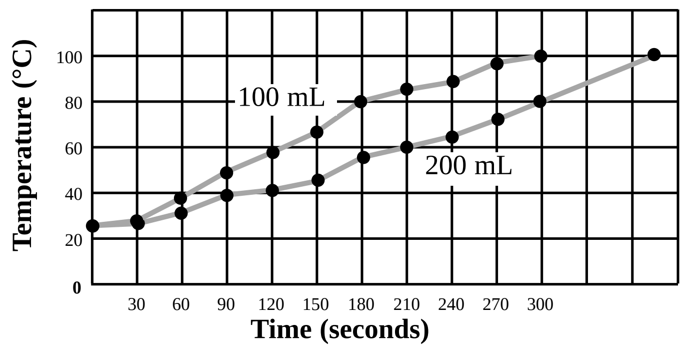
SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7: (Sections 2.5-2.6)

Addison Wesley Science & Technology 7 (Chapter 3, Sections 3.0-3.2)

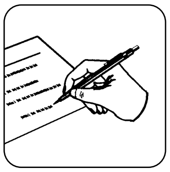
Prescribed Learning Outcomes	**Suggestions for Instruction**
Students will...	
7-2-07 *(continued)*	*(continued)*

Volume Comparison: Heat Versus Temperature



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

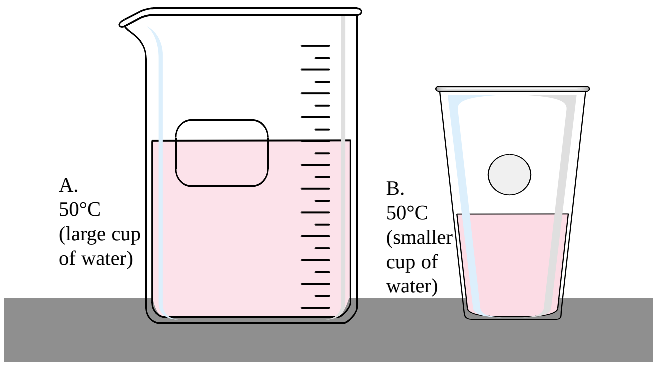


Restricted Response

Note: This learning experience could be used as an Exit Slip. Provide students with the following:

Which Has More Heat Energy?

Study the following diagrams. Which container has more energy in it? Why?



Look for:

Cup A has more energy because it has more particles that are vibrating due to transferred heat energy.

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-08 Demonstrate how heat can be transmitted through solids, liquids, and gases.

Include: conduction, convection, radiation.

GLO: C1, D3, D4, E4

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Conduction in Solids**

Using the method described below, demonstrate the *conduction* of heat in solids. Have students observe and then explain what happened, using the particle theory of matter.

Bring to class a candle, stopwatch, clamp, paper clips, retort stand, wax, ruler, heat resistant gloves, and a metal rod (e.g., copper, steel, brass). **Note:** A commercial conductometer may be used if one is available. Small birthday candles work well with a commercial conductometer.

Complete the following as a class demonstration:

- Clamp the rod to the ring/retort stand.
- Place a small ball of wax on each of six paper clips.
- Place the clips on the rod at equally measured intervals along the rod.
- Hold a lit candle under one end of the rod and time how long it takes for each of the wax balls to melt off.
- Record what happened. (Heat energy from the candle caused the particles to vibrate faster in the rod. Particles bumped into other particles and slowly passed the heat energy along the rod.)

➢ **Convection in Liquids and Gases**

Liquid

Demonstrate *convection* (the transfer of heat in fluids) by conducting the following experiment, using two identical clear bottles (e.g., 750 mL pop bottles, collecting bottles, or quart sealers), a pan, index cards, and blue food colouring. Complete the following as a class demonstration:

- Fill one bottle with hot water and the other with cold water.
- Add blue food colouring to the bottle of hot water.
- Place an index card on the opening of the bottle of cold water, then invert it so that the bottle of cold water rests on top of the bottle of hot water.
- Slowly pull out the index card from between the two bottles, and observe the movement of the coloured water.

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

- *Conduction:* Heat transfer occurs in solids by conduction. As each particle of matter collides with another particle of matter, heat energy is transferred.
- *Convection:* Heat transfer in fluids (liquids and gases) is called convection. In convection, the particles of matter collide as fluids move. Convection currents are caused by warm fluids rising.
- *Radiation:* Radiation is the transfer of heat energy by means of waves. These waves can travel across empty space.

Note: More than one type of heat transmission may take place at the same time. A light bulb, for example, radiates heat and also transmits heat through convection (air particles).

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 2.1, 2.10)

Sciencepower 7 (Chapter 9)

Addison Wesley Science & Technology 7 (Chapter 3, Sections 4.0-4.4)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION

Students will...

7-2-08 *(continued)*

(continued)

Have students answer the following questions in their science notebooks:

Questions:

1. Was the movement of water from hot to cold or from cold to hot? (hot to cold) What evidence is there to show this? (The dye moved up.)
2. At what point do you think the heat transfer stopped? (When the temperature in both bottles was the same.) How do you know? (Because both bottles were evenly coloured blue.)

Gas

Have students identify examples of convection of heat in gases (e.g., it is hotter in a room near the ceiling).

➢ **Radiation**

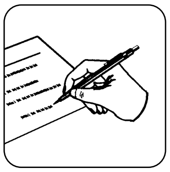
Radiation is the transfer of heat by waves. Particles are not needed for the heat to transfer and, unlike convection currents, heat waves move outward from their source in all directions.

Use explicit instruction to introduce the term *radiation* to students. As a demonstration, have a student place a hand near a light bulb, move the hand in all directions around the bulb, and describe where he or she feels heat.

Safety Precaution: Ensure that students do not touch the bulb! Students will find that it is equally hot in all directions from the light bulb at a given distance. As a class, brainstorm other examples of radiant heat (e.g., a fire). Have students recognize that often more than one type of heat transfer takes place (a fire is also transferring heat through convection).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Restricted Response

Note: This learning activity can be used as an Exit Slip. Provide students with the following:

Heating It Up!

Fill in the blanks below, using one of the following terms: *conduction*, *convection*, *radiation*.

1. _______________ does not need particles to transfer heat.
2. _______________ is the transfer of heat in solids.
3. _______________ is the transfer of heat as particles rise and collide.

Look for:

1. radiation
2. conduction
3. convection

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-09 Plan an experiment to identify materials that are good heat insulators and good heat conductors, and describe some uses of these materials.

GLO: B1, D3, D4

7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7)

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4)

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots…* GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)

7-0-6b Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

SUGGESTIONS FOR INSTRUCTION

➢ Discrepant Event

Prepare two devices before class (do not show students your preparations):

- Device A: Push a 30 cm section of wire through a natural cork stopper until the cork is located at the midpoint of the wire.
- Device B: Divide wire into two 15 cm sections and push one end of each piece into opposite ends of a cork stopper. Device B should appear the same as Device A, but ensure that the two ends of the wire do not meet inside the cork.

In class, have one student hold one end of Device A and another student hold one end of Device B. Use a heat source to heat the ends of the two devices that the students are not holding. Instruct students to let go as soon as they feel the wire they are holding getting hot. Only Device A (the unbroken wire) will transfer heat, so be sure that the student holding this device does eventually let go.

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to discuss what happened and brainstorm possible explanations as to why one device did not transfer heat energy.

➢ Insulator and Conductor Experiment

Good *heat insulators* are substances that slow the transfer of heat from one area to another and good *heat conductors* are substances that allow the transfer of heat readily.

Safety Precaution: Review students' proposed methods before testing occurs. Ensure that all safety issues have been addressed before allowing students to test their materials.

Based on this statement, have students plan an experiment to determine whether a substance is a good heat insulator or heat conductor. Ask them to submit a plan that includes variables, predictions, materials, controls, and a method.

Have students

- conduct their experiment
- record and graph results
- draw conclusions and rank the materials tested from best conductor to best insulator Students can record information on the "Experiment Report" (BLM 7-Q).
- describe the possible uses of each material based on its ability to conduct or insulate

Suggestions for Assessment

Insulators and Conductors

Using the Three-Point Approach (Simons, 1991), have students define good insulators and good heat conductors. Ask them to list examples and draw and label a diagram of where each might be used.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

Look for:

- A good insulator prevents the transfer of heat. Examples: a wooden or plastic handle of a frying pan, fibreglass insulation, styrofoam insulation.
- A good conductor readily allows the transfer of heat. Examples: metals (copper, aluminum, silver, brass).

Refer to the following BLMs for assessment suggestions related to the Insulator and Conductor experiment:

"Conducting a Fair Test: Observation Checklist" (BLM 7-P)

"Experiment Report: Assessment" (BLM 7-R)

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 2.15-2.16)

Sciencepower 7 (Section 9.1)

Addison Wesley Science & Technology 7 (Chapter 3, Section 4.1)

Prescribed Learning Outcomes

Students will...

7-2-10 Use the design process to construct a prototype that controls the transfer of heat energy.

Examples: insulated lunch bag, solar oven, home insulation...

GLO: A5, B2, C3, C4

7-0-1c Identify practical problems to solve. *Examples: How can I keep my soup hot? Which type of sunscreen should I buy?…* GLO: C3

7-0-1d Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.7)

7-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-4b Construct a prototype. GLO: C3

7-0-5b Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-6d Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

7-0-7d Propose and justify a solution to the initial problem. GLO: C3

Suggestions for Instruction

Teacher Notes

Discuss with students the importance of having controls to ensure that the results of prototype testing are reliable and not biased.

Teachers may wish to pick one type of device to be designed or allow students to design a variety of different types of devices. If students construct the prototype at home, have them

- submit a plan
- construct their device at home
- bring prototypes to school to conduct tests or present well-documented data with photographs, videos, or visual representations with prototypes available for viewing

➢ Design Project Suggestions

Suggestion 1: Cool Contest

Using the design process, have students build a device that stops heat transfer and keeps an ice cube solid for an extended period of time. Suggest the following design criteria:

- Do not use electricity, dry ice, or an outside source for keeping your containers cool.
- Include a hatch opening/transparent port that allows you to observe the ice.
- Include a cost and practicality review of your design.

Students may use the “Design Project Report” (BLM 7-N) to record their work.

Suggestion 2: Create a Solar Cooker/Heater

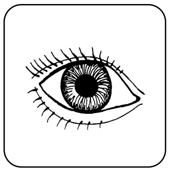
Using the design process, have students work in groups to build a device that uses the radiant energy of the Sun to heat a substance.

Examples:

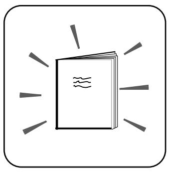
- solar water heater
- hotdog cooker
- marshmallow cooker

Suggestions for Assessment

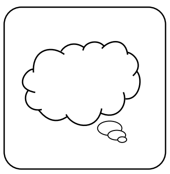
Refer to the following BLMs for assessment suggestions:



"Constructing a Prototype: Observation Checklist" (BLM 7-M)



"Design Project Report: Assessment" (BLM 7-O)



Design Process

Provide students with the following self-assessment tool:

Self-Assessment of the Design Process

1. One problem I had was ______________________________
2. I did well on ____
3. One thing I would suggest to another student __________
   ____
4. I would like to learn more about ____________________
   ____
5. I could improve it by _________________________________

Suggested Learning Resources

Nelson Science & Technology 7 (Unit 2, Controls or Uses Heat)

Sciencepower 7 (Chapter 9, Unit 3, project)

Addison Wesley Science & Technology 7 (Chapter 3, Section 4.1)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-11 Recognize that heat energy is the most common by-product of energy transformations, and describe some examples.

Examples: thermal pollution, body heat, friction...

GLO: B1, D4, E4

7-2-12 Identify different forms of energy that can be transformed into heat energy.

Include: mechanical, chemical, nuclear, electrical.

GLO: D4, E4

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ Heat As a By-product

Have students identify one device or piece of technology in each room of their home, as well as their garage and/or yard (where possible). Have students indicate whether heat energy occurs as a by-product in each device.

Examples of devices where heat is a by-product:

- television
- refrigerator
- lamp

➢ Transforming Mechanical Energy to Heat

Have students use a Think-Pair-Share strategy (McTighe and Lyman, 1992) to describe *friction*. Have them rub their hands together and take note of how this feels with regard to heat. (Alternatively, have students put a tack on the end of a pencil and rub the flat end of the tack on the desk and then feel the tack.)

Ask students to answer the following questions in their science notebooks and to share their answers with the class:

1. List examples of where friction creates heat. (two surfaces rubbing against each other, e.g., engine parts, trumpet valves, machine parts, two sticks)
2. What are some negative effects of heat created by friction? (Heat could cause excessive wear on machine parts, or it could cause metal to become soft and then bend and jam. It could start a fire, or cause a machine to lose too much energy to heat efficiently.)
3. What are some ways of reducing friction? (adding lubricants, ensuring surfaces are smooth)

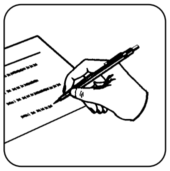
➢ Transforming Chemical Energy to Heat

Have students observe a burning candle. Ask them to use a Think-Pair-Share strategy (McTighe and Lyman, 1992) to answer the following questions:

1. Is the candle staying the same throughout the burning process?
2. The candle itself contains chemical energy. Chemical energy within the candle is being transformed into what two forms of energy? (light and heat) Identify examples where chemical energy is transformed into heat energy. (in burning of oil, natural gas, gas, and wood, in hot packs and hand warmers, and in the body sugar and oxygen combine to create heat)

(continued)

SUGGESTIONS FOR ASSESSMENT



Restricted Response

(Learning outcomes 7-2-04 to 7-2-09)

Create-a-Quiz: Heat and the Particle Theory of Matter

Assign groups of students two or three terms from the list below. Have them create fill-in-the-blank statements related to those terms. Review the statements and select a number to include in a class quiz.

Terms:

- boiling point
- melting point
- scientific theory
- particle theory of matter
- temperature
- heat
- conduction
- convection
- radiation
- heat insulator
- heat conductor
- heat energy
- mechanical energy
- chemical energy
- nuclear energy
- electrical energy

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 2.20-2.22)

Sciencepower 7 (Section 9.2)

Addison Wesley Science & Technology 7 (Chapter 3, Sections 5.0-5.4)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-11, and **7-2-12** *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

3. Thermal pollution occurs when unwanted heat affects the environment. It may occur in the air by the burning of a fossil fuel, or in water which is used in thermal and nuclear power plants. In the case of thermal pollution of water, no contaminants are added to the water but the heat itself poses a problem. How would too much heat in an ecosystem affect the organisms in the system? (Thermal pollution of air could cause climate change. This would affect the growth of plants that are accustomed to certain conditions and subsequently it would affect the animals that depend on the plants. When thermal pollution occurs in water, those fish that need cold water to survive may die if the water temperature rises significantly.)

7-2-13 Differentiate between pure substances and mixtures by using the particle theory of matter.

Include: a pure substance is made up of one type of particle; a mixture is made up of two or more types of particles.

GLO: A2, D3, E1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

➢ **Pure Substances Versus Mixtures**

Have students, working in groups, observe two samples representing pure substances and two samples of mixtures. (Examples of pure substances include sugar, salt, and copper; examples of mixtures include snack mix, chocolate cookies, granola cereal, and sugar and water.) Using a Venn diagram, have students represent the relationship between pure substances and mixtures.

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 7-2-14.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 1.2)

Sciencepower 7 (Sections 4.2-4.3)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 2.0-2.1)

Prescribed Learning Outcomes

Students will...

7-2-14 Differentiate between the two types of mixtures, solutions and mechanical mixtures.

Include: solutions — homogeneous; mechanical mixtures — heterogeneous mixtures.

GLO: D3, E1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

Suggestions for Instruction

Teacher Notes

Background Information

A *solute* is the substance that dissolves and a *solvent* is the substance that does the dissolving. This concept is addressed in greater detail in relation to learning outcome 7-2-16.

➢ Solutions Versus Mechanical Mixtures

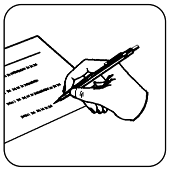
Give groups of students samples of two solutions and two mechanical mixtures. Have students note their similarities and differences using a Concept Relationship Frame (Matchullis and Mueller, 1994). As a class, generate a list of characteristics of solutions based on students' findings.

Example:

Solutions	Mechanical Mixtures
General characteristics of solutions: • composed of at least two parts: solute and solvent • do not settle out upon standing • uniform, appear as one state • evenly mixed or homogeneous • can be solid, liquid, or gas	General characteristics of mechanical mixtures: • two or more substances mixed together • each component is visible • heterogenous
Examples: • salt and water • vinegar and water • drink mix and water • sugar and water	Examples: • pepper and water • vegetable oil and water • soil and water • sand and water • granola cereal • snack mix

(For a BLM of a Concept Relationship Frame, see *SYSTH*, Attachment 11.1, or *Success*, 6.104.)

SUGGESTIONS FOR ASSESSMENT



Restricted Response

Provide students with the following:

Vocabulary

Define and represent the following terms:

1. pure substance
2. mechanical mixture
3. heterogeneous mixture
4. homogeneous mixture
5. solution

SUGGESTED LEARNING RESOURCES

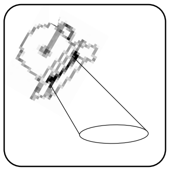
Nelson Science & Technology 7 (Sections 1.2-1.3)

Sciencepower 7 (Sections 4.1-4.2)

Addison Wesley Science & Technology 7 (Chapter 2, Section 2.1)

Prescribed Learning Outcomes	**Suggestions for Instruction**
Students will...	
7-2-15 Classify a variety of substances used in daily life as pure substances, solutions, or mechanical mixtures. *Examples: distilled water, paint thinner, mouthwash, peanut butter, liquid soap, medicines, sunscreens...* GLO: B1, E1	➢ **Scavenger Hunt** Have students collect samples and/or pictures (pictures are advisable for controlled materials identified in Workplace Hazardous Materials Information System [WHMIS], such as paint thinner, harsh cleaners, chemicals, or medicines) of pure substances, mechanical mixtures, and solutions that are used in daily life. Ask students to identify each sample with a flap label that reveals the classification of the substance according to the three terms: pure substances, solutions, or mechanical mixtures. Then the class may set up a sample table for students to practise their skills by classifying each of the samples or pictures of substances, solutions, or mechanical mixtures provided by students.
7-2-16 Identify solutes and solvents in common solid, liquid, and gaseous solutions. GLO: D3 **7-0-5f** Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)	➢ **Research** Have students conduct research to identify the solutes and solvents of a variety of solutions (e.g., chocolate, soft drinks, brass, air). Ask students to record their information on index cards, labelled as solute, solvent, and solution. Student groups can challenge others to match up the components with the correct solution.

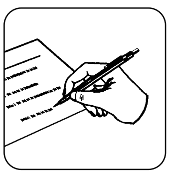
SUGGESTIONS FOR ASSESSMENT



Classifying Substances as Pure, Mechanical Mixture, or Solution

Using a Sort and Predict Frame (Matchullis an Mueller, 1994), have students organize into categories a list of substances submitted in the Scavenger Hunt learning experience (see learning outcome 7-2-15). Have students label each category as a pure substance, a mechanical mixture, or a solution.

(For a BLM of a Sort an Predict Frame, see *SYSTH*, Attachment 10.3, or *Success*, p. 6.100.)



Restricted Response

Provide students with the following:

Identifying Solutes and Solvents

Complete the following chart:

Solution	Solute	Solvent
1. iced tea 2. frozen ice treat 3. gelatine dessert		

Look for:

1. solute—drink crystals; solvent—water
2. solute—sugar, flavour, colouring; solvent—water
3. solute—gelatine, sugar, flavour; solvent—water

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 1.11)

Sciencepower 7 (Section 4.1)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 2.1-2.3)

Nelson Science & Technology 7 (Section 1.11)

Sciencepower 7 (Section 5.1)

Addison Wesley Science & Technology 7 (Chapter 2, Section 2.3-2.4)

Prescribed Learning Outcomes

Students will...

7-2-17 Describe solutions by using the particle theory of matter.

Include: particles have an attraction for each other; the attraction between the particles of solute and solvent keeps them in solution.

GLO: A1, D3, E1

7-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

Suggestions for Instruction

➢ **Visualizing Solvent and Solute Particles**

Remind students that the particle theory of matter states that particles are attracted to each other and that, in some cases, the particles of a certain substance may be more attracted to particles of a different substance than to their own.

Fill two graduated cylinders to the 100 mL mark, one with sand and the other with marbles. Have students predict what the volume would be if the two solids were combined. Pour the sand into the graduated cylinder with the marbles. Ask students to observe, and then answer the following questions in their science notebooks:

1. If the marble particles had a greater attraction for each other and did not let anything come between them and the sand, what would be the combined volume of the substances? (200 mL)
2. If the marbles were poured into the sand instead of the reverse, would the two substances combine? (No, because the sand particles are closely packed and are more attracted to each other.) What allows the combining to occur? (Space between the marbles and the subsequent lessened amount of attraction between them allows the sand to come between the marbles.)
3. According to the particle theory of matter, would it be possible for two solids to become a solution? Why or why not? (They could not be combined as solids because their particles are too closely packed and have a strong attraction to each other. They would have to be liquefied and combined, and then allowed to solidify.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 1.11)

Sciencepower 7 (Section 5.1)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 4.2, 4.4)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-18 Demonstrate different methods of separating the components of both solutions and mechanical mixtures.

Examples: distillation, chromatography, evaporation, sieving, dissolving, filtration, decanting, magnetism, sedimentation...

GLO: C1, C2

7-2-19 Identify a separation technique used in industry, and explain why it is appropriate.

GLO: B1, C4

7-0-1c Identify practical problems to solve. *Examples: How can I keep my soup hot? Which type of sunscreen should I buy?…* GLO: C3

7-0-1d Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.7)

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-4b ➲ Construct a prototype. GLO: C3

7-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

7-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

SUGGESTIONS FOR INSTRUCTION

➢ Separating Components of Mixtures

Using the Think-Pair Share strategy (McTighe and Lyman, 1992), have students generate possible methods for separating the mixtures below. Then assign a different problem or scenario to each group of students and have them

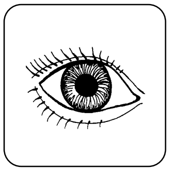
- research, plan, test, and revise (retest if needed) a way to separate the components of their mixture
- identify where their particular separation technique is used in industry
- present their results to the class

Note: All students should record information about each method in their science notebooks.

Methods of Separating Mixtures

- **Scenario A:** Minute metal shards have fallen onto the sandy floor of a workshop. How could the owner clean the sandy floor of the dangerous metal pieces? (Use a magnet.)
- **Scenario B:** To improve the icy road conditions, a sand-salt mixture has been used on the highways all winter. The spring cleanup crew has scooped up the mixture and would like to use the sand for road construction but the workers must first remove the salt. How could this be achieved? (Add water to dissolve salt and decant liquid.)
- **Scenario C:** Pens were confiscated from three people suspected of forging a signature. How could one determine which pen was used to forge a signature on the given document? (Use chromatography.)
- **Scenario D:** You are stranded on a deserted island in the Pacific Ocean. There is no fresh drinking water, only salt water from the ocean. How could you obtain drinking water? (Distill the water.)
- **Scenario E:** A gardener would like to use some soil from the backyard to start some seeds but there are a lot stones in it. How could the stones be removed? (Use screens for sifting.)
- **Scenario F:** A person would like to make a glass of fresh pulpless orange juice. What method could the person use? (Strain and filter the juice.)
- **Scenario G:** A community by the ocean would like to establish a small business that sells salt and pepper. Farmers are already growing peppers to be dried and used in the business but there are no salt mines within the vicinity. Someone has suggested obtaining the salt from the salt water of the ocean. How would this be done? (Evaporate the water and collect the salt that remains.)

Suggestions for Assessment



Separation Problems

When assessing the learning experience, Separating Components of Mixtures, look for indications of the following in student work:

Checklist:

The student

- ❑ understands the problem
- ❑ brainstorms possible solutions
- ❑ creates a written plan
- ❑ develops criteria for success
- ❑ includes a labelled diagram
- ❑ tests the separation technique
- ❑ identifies and makes improvements
- ❑ identifies which industry uses the same separation technique or a similar separation technique
- ❑ uses appropriate safety equipment
- ❑ displays the proper disposal method of used materials

Suggested Learning Resources

Nelson Science & Technology 7 (Section 1.21)

Sciencepower 7 (Section 5.2)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 3.0-3.3)

Prescribed Learning Outcomes
Students will...
7-2-20 Experiment to determine factors that affect solubility. Include: agitation, surface area, temperature. GLO: C2, D3
7-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 7, 3.1.2; Math: SP-I.1.7) **7-0-1b** Select and justify a method to be used in finding the answer to a specific question. GLO: C2 (ELA Grade 7, 3.2.3; Math: SP-II.1.7) **7-0-3a** Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7) **7-0-3b** Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2 **7-0-3c** Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4) **7-0-4a** Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2 **7-0-5a** ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2 **7-0-5c** Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5 **7-0-5e** Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-III.1.6, SS-I.1.5) **7-0-5f** Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7) **7-0-6b** Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5 **7-0-6f** Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 7, 3.3.4) **7-0-7a** Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

Suggestions for Instruction

➢ Factors That Affect Solubility

Solubility is the ability of a substance to go into a solution by dissolving. Have students brainstorm ways to increase the solubility of a sugar cube. Then have pairs of students conduct an experiment to test one of their hypotheses.

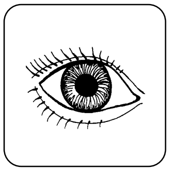
Student experiments could address one of the following:

- the effect of particle size or surface area on solubility
- the effect of agitation/stirring on solubility
- the effect of temperature on solubility

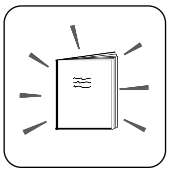
Ask students to identify the independent and dependent variables for their experiment, as well as at least three controls. Reinforce the concept of a “fair test.” Have students present their findings to the class. Students can use the “Experiment Report” (BLM 7-Q) to record their work.

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Conducting a Fair Test: Observation Checklist" (BLM 7-P)



"Experiment Report: Assessment" (BLM 7-R)

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 1.8-1.9)

Sciencepower 7 (Section 6.2)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 4.4-4.5, 5.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-21 Describe the concentration of a solution in qualitative and quantitative terms, and give examples from daily life when the concentration of a solution influences its usefulness.

Include: dilute, concentrated, grams of solute per 100 mL.

GLO: C6, D3

7-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ **Importance of Being Quantitative**

Without providing measurement instructions, have students prepare a solution of unsweetened drink mix, sugar, and water in a small paper cup. Have them taste their solution and then write their observations in their science notebooks. Have them add more of the ingredients to improve the taste. When they have settled on an acceptable solution, have students write instructions on how to make a palatable drink.

After they have finished their investigation, have students answer the following questions in their science notebooks:

1. What would assist you in writing accurate instructions for someone else on how to make a tasty drink without continuously having to taste test and add more of an ingredient? (use of measurement tools)
2. What term might be used to describe a watery tasting drink solution: diluted or concentrated? Explain your answer. (diluted—very little solute and a large amount of solvent)
3. You can purchase orange juice in one-litre containers. You can open and drink this juice without adding water. There are also frozen juices to which you have to add water in order to drink them. What term is used to describe the latter type of solution: diluted or concentrated? Explain your answer. (concentrated—more solute than solvent.) Explain why orange juice is available in different forms. (type of packaging, cost, allowing purchaser to control concentration)
4. Which of the following is a more concentrated solution:
   a. 5 grams per 100 mL
   b. 37 grams per 100 mL
   c. 17 grams per 100 mL

   (Answer: 37 grams per 100 mL)
5. If you were receiving medication mixed by a pharmacist, would you rather he or she used quantitative (measured amounts) or qualitative (without measuring) qualities to prepare it? Why? (Quantitative, because it would be more exact and the person receiving the medication would not have to worry about being poisoned.)

SUGGESTIONS FOR ASSESSMENT

Journal Reflection

Have students reflect, in their science journals, on the many ways in which their own lives would be affected over the course of a day if it were not possible to measure the concentration of solutions quantitively.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 1.8-1.9)

Sciencepower 7 (Section 5.4, Chapter 5, Chapter-at-a-Glance)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 5.0-5.1)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-2-22 Demonstrate the difference between saturated and unsaturated solutions.

GLO: C2, C6, D3

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Creating Saturated Solutions**

Provide students with the following scenario:

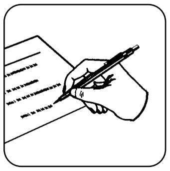
A company that makes hummingbird feeders for indoor aviaries would like to include, with its product, instructions on how to make the liquid food that goes into the feeders. The feeders are built to release the sugary liquid when a bird sticks its beak into the sipping holes. Hummingbirds require a lot of energy to survive; thus, they require high concentrations of sugar. Therefore, the water must be saturated (no more solute will dissolve in it) with the sugar. It has been found that if too much sugar is added, the sipping holes clog up.

Working in groups, have students

- create a plan to determine, quantitatively, the amount of solute per 100 mL solvent needed to saturate the water at room temperature
- test the plan
- draw up their results as a set of instructions that can appear on the box of the hummingbird feeders

Extension: The hummingbird feeder company would also like to have a version of its product for outdoor use. What factors would the company have to consider to determine the concentration of sugar per 100 mL for the food recipe? Explain. (Temperature variances will alter how much solute will dissolve.)

SUGGESTIONS FOR ASSESSMENT



Restricted Response

Provide students with the following:

Analyzing Data: Saturated Solution

An experiment was conducted to determine how much salt is needed to saturate 100 mL of water. Use the following data to answer the questions below.

Steps	Amount of Solute Added	Observations
1	2 grams	After stirring, the solute was totally dissolved (no solute was seen at the bottom of the beaker).
2	2 grams	After stirring, the solute was totally dissolved (no solute was seen at the bottom of the beaker).
3	2 grams	After stirring, the solute was totally dissolved (no solute was seen at the bottom of the beaker).
4	2 grams	After stirring, the solute was totally dissolved (no solute was seen at the bottom of the beaker).
5	2 grams	After stirring, some solute is seen at the bottom of the beaker.

1. Identify the solute and the solvent of the solution above.
2. Indicate at which step the solution reached its saturation point. Justify your answer.
3. What was the total amount of solute needed to saturate this solution?
4. What is the concentration of the solution in step 3?

Look for:

1. The solute is salt; the solvent is water.
2. The solution reached its saturation point at step 4. At step 5, some solute was seen to come out of solution; therefore, the saturation point was the step before when all solute was dissolved.
3. The total amount of solute needed to saturate the solution is 8 grams of salt.
4. 6 grams/100mL

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 1.8-1.9)

Sciencepower 7 (Section 6.2)

Addison Wesley Science & Technology 7 (Chapter 2, Section 5.2)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-2-23 Discuss the potential harmful effects of some substances on the environment, and identify methods to ensure their safe use and disposal. *Examples: pollution of groundwater from improper disposal of paints and solvents; pollution of the atmosphere by car exhaust...* GLO: B1, B3, B5, C1
7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1) **7-0-2b** Evaluate the usefulness, currency, and reliability of information, using predetermined criteria. GLO: C6, C8 (ELA Grade 7, 3.2.3; TFS 2.2.2) **7-0-2c** Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2) **7-0-7g** ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Disposing of Toxic Wastes**

Have students research how substances such as paints, solvents, used oil, farm chemicals, and industrial chemicals affect the environment, and what proper disposal techniques for these substances are in place locally. Have them create a brochure or computer-generated presentation explaining their research information.

Note: Acid rain caused by industrial wastes could also be included.

Suggestions for Assessment

Disposing of Toxic Wastes Project

Use the following to assess students' Toxic Waste Disposal brochures or presentations:

Assessment of Toxic Waste Disposal Project			
Criteria	**Possible Points**	**Self-Assessment**	**Teacher Assessment**
• the effects of toxic waste on the environment are identified			
• proper disposal techniques are identified			
• charts, pictures, graphs, or other visual matter are used to help support ideas within project			
Total			

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 1.19, 1.21)

Sciencepower 7 (Section 5.2)

Addison Wesley Science & Technology 7 (Chapter 2, Sections 6.0, 7.4)

Notes

Grade 7

Cluster 3: Forces and Structures

Overview

In this cluster, students explore a variety of natural and human-built structures, and the forces that act on them. Students investigate internal and external forces acting on structures and recognize that these forces may affect structural strength and stability. Students identify common shapes used to increase strength and stability in structures, and methods used to enhance the strength of the materials used. The efficiency of a structure is assessed by comparing its mass with the mass of the load it supports. Students apply their understanding of forces and structures by evaluating the appropriateness of a specific structure's design, and by constructing a structure of their own that supports a given load and remains standing when a particular force is applied.

Prescribed Learning Outcomes

Students will...

7-3-01 Use appropriate vocabulary related to their investigations of forces and structures.

Include: frame, shell, solid, centre of gravity, stability, compression, tension, shear, torsion, internal and external forces, stress, structural fatigue, structural failure, load, magnitude, point and plane of application, efficiency.

GLO: C6, D4

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to forces in Grade 6, Cluster 2: Flight, and in Grade 5, Cluster 3: Forces and Simple Machines.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Three-Point Approach**

Have students use the Three-Point Approach (Simons, 1991) to write a definition of a term in their own words, represent it with a picture/diagram, and give an example or synonym.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

Suggestions for Assessment

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

7-3-02 Classify natural and human-built structures found locally and around the world.

Include: frame, shell, solid.

GLO: E1

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

Suggestions for Instruction

➢ Classifying Structures According to Design

Provide students with pictures (from pamphlets, travel brochures, or magazines) of the three types of structures: solid, frame, and shell.

Examples:

- *solid*: Great Wall of China, castle, dam, cliffs along the sea, iceberg
- *frame*: house (frame), tower, umbrella, stairway, skeleton
- *shell*: quinzhee, tent, ball, wasp nest, cocoon, freshwater clam shell, canoe, tipi

Using a Sort and Predict strategy (Brownlie and Close, 1992), have students

- sort the pictures of structures into categories
- create category names to identify characteristics of the different types of structures. Explain to students the terms *solid, frame,* and *shell,* and ask them whether they categorized their samples in a similar fashion.

Note: Students may have put structures that were combinations of structure types in the fourth category or the Sort and Predict sheet. Many structures are actually combinations of types. Have students identify the structure types within the combinations.

(For a BLM of the Sort and Predict strategy, see *SYSTH*, Attachment 10.3; *Success*, p. 6.100.)

➢ Structure Walk

Have the class walk through the neighbourhood to identify various structures and structure types. Ask students to answer the following questions in their science notebooks:

1. Fill in the following chart with examples you saw on the structure walk:

Solid Structure	Frame Structure	Shell Structure

2. Did you observe any structures that were a combination of two types? If so, identify the structures and the types involved in their construction.
3. What type of structure is the human body? Explain.

Suggestions for Assessment

Restricted Response

Provide students with the following:

Classifying Structures: Solid, Frame, or Shell?

Identify the following as solid, frame, or shell structures.

1. stone bridge
2. igloo
3. Eiffel Tower
4. dam
5. staircase

Look for:

1. solid
2. shell
3. frame
4. solid
5. frame

Teacher Notes

Background Information

- *Solid structures* are made of solid piece(s) of strong material (e.g., a stone bridge).
- *Frame structures* are made of parts connected into a set arrangement (e.g., framing for a house).
- *Shell structures* are moulded into a shape that provides strength and stability (e.g., a basketball).

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.13)

Sciencepower 7 (Section 13.1)

Addison Wesley Science & Technology 7 (Chapter 4, Sections 1.2-1.4)

Prescribed Learning Outcomes
Students will...
7-3-03 Identify the centre of gravity in a model structure, and demonstrate that changes in the location of a structure's centre of gravity affect its stability. GLO: C1, D4
7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7) **7-0-4c** ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1) **7-0-4d** ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2) **7-0-5a** ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2 **7-0-7h** Identify and evaluate potential applications of investigation results. GLO: C4
(continued)

Suggestions for Instruction

➢ **Identifying the Centre of Gravity**

Part A

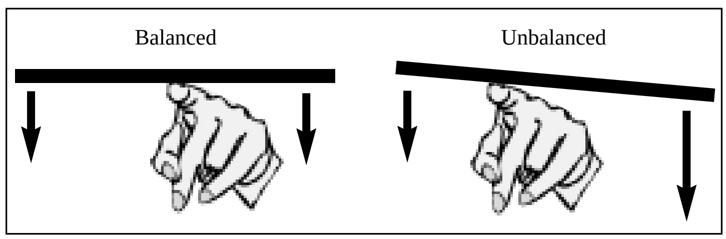
Have students balance a ruler with one finger and record where their finger is placed along the length of the ruler. Then have students place their finger towards one end of the ruler and observe what happens.

Ask students to answer the following questions in their science notebooks:

1. Where along the length of the ruler did you place your finger to balance the ruler? (the middle)
2. What force was pulling on the ends of the ruler? (gravity)
3. Your finger, pushing on the ruler, counteracted the pull of gravity only when the force of gravity was divided equally on either side of the ruler. Draw two force diagrams using arrows to illustrate the forces when the ruler was balanced and when it was not.

   Example:

Force Diagrams



4. The balancing point you found with the ruler is called the centre of gravity, the object's most stable point. Draw a 10 cm circle on a piece of cardboard and cut it out. Predict and then test to determine where the centre of gravity is located so that you can balance the circle on your fingertip. Record your observations. Create a variety of shapes and try to find the balancing point for each.

Part B

Have pairs of students connect one end of a string to the buckle of a belt that one partner is wearing, and the other end of the string to a large washer which should hang at knee level on the person wearing the belt. The partner wearing the belt will be asked to stand straight in four positions:

- with feet together
- with feet slightly apart

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

- The direction and strength of a force is represented by arrows called *vectors*. A longer arrow represents a stronger force. The point of the arrow shows the direction in which the force is being applied.
- Pairs of forces are usually included in force diagrams and it is possible to predict the effects of forces by comparing their relative size.
- Force diagrams are drawn for a particular purpose and may not be a true representation of how a force is acting on an object. For example, even though gravity is acting on all parts of a structure we may use one arrow to illustrate its relative strength.
- Identifying forces acting on structures is a complex task. The emphasis should be on direction and relative strengths of forces as opposed to exact placement of vector arrows.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.13)

Sciencepower 7 (Section 15.2)

Addison Wesley Science & Technology 7 (Chapter 4, Section 2.1)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

7-3-03 *(continued)*

(continued)

(continued)

- with feet shoulder-width apart, and knees bent
- on one foot

Ask students to record their predictions of where the washer will be located in each stance/position. Then have the belted partners assume each of the four positions and attempt to reach for something in front of them without moving their feet. Have students observe and record the position of the washer at the point at which balance is lost or almost lost.

After the demonstration, ask students to answer the following questions in their science notebooks:

1. What was the position of the washer in relation to the student's feet and hips when he or she lost balance? (It was no longer lined up with the student's feet and hips.)
2. The centre of gravity of a person is located in the mid-abdomen region, over the hips. Where must the centre of gravity be in relation to your feet for you to remain balanced while standing? (The centre of gravity must remain between your feet.)
3. a. Of the four demonstrated stances/positions, which one provided the most stability? (the third stance) why? (because the centre of gravity was between the student's feet and lower to the ground)
   b. Test your previous answer by having your partner take the same set of positions again, but this time try to push him or her over with one hand.
   c. Was your prediction correct? If not, which position was found to be the most stable? Explain why.
   d. How is this knowledge of stability, balance, and centre of gravity used in sports? (It is used in the stance of defensive football players so that the opposing team will not push the players over. It is used in the stance of volleyball players receiving a bump so that they can withstand the force of the ball without losing their balance. It is used in the stance of a hockey goalie so that he or she can stretch to the puck without losing balance.)

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes	**Suggestions for Instruction**

Students will...

7-3-03 *(continued)*

(continued)

➢ **Tower-Building Contest**

Have groups of students participate in a contest to build the tallest free-standing structure with blocks or dominoes (not interlocking) in a given period of time. This can be done at a station with poster paper on the wall, so that teams can mark off their tower height.

Ask students to follow these guidelines:

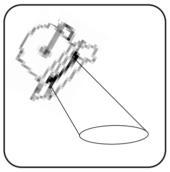
- Prior to building, create a plan for your tower.
- Decide, as a class, the time limit allowed for construction, taking into consideration time allowed for "stability checks."
- During construction, you may not modify the structure once the blocks are in place. However, you may modify your plans for subsequent layers.
- The structure must be stable for a 10-second count, so you may wish to conduct stability checks as you build. You should record the height you achieved at each stability check.
- Draw your final structure and record the height on the poster paper.

After all groups have completed the tower construction, compare diagrams and heights and have students answer the following questions:

1. What similarities in structure were found among the shortest towers? (a narrow base)
2. What was the common characteristic of the taller towers? (a wide base)
3. Using the terms *stability* and *centre of gravity,* describe what is needed to ensure that a tall tower is stable. (It needs to have a wide base so that the centre of gravity lies within the area of the base and can provide stability for all the blocks above.)

Suggestions for Assessment

Suggested Learning Resources



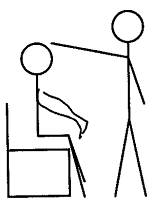
Balance, Force, and Centre of Gravity Investigation

Have students, working in pairs, take turns sitting on a chair and then standing up without using their hands.

Note: Having students work with same-sex partners for this learning activity may relieve the self-consciousness this age group may experience while observing body actions.

Have one partner sit in a chair while the other partner stands in front of the chair, placing his or her outstretched hand on the seated partner's forehead. Ask the seated partner to attempt to stand up. The standing partner should not move or bend his or her arm as the seated partner attempts to stand up from the chair. The standing partner should not use undue force in preventing the seated partner from standing, but should keep the seated partner from passing a certain plane. Have students change roles and repeat the experiment.

Example:



Ask students to answer the following question in their science notebooks, using the terms *balance, force,* and *centre of gravity*: Why is it difficult to stand up from the seated position with a person's hand on your forehead?

Look for:

It is difficult because the student is unable to bend forward. To achieve balance when rising from a sitting position we lean forward to shift our centre of gravity over our feet, which will support us when we stand. Having a partner restrict our movement when rising prevents us from overcoming the force of gravity.

Scoring Rubric	
Score	**Criteria**
3	The explanation uses the terms *balance, force,* and *centre of gravity* appropriately and shows an understanding of the concepts.
2	The explanation uses two of the three terms appropriately and shows an understanding of the concepts stated.
1	The explanation has one or fewer terms used appropriately.

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-04 Identify internal forces acting on a structure, and describe them using diagrams.

Include: compression, tension, shear, torsion.

GLO: D4, E4

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

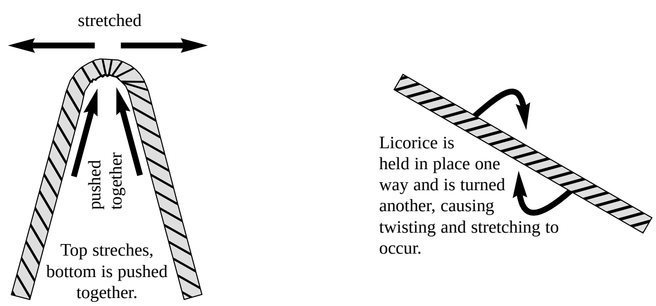
SUGGESTIONS FOR INSTRUCTION

➢ **Observing the Effects of Forces**

Provide students with licorice strips. To help students observe the effects of forces, ask them to complete the following:

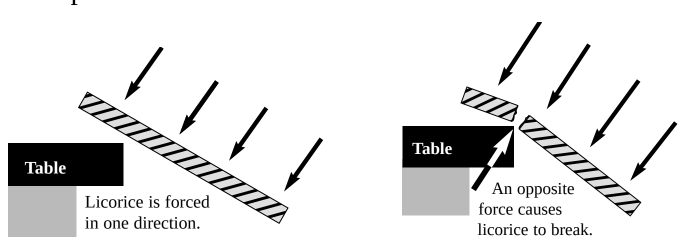
1. Bend a licorice strip in half and observe where the bend occurs. In your science notebook, draw a diagram of the licorice and label the top and the bottom part of the bend with arrows to indicate the direction of the forces acting within the licorice. Write a brief description of what is happening.
2. Straighten the licorice and, holding one end steady, turn the other end of the licorice. In your science notebook, draw a diagram of the licorice and label the directional forces. Write a brief description of what is happening.

   Example:



Demonstration: Break frozen licorice against the edge of a table. Be sure to wear safety goggles and have students at a safe distance. Show students the pieces. Have them draw the licorice, label the directional forces, and describe their observations in their science notebooks.

Example:



Ask students to identify which licorice example best illustrates the following:

- *Compression* is the result of forces squeezing together. (bottom of bent licorice)
- *Tension* is the pulling apart of a structure. (top of bent licorice)
- *Shear* is the result of forces acting in opposite directions of each other. (broken licorice)
- *Torsion* is a twisting force. (twisted licorice)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 7-3-08.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.12)

Sciencepower 7 (Section 14.3)

Addison Wesley Science & Technology 7 (Chapter 4, Section 2.4)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-05 Identify external forces acting on a structure, and describe them using diagrams.

Examples: snow on a rooftop, wind on a tent, water against a beaver dam...

GLO: C6, D4, E4

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

(continued)

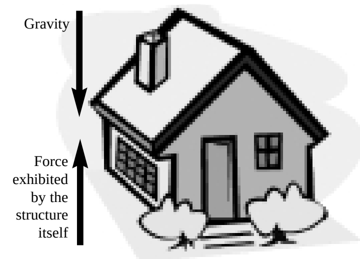
SUGGESTIONS FOR INSTRUCTION

➢ **External Forces**

Part A

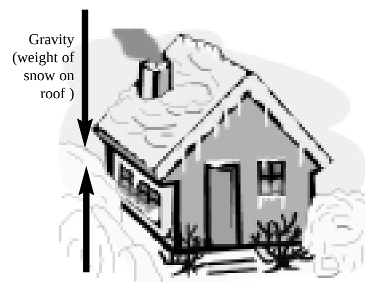
Using a Think-Pair-Share strategy (McTighe and Lyman, 1992), have students brainstorm the external forces that act on the structure of a house. Show students a diagram of what those forces are and how to identify them on a diagram, noting that gravity and the force exhibited by the structure itself are equal and thus balanced. Inform students that force diagrams usually show pairs of forces.

Example:



Now change the scenario slightly by adding the weight of a heavy snowfall onto the house. Ask students what the size of the arrow signifying gravity would be now in relation to the previous diagram. (It would be longer.)

Example:



Have students answer the following questions in their science notebooks:

1. If the snow-covered house represented in the second diagram were to remain standing, what would the force exhibited by the structure of the house have to be in relation to the force of gravity? (It would be the same as the force of gravity.)
2. What would happen if there was too much snow on the house? How would you picture this using a force diagram? (The house would collapse. The picture drawn should show some collapse and the arrow indicating the force of gravity should be longer than the one representing the force exhibited by the house.)

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.21)

Sciencepower 7 (Section 14.3)

Addison Wesley Science & Technology 7 (Chapter 4, Section 2.1)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-05 *(continued)*

(continued)

SUGGESTIONS FOR INSTRUCTION

(continued)

3. Why do engineers have to take these concepts of force into consideration when designing and building a structure? (Because the structure could fail, people could be hurt, and property could be damaged.)

Part B

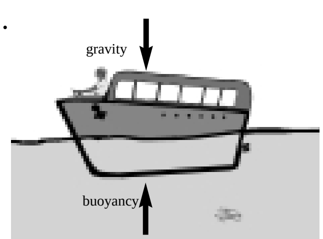
Have students create force diagrams identifying the forces in the following scenarios about a boat. Inform students that the force acting to keep the boat up is called *buoyancy*. When students have completed their force diagrams, review them with the class.

Examples:

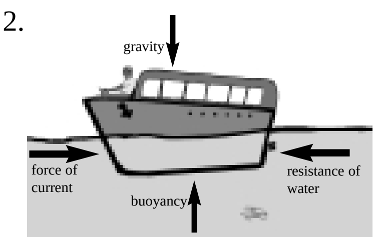
1. The boat is floating in one place on a calm lake.
2. The boat gets caught in a current of water that begins to move it backwards.
3. The driver starts the motor and goes against the current.

   (**Note:** Students may not know that the motor works on the basis of one of Newton's laws. The important aspect is that the ultimate force of the motor overpowers the force of the current.)
4. The driver has picked up 10 people at the dock and the boat is sitting a little lower in the water.

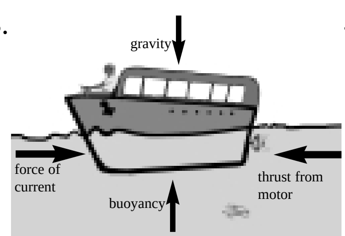
1.



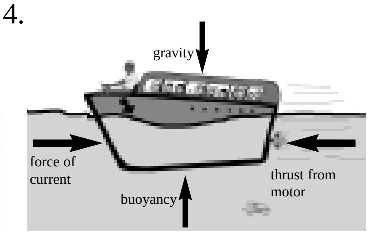
2.



3.



4.



(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

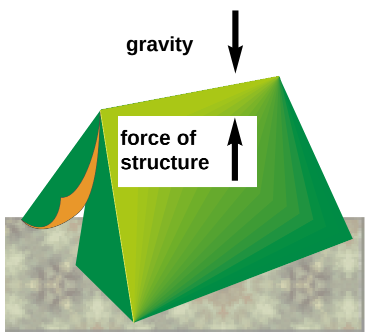
Restricted Response

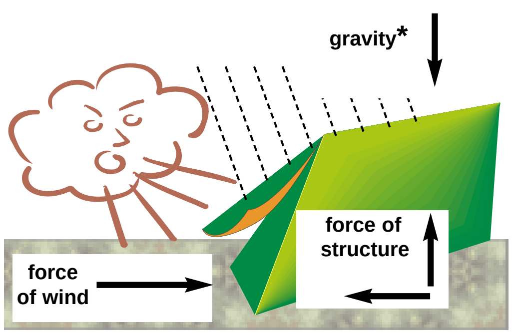
Provide students with the following:

Force Diagram

Draw a force diagram detailing the forces acting on a tent or tipi before and during a summer storm. The diagram should indicate opposing forces (during the summer storm), and, if the arrows are unbalanced, the structure (tent) should show signs of collapse.

Look for:





(* The weight of the tent fabric increased because rain caused gravitational pull to increase.)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-06 Recognize that internal and external forces apply stress to structures, and describe examples in which this stress has led to structural fatigue or structural failure.

GLO: D4, E3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-2c Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

- *Structural stress* occurs when a combination of external and internal forces act on a structure at one time.
- *Structural fatigue* occurs when a combination of external and internal forces weakens components of a structure (e.g., weakening of beams or concrete).
- *Structural failure* occurs when the structure itself collapses.

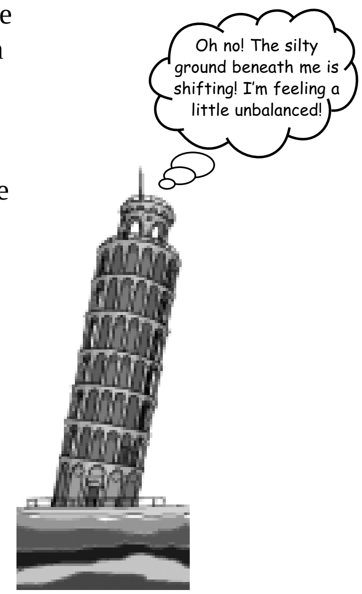
➢ Tower of Pisa Comic Strip

Have pairs of students read the article "Anti-gravity in Pisa" (BLM 7-F). In reading this text, students will need to use reading comprehension strategies such as partner reading, SQ3R, or structured note taking. (See *5-8 ELA*, learning outcome 2.1.2.)

It would be helpful for students to insert subheadings into the article, depicting the major undertakings to correct the lean, over time.

Have students

- create, in storyboard/comic strip fashion, a series of pictures that depict the internal and external forces that have caused the structural stress to occur and the attempts to correct it
- include brief captions or speech bubbles that provide textual information to support each concept



Example

➢ Structural Fatigue

Working in groups, have students

- research print and electronic multimedia resources to find other examples of structures that show signs of structural fatigue and/or failure
- identify the internal and external forces adding to the structural stress causing fatigue or failure, and explain what happened
- present their information in a labelled poster to be displayed in a gallery or bulletin board display

Suggestions for Assessment

Tower of Pisa Comic Strip

Provide students with the following tool for peer assessment of the Tower of Pisa comic strip:

Peer Assessment of Comic Strip

Comic strip author: ____

Peer assessor: ____

Criteria	Poor		Good		Excellent
The comic strip					
• shows creativity	1	2	3	4	5
• clearly illustrates major stages	1	2	3	4	5
Constructive comment:					

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 3.8-3.10)

Sciencepower 7 (Sections 14.3, 15.1)

Addison Wesley Science & Technology 7 (Chapter 4, Sections 2.6-2.7)

Prescribed Learning Outcomes

Students will...

7-3-07 Investigate to determine that the effect of a force on a structure depends on its magnitude, direction, and point and plane of application.

GLO: D4

7-0-1a ⊃ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 7, 3.1.2; Math: SP-I.1.7)

7-0-3a Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.7)

7-0-3b Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2

7-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4)

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ⊃ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-5e Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, SS-III.1.6, SS-I.1.5)

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots… GLO: C2, C6 (ELA Grade 7, 3.3.1;Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)

7-0-6b Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

Suggestions for Instruction

➢ **Spaghetti Beam Bridge**

Have students conduct an experiment to determine whether the magnitude of weight needed to cause structural failure of a "spaghetti bridge" (see diagram below) differs at various points along the plane of a bridge. Have students record their work on the "Experiment Report" (BLM 7-Q).

For this experiment, ask students to

- identify the independent variable (point of application of load force) and dependent variable (magnitude of weight)
- discuss, as a class, some of the controlled variables that need to be addressed (e.g., type of spaghetti, number of strands, type of elastic bands to hold spaghetti together, types of masses used)
- develop a hypothesis, list of materials needed, and method
- chart or graph the magnitude versus the point of application
- develop a conclusion based on their data. The conclusion should show the relationship between magnitude of weight and point of application, and also identify the strongest and weakest points along the plane of the bridge.

Example:

Note: A basket may be used to add mass to the bridge. The basket could be filled with objects such as pennies, weights, or sand.

7-0-6c Identify strengths and weaknesses of different methods of collecting and displaying data, and potential sources of error. GLO: A1, A2, C2, C5 (ELA Grade 7, 3.3.3)

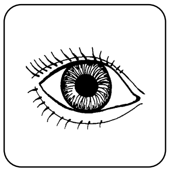
7-0-6f Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 7, 3.3.4)

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

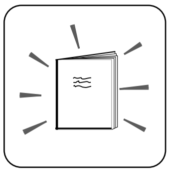
7-0-9c ⊃ Demonstrate confidence in their ability to carry out investigations. GLO: C5

SUGGESTIONS FOR ASSESSMENT

Refer to the following BLMs for assessment suggestions:



"Conducting a Fair Test: Observation Checklist" (BLM 7-P)



"Experiment Report: Assessment" (BLM 7-R)

Also refer to the assessment strategy suggested for learning outcome 7-3-08.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 3.14)

Sciencepower 7 (Section 15.1)

Addison Wesley Science & Technology 7 (Chapter 4, Section 2.6)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-08 Describe, using diagrams, how common structural shapes and components can increase the strength and stability of a structure.

Examples: a triangle distributes the downward force of a load evenly between its two vertices...

GLO: C6, D3, D4

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-5f Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.7)

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Structure Shape Test**

Give groups of students one piece of manila paper each and an equal portion of tape. Have groups predict what shape of structure created with these materials will be able to hold the most books on the top and then have them build their structure. Students may shape their structure into a cylinder or fold it into a box-like or prism shape, but should have minimal overlap of paper. A time limit may be imposed. When the students are finished, test each structure with a set of equally weighted books. As a culmination, have a class discussion about which shape has the most structural strength.

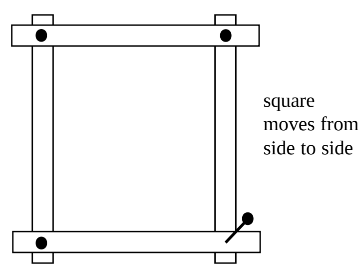
➢ **Components That Add Stability**

In conducting the “Spaghetti Beam Bridge” learning activity associated with learning outcome 7-3-07, students discovered that the weakest point in a beam bridge is the middle. Have students draw a diagram indicating what they could add to bridges to strengthen them. Have them share their suggestions with the class. Some possibilities are: placing a pillar in the middle, adding arches under the bridge, or adding struts or ties. (Refer to the Teacher Notes on the following page.)

➢ **Stable Shapes**

Have students make a square using four straws and four straight pins. Ask students to push or pull on the sides of the square and record their observations in their science notebooks.

Example:



Have students

- determine the placement of one more straw to make the square more stable, diagram their results, and identify the shape that brought stability to the square
- determine where a support straw should be placed for a rectangle, diagram their results, and identify the shape that brought stability to the rectangle

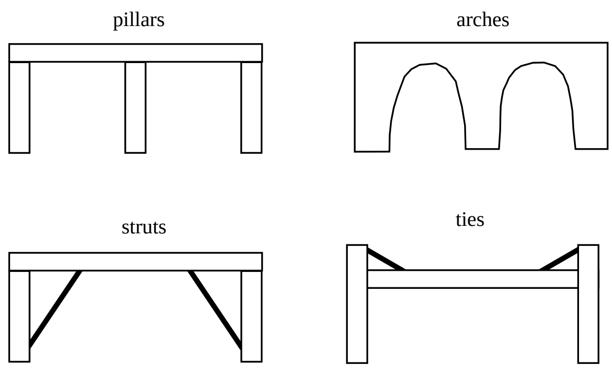
(continued)

Suggestions for Assessment

Teacher Notes

Background Information

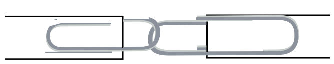
The following structures include components that add stability.



Students may use the following joints for the "Stable Shapes" and "Three-Dimensional Stability" learning experiences suggested for learning outcome 7-3-08.

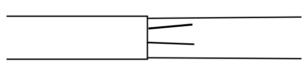
Joint A

Place a paperclip into the end of one straw and connect it with a second paper clip. Then place the second paper clip into another straw.



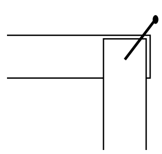
Joint B

Bend one end of a straw and slide it into the end of a second straw.



Joint C

Pin two straws together using a straight pin.



Suggested Learning Resources

Nelson Science & Technology 7 (Sections 3.17-3.19)

Sciencepower 7 (Sections 14.3, 15.3)

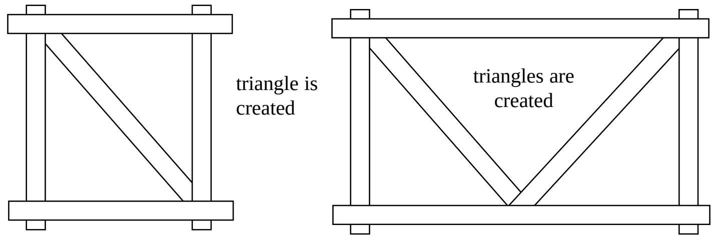
Addison Wesley Science & Technology 7 (Chapter 4, Section 3.1)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-3-08 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

Examples:



➢ **Three-Dimensional Stability**

Have students work in small groups to build the biggest possible frame, using drinking straws, for a clubhouse. The structure must be relatively stable. When students have finished their basic frame, have them predict what structural supports could be added to make the structure even more stable. Then have students add the structural supports, periodically testing for stability.

When students are finished constructing their clubhouses, have them answer the following questions:

1. Draw a diagram of one wall of your constructed house. Indicate where you added the structural support and explain why.
2. What main shape did you use to give your clubhouse stability? (a triangle)
3. Square and rectangular structures are not the strongest or most stable structures, but they are easy to make. Engineers have developed adaptations to strengthen these types of structures, including the addition or use of: arches, struts, ties, pillars, trusses, gussets, cantilevers, and braces. Research these terms and record your information using a Three-Point Approach (Simons, 1991).

   (For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2 or *Success*, p. 6.101.)

Suggestions for Assessment

Suggested Learning Resources

Restricted Response

(Learning outcomes 7-3-04 to 7-3-08)

Provide students with the following:

Forces Acting on Structures

Circle the best answer.

1. A twisting force that acts on structures is called:
   a. torsion c. shear
   b. tension d. magnitude
2. Forces acting in opposite directions of each other results in:
   a. torsion c. shear
   b. tension d. magnitude
3. The amount of force applied is called:
   a. torsion c. shear
   b. tension d. magnitude
4. One spot of paint is to a whole painted wall is point of application is to ________of application.
   a. magnitude c. plane
   b. structural fatigue d. shear
5. A combination of external and internal forces acting on a structure at one time is called:
   a. structural fatigue c. structural failure
   b. structural stress d. plane failure
6. A structure that allows for the load force to be transferred along its curves instead of one particular point is called:
   a. strut c. tie
   b. gusset d. arch
7. Trusses rely on this shape to give them stability:
   a. circle c. triangle
   b. cube d. arch

Look for:

1. a
2. c
3. d
4. c
5. b
6. d
7. c

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-09 Describe and demonstrate methods to increase the strength of materials.

Examples: corrugation of surfaces, lamination of adjacent members, alteration of the shape of components...

GLO: C2, C3, D3, E3

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

7-0-9d Value skepticism, accuracy, precision, and open-mindedness as scientific and technological habits of mind. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ **Analyzing Boxes**

Provide small groups of students with various types of boxes (e.g., a donut box, a shoe box, a cardboard box) and have them

- identify which boxes are the strongest
- identify the characteristics that make some boxes stronger than other boxes
- record their findings in their science notebooks
- share their observations with the class

Have students focus on the materials used to create the boxes, not on the joints, glue, or staples.

➢ **Penny-Paper Bridge**

Working in small groups, have students place a piece of paper between two stacks of books to create a beam bridge. Have students place pennies on the bridge until structural failure occurs.

Have students plan and build a paper beam bridge that will hold more pennies than the previous one, following these guidelines:

- The span of the new beam bridge must be the same length as that of the previous one.
- The type of paper used must be the same, but there is no limit on the quantity.
- The paper can be folded (e.g., corrugated).
- Small amounts of tape and glue may be used to create box beams or I-beams as bridge spans.

Have students share their end product with the class, discussing their modifications and how successful they were at increasing the amount of load that the bridge was able to hold.

Suggestions for Assessment

Refer to "How We Worked Together" (BLM 7-G).

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.15)

Sciencepower 7 (Section 13.2)

Addison Wesley Science & Technology 7 (Chapter 4, Sections 3.2-3.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-10 Determine the efficiency of a structure by comparing its mass with the mass of the load it supports.

GLO: C1, C5

7-0-1c Identify practical problems to solve. *Examples: How can I keep my soup hot? Which type of sunscreen should I buy?…* GLO: C3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-4b ➲ Construct a prototype. GLO: C3

7-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

7-0-6e ➲ Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

7-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

7-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

SUGGESTIONS FOR INSTRUCTION

➢ **Load Force Capacity Versus Mass of Bridge**

Divide the class into teams of "student engineers." Present each team with the following scenario:

A construction company is looking for a method to build a bridge across a specific span with the least possible amount of materials, but still strong enough to carry a large load force.

Using a set of criteria established with the class (e.g., types of materials, load force, time allotment, span, aesthetics), have each team design and construct a bridge that meets the required specifications. Students may need to conduct background research to investigate types of building materials and bridge design.

Have each team present information related to the mass of its bridge and the mass of the load it supported. Compile the information into a class data table and have students analyze the results. If the bridges vary greatly in mass, the following formula can be used to calculate and compare the structural efficiency of each bridge. Have students identify key features of the bridges that were most efficient.

$$\text{Structural efficiency} = \frac{\text{Maximum mass}}{\text{Mass of structure}}$$

Suggestions for Assessment

Restricted Response

Provide students with the following:

Which Bridge to Build?

Which of the following bridge specifications would be the most efficient and most cost-effective to build? Assume that all three bridges use the same types of materials.

- Bridge A holds 100 kg load and has a mass of 10 kg.
- Bridge B holds 100 kg load and has a mass of 50 kg.
- Bridge C holds 100 kg load and has a mass of 5 kg.

Look for:

Bridge C would be the most efficient and most cost-effective to build. It would be least expensive to construct (it requires the least amount of materials) but would be just as strong as the other bridges.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 3.15)

Sciencepower 7 (Section 14.1)

Addison Wesley Science & Technology 7 (Chapter 4, Sections 2.2-2.3)

By Design: Technology Exploration and Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Prescribed Learning Outcomes

Students will...

7-3-11 Evaluate a structure to determine the appropriateness of its design, using the design process.

Examples: jacket, foot stool, local building...

GLO: C3, C4, C8, D4

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-6e ➲ Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

Suggestions for Instruction

➢ **Evaluating the Design of a Structure**

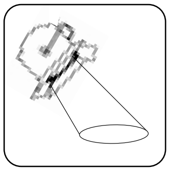
Inform students that the school wishes to buy classroom furniture and would like input from the student body.

- Have groups of students choose a structure in the classroom/school (e.g., a chair, desk, or table) and evaluate it to determine the suitability of its design. Students should establish a list of criteria for determining the suitability of the design, or this should be determined in a class discussion.
- Have each group decide on a method to evaluate the structure, such as conducting surveys (e.g., to determine which type of chair people prefer) or obtaining feedback from a custodian regarding durability.
- When groups have collected and charted their data, ask them to make recommendations as to which type of furniture the school should purchase and justify their decisions according to their data.
- Have groups share their results and recommendations with the class.

Ask students to answer the following questions:

1. On what basis did you make your choice of furniture?
2. Would a school administrator decide on the same piece as you? Why or why not?
3. What factors would have the greatest influence on the administrator's decision?

SUGGESTIONS FOR ASSESSMENT



Which Chair?

Provide students with the following:

Which Chair?

Your parents/guardians are going to purchase a new chair for your living room. What characteristics should you tell them to keep in mind?

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 3.19)

Sciencepower 7 (Chapter 13 Review)

Addison Wesley Science & Technology 7 (Chapter 4, Sections 4.0-4.6)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-3-12 Use the design process to construct a structure that will withstand the application of an external force.

Examples: a tower that will remain standing during a simulated earthquake...

GLO: C3, D3, D4

7-0-1c Identify practical problems to solve. *Examples: How can I keep my soup hot? Which type of sunscreen should I buy?…* GLO: C3

7-0-3d Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

7-0-3e Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6

7-0-4b ➲ Construct a prototype. GLO: C3

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

7-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Constructing a Stable Structure**

Present students with the following scenario:

Prospective customers have approached your engineering firm about designing and constructing five different structures. Each structure is in a different location, and each location has special factors that will affect the design of the structure.

Read through the following list of structures with your development team and choose the structure for which you will design and create a model. The design, model, and structural stress results must be presented to the company board (class) before they can be forwarded to the customers.

Students may use the “Design Project Report” (BLM 7-N) to record their work.

Designing Structures

Structure 1: An apartment block in Vancouver where slight earthquakes have recently occurred. The developer and the future renters want the structure safe to live in during such earthquakes.

Structure 2: A ski chalet built on the side of a mountain. The area where it is to be situated has heavy snowfalls and a history of avalanches.

Structure 3: A railroad track from Thompson to Churchill. The factors to be taken into consideration are the permafrost conditions on which to build, and the weight of the grain that the railroad line owner wishes to transport.

Structure 4: Microwave towers for Churchill, an area that experiences some of the strongest winds in the province.

Structure 5: Hydro line towers for southern Manitoba. These towers need to be able to withstand the added load of ice as well as strong winds.

Suggestions for Assessment

Design Process

Provide students with the following self-assessment tool:

Design Process Self-Assessment
Name: ____________________________________
1. What I did well: ____________________________
2. What did not work: __________________________
3. What I would do differently next time: __________ ______________________________________

Suggested Learning Resources

Nelson Science & Technology 7 (Unit 3: Design Challenge, Section 3.22)

Sciencepower 7 (Sections 13.1-13.2)

Addison Wesley Science & Technology 7 (Section 3.3)

By Design: Technology Exploration and Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Notes

Grade 7

Cluster 4: Earth's Crust

Overview

In this cluster, students investigate Earth's geology, including rock and mineral formation, changes in the landscape over time, and human use of geological resources. Students describe processes involved in the location, extraction, processing, and recycling of geological resources found in Manitoba and Canada. Students recognize that soil is an important natural resource and they discuss the importance of soil conservation. Students identify environmental, social, and economic factors that should be considered in making informed decisions about land use. They examine theories explaining the Earth's geology, and recognize the role of technology in the development of new scientific theories. Specialized careers involving the science and technology of the Earth's crust are also explored.

PRESCRIBED LEARNING OUTCOMES

Students will...

7-4-01 Use appropriate vocabulary related to their investigations of the Earth's crust.

Include: crust, mantle, outer core, inner core, weathering (physical, biological, and chemical), erosion, rock cycle, fossil fuel, geothermal energy, continental drift theory, theory of plate tectonics.

GLO: C6, D5

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experience related to this cluster in Grade 4, Cluster 4: Rocks, Minerals, and Erosion.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Vocabulary Hopscotch**

Provide students with a list of approximately 20 terms that are related to this cluster. Have students

- choose 10 of these terms
- print each term with every other letter missing and then write a definition for the term beside it
- exchange hopscotch papers, either with partners or randomly, and solve the vocabulary puzzles

Example:

_ e _ t _ e _ i _ g is the breaking down of rocks. (weathering)

Suggestions for Assessment

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

7-4-02 Describe the Earth's structure.

Include: crust, mantle, outer core, inner core.

GLO: C6, D5

7-0-2a ⊂ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

Suggestions for Instruction

➢ Diagram of a Layered Earth

Introduce students to the concept of a layered Earth. Have students use print and/or multimedia resources to

- draw and label a diagram depicting the composite layers of the Earth, including representative sizes for each layer, with the crust being very thin (Refer to the "Include" portion of learning outcome 7-4-02.)
- write a brief description of each layer

7-4-03 Describe the geological processes involved in rock and mineral formation, and classify rocks by their method of formation.

GLO: D3, D5, E3

7-0-3c Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 7, 3.1.4)

7-0-4a Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

7-0-4c ⊂ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ⊂ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-5c Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5

7-0-7a Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 7, 3.3.4)

(continued)

➢ Activating Prior Knowledge

Have students complete a Knowledge Chart (Matchullis and Mueller, 1994) describing what they know about rocks and minerals, including the types of rock, how they are formed, and how they change.

(For a BLM of a Knowledge Chart, see *SYSTH*, Attachment 9.2, or *Success*, p. 6.95.)

➢ Classifying Rock As Sedimentary, Igneous, or Metamorphic

Provide students with a copy of "Using a Rock Classification Key" (BLM 7-H) and have them use it to determine whether a rock type is *sedimentary*, *igneous*, or *metamorphic*. (Students may find some types of rock difficult to classify.) Through this learning activity students gain experience using known characteristics to determine rock type and using a classification key. Inform students that additional types of testing would need to be done to determine definitively whether a rock type is sedimentary, igneous, or metamorphic.

➢ Taking a Closer Look at Igneous Rock

Provide students with the following information:

Igneous rock is produced when magma (liquefied rock beneath the Earth's surface) or molten lava (liquefied rock on the Earth's surface) solidifies. When rock solidifies beneath the Earth's surface, it is called *intrusive.* When it solidifies above the Earth's surface, it is called *extrusive*. As the molten rock cools, it creates *crystals.* The size of the crystals depends on how fast the molten rock solidifies.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 7 (Section 4.1)

Sciencepower 7 (Section 11.4)

Addison Wesley Science & Technology 7 (Chapter 5, Section 1.1)

Nelson Science & Technology 7 (Sections 4.13-4.14)

Sciencepower 7 (Section 10.2)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 3.1-3.2)

Teacher Notes

Background Information

Minerals are inorganic solids that occur naturally on the Earth. A mineral is usually made up of crystals, which can be identified by properties such as colour, hardness, and crystal form. Minerals look the same inside and out.

Minerals are the building blocks of rocks. *Rocks* are mixtures of minerals and vary in the number and amount of minerals present.

The three types of rock are formed in the following ways:

- *Igneous rock* is made from magma (liquefied rock beneath the Earth's surface) or molten lava (liquefied rock on the Earth's surface) that has solidified. (Examples of igneous rock: pumice, basalt, and granite.)
- *Sedimentary rock* is made of sediment (e.g., sand, mud, pebbles, silt, remains of plants and animals) that settles in layers on the ground and at the bottom of lakes and oceans. This deposition of sediment is called *sedimentation*. The weight of the layers eventually compresses them into rock, a process called *compression*. Plant or animal remains are often trapped in the layers and can result in fossil formation. (Examples of sedimentary rock: sandstone, limestone, and shale.)
- *Metamorphic rock* changes from its original form by heat and pressure below the Earth's surface. (Examples of metamorphic rock: marble, slate, and gneiss.)

Prescribed Learning Outcomes
Students will...
7-4-03 *(continued)*

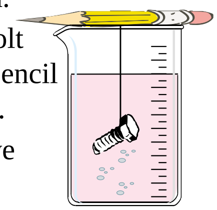
Suggestions for Instruction

(continued)

Part A: Investigating the Formation of Crystals

Have students observe the growth of crystals by carrying out the following steps:

1. Place 60 mL of water in a beaker and heat it on a hotplate.
2. When the water begins to boil, add 180 mL of sugar and stir until the sugar dissolves and the solution looks clear. If the solution begins to bubble vigorously, remove it from the heat and let it settle in order to see whether it has cleared.
3. Pour the heated solution into a beaker, with a bolt attached to a piece of string suspended from a pencil lying across the top of the beaker (see diagram).
4. Leave the bolt in the solution overnight. Observe crystals the next day.



Many other methods are available to grow crystals. One alternative is to use a saturated salt solution such as Epsom salts. If this method is used, have the solution cool in a Petri dish instead of having the crystals form on the string.

Part B: Comparing Crystal Sizes

As a class, discuss what changes would have to be made to Part A of this investigation to demonstrate the effect of different cooling rates on the crystal size. Have students carry out a further investigation to compare the crystal size of the solution that cooled slowly and the one that cooled quickly (e.g., in the fridge, on ice, or in snow outdoors). Have students

- record their observations (The mixture that cooled slowly has large crystal facets, and the one that cooled quickly has small crystal facets.)
- draw diagrams depicting the two samples of crystals
- write a conclusion stating the relationship between the cooling rate of a solution and the size of the crystals formed (The cooling rate affects the size of the crystals formed. A slower cooling rate creates large crystals, and a faster cooling rate creates small crystals.)

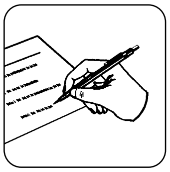
> **Safety Precaution:**
> Avoid placing hot glassware directly on a very cold surface (such as snow or ice). After heating a solution, pour it into another container (e.g., plastic).

Part C: Determining Cooling Rates of Rock Samples

Give students samples of igneous rock that have varying sizes of crystal facets. Based on the outcome of the above investigations, have students determine the cooling rates (fast or slow) of each igneous rock.

Suggestions for Assessment

Suggested Learning Resources



Restricted Response

Using the Three-Point Approach (Simons, 1991), have students define and provide an example for each of the following terms: *mineral, rock, igneous rock, sedimentary rock,* and *metamorphic rock.* (For definitions and examples, see Teacher Notes for learning outcome 7-4-03.)

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

Prescribed Learning Outcomes

Students will...

7-4-04 Investigate and describe the processes of weathering and erosion, and recognize that they cause changes in the landscape over time.

Include: physical, biological, and chemical weathering.

GLO: D3, D5, E3

7-0-4e Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

7-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

7-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

(continued)

Suggestions for Instruction

➢ **Changes to the Landscape**

Part A: Physical Weathering

Physical weathering involves factors such as water, ice, and/or wind. Have students investigate physical weathering by completing the following steps.

- *Water:* Have students cite, in their science notebooks, occurrences in nature where physical weathering involves water. As a class, develop a list of examples (e.g., waves crashing against a shore, rocks knocking against other rocks in the water, river water helping to break down riverbanks).
- *Ice:* To demonstrate how freezing water can assist in the breakdown of rocks, follow these steps:
  — Fill a small glass jar with water. Cover it with a lid.
  — Place the jar in a thick plastic bag and then into the freezer.
  — After the water has frozen, pull the bag from the freezer, open the bag, and have students observe its contents.

  Have students describe, in their science notebooks, what happened to the water and the jar and relate this to water seeping into cracks in rocks and then freezing. (The water froze and expanded and broke the glass jar. In nature, water seeps into cracks in rocks and when it freezes it widens the cracks and eventually causes the rocks to break into smaller pieces.)
- *Wind:* Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to suggest ways in which wind helps break down rocks. (Wind blows materials that strike against rocks, causing them to wear down or break apart.)

Part B: Chemical Weathering

Have students conduct the following investigation to observe *chemical weathering* in action:

- Place coarse limestone gravel into a plastic container half filled with water.
- Place the same amount of gravel into a plastic container half filled with vinegar.
- Cover each container with a lid and shake the containers for 10 minutes.
- Record your observations.
- Let the containers stand overnight.
- Pour the contents of each container into separate dishes.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 4.6-4.7)

Sciencepower 7 (Section 10.2)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 4.0-4.1)

PRESCRIBED LEARNING OUTCOMES
Students will...
7-4-04 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

- Use a coin to attempt to scratch gravel from each container.
- Record your observations in your science notebook. (At first, both the water and vinegar were clear. In the process of being shaken, both liquids became cloudy and the vinegar formed many bubbles. The gravel in both containers broke apart slightly. After a day, the gravel in the vinegar was easier to scratch with a coin and more sediment gathered. The vinegar seems to help soften the gravel and cause it to break down faster.)

Extension: Have students research to find out how limestone caves are formed, how acid rain affects rocks and concrete structures, or how mosses and lichens slowly help wear down rocks with the secretion of acids.

Part C: Biological Weathering

Have students do research to identify ways in which animals and plants cause chemical or physical weathering. (Animals burrow, plant roots grow in rock cracks and separate the rock as the plant grows, the roots secrete an acid that softens the rock and causes it to wear down more quickly, lichens and mosses secrete acids and chemically weather the rock beneath them.)

➢ **Picture It**

Have students create and label an illustration that shows several different examples of chemical, physical, and biological weathering. Remind students that some examples of weathering will have two labels (e.g., roots causing cracks in rocks are an example of both physical and biological weathering).

Suggestions for Assessment

Restricted Response

Note: the following learning activity can be used as an Exit Slip. Provide students with the following:

True or False?

Indicate whether the following statements are true or false:

1. ______ Living things can cause chemical weathering.
2. ______ Waves crashing against a shoreline cause biological weathering.
3. ______ The production of bubbles in a vinegar and gravel mixture indicates that a chemical change is occurring.
4. ______ Living things cannot cause physical weathering.
5. ______ Water expands as it freezes.

Look for:

1. true
2. false
3. true
4. false
5. true

Suggested Learning Resources

Prescribed Learning Outcomes
Students will...
7-4-05 Explain how rocks on the Earth constantly undergo a slow process of change through the rock cycle. GLO: D5, E3
7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

Suggestions for Instruction

➢ Rock Cycle: Word Splash

Have students use a Word Splash (Saphier and Haley, 1993) to obtain information about the rock cycle.

Divide students into groups of three and ask them to assign a recorder. Give each group the title of the article "The Rock Cycle" (BLM 7-I) and the corresponding "Word Splash: The Rock Cycle" (BLM 7-J). Before students read the article, ask groups to

- make and record thought/concept connections among the different words in their list
- identify the thought connections they believe to be true and the thought connections of which they are unsure

Once students have read the article, have each group analyze their word connection map, identifying differences and similarities between their map and the given article.

➢ Is It a Cycle?

Have students explain, using diagrams and/or written text, why the rock cycle is not really a cycle at all. (A cycle implies a change from one stage to the next, eventually getting to the stage where the process begins all over again. In the rock cycle, changes happen in a number of directions, and stages can be missed.)

SUGGESTIONS FOR ASSESSMENT

Concept Mapping

(Learning outcomes 7-4-03 to 7-4-05)

Provide students with the following:

Concept Map of the Rock Cycle

Create a concept map that identifies the three types of rock and the forces that can cause one rock form to change to another.

Look for:

Refer to the Teacher Notes provided for learning outcome 7-4-03.

Concept Map Assessment

Criteria	**Possible Points**	**Self-Assessment**	**Teacher Assessment**
The concept map • identifies three types of rock			
• makes main connections among the three types of rock and magma			
• describes the changes that occur			
• makes subsidiary connections among the types of rock			
Total			

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Section 4.21)

Sciencepower 7 (Section 10.2)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 3.1-3.3, 4.3-4.4)

Keepers of the Earth: Native Stories and Environmental Activities for Children (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-4-06 Identify geological resources that are used by humans as sources of energy, and describe their method of formation.

Include: fossil fuels, geothermal energy.

GLO: D4, D5, E3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-2b Evaluate the usefulness, currency, and reliability of information, using predetermined criteria. GLO: C6, C8 (ELA Grade 7, 3.2.3; TFS 2.2.2)

7-0-2c Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Research Project: Fossil Fuels and Geothermal Energy**

Have students use the SQ3R (Survey, Question, Read, Recite, Review) method (Robinson, 1961) to

- research how *fossil fuels* and *geothermal energy* are formed and how humans use these resources
- present findings to the class, using a multimedia presentation format (e.g., PowerPoint)

(For a discussion of the SQ3R learning strategy, see *5-8 ELA*, Strategies, pp. 179-180, and for the assessment strategy SQ3R Bookmark for Students, see *5-8 ELA*, Grade 8, p. 225.)

Suggestions for Assessment

Research Project: Fossil Fuels and Geothermal Energy

Look for indications of the following in student work:

Knowledge Checklist for Research Project		
Fossil Fuels Project	**Yes**	**No**
• defines fossil fuels as fuels formed from long-dead organisms and found in or near sedimentary rock		
• provides a brief, succinct description of coal		
• describes the origin of coal		
• provides a brief, succinct description of crude petroleum		
• provides a brief, succinct description of natural gas		
• describes the origin of crude petroleum and natural gas		
• includes examples of each of the fossil fuels and examples of devices that use fossil fuels as an energy resource		
• includes a picture/diagram/visual on each page of the slide show or multimedia presentation to represent or support the text		
Geothermal Energy Project		
• defines geothermal power as using the heat energy from the Earth's core		
• identifies what magma is and describes how it heats groundwater to create steam		
• describes at least two ways in which geothermal energy is used		
• provides a map that identifies locations of suitable places where geothermal energy may be used		
• identifies environmental impacts of the use of geothermal energy		
• includes a picture/diagram/visual on each page of slide show or multimedia presentation to represent or support the text		

Suggested Learning Resources

Sciencepower 7 (Sections 3.2, 11.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-4-07 Identify geological resources that are present in Manitoba and Canada, and describe the processes involved in their location, extraction, processing, and recycling.

Include: fossil fuels, minerals.

GLO: A5, B5, D3, D5

7-4-08 Identify environmental impacts of geological resource extraction, and describe techniques used to address these.

GLO: B1, B5, C1, C3

7-0-2a Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-2b Evaluate the usefulness, currency, and reliability of information, using predetermined criteria. GLO: C6, C8 (ELA Grade 7, 3.2.3; TFS 2.2.2)

7-0-2c Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ Geological Resources in Manitoba/Canada

Have students work in pairs to complete the following research, with the intent of preparing a class reference book or bulletin board display:

- Choose a geological resource that is present in Manitoba or elsewhere in Canada.
- Research a variety of sources (e.g., by contacting mining associations, museums, and so on) to find the information or materials needed to complete the Research Project Components listed below. Scrutinize sources carefully for currency and possible bias.
- Submit five questions addressed in the research project.

Compile students' questions so that everyone has the opportunity to use the finished class book or bulletin board display to find answers to questions about geological resources.

Research Project Components

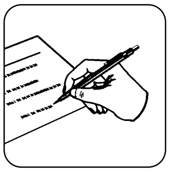
Students' research projects will include information on the

- geological resource and its use
- importance of the resource to the economy
- location of mines in Manitoba and/or Canada, including a map
- method(s)/process(es) used to
  - — locate the resource
  - — extract the resource, including techniques used to address environmental impacts
  - — process the resource
  - — recycle the resource

Possible sources of information:

- Association of Manitoba Museums <http://www.escape.ca/~amm/> (204-947-1782) can assist with the location of museums in Manitoba that provide information on resource extraction (e.g., museums in Flin Flon, Thompson, Lynn Lake, Wabowden).
- Manitoba Industry, Trade and Mines <http://www.gov.mb.ca/em> (204-945-6569)
- The Mining Association of Canada <http://www.mining.ca/> (613-233-9391) offers a free magazine, *What Metals and Minerals Mean to Canadians*. It includes information on topics such as prospecting and exploration, extraction of ore, processing of resources, and mining and the environment.

Suggestions for Assessment



Restricted/Extended Response

Some of the project questions that students submit as part of their research project on Geological Resources in Manitoba/Canada may be used on a Cluster 4 test.

Teacher Notes

Background Information

Manitoba has an abundance of mineral resources, ranking fourth among Canadian provinces in production. Metallic minerals are found in the Canadian Shield. The chief metals mined in Manitoba are nickel, copper, and zinc. The Thompson nickel belt is one of the richest in the world. Gold, silver, cobalt, and platinum are by-products of nickel and copper mining. The entire Canadian output of tantalum is mined in southeastern Manitoba. Zinc and copper mining have been conducted at Fin Flon, Lynn Lake, and Leaf Rapids.*

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* Source: *Senior 3 Agriculture: A Full Course for Distance Education Delivery, Field Validation Version.* Winnipeg, MB: Manitoba Education and Training, 1999. p. 103.

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 4.3-4.5)

Sciencepower 7 (Section 10.1, Unit 4: Issue to Analyze)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 3.2, 6.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-4-09 Recognize that soil is a natural resource, and explain how the characteristics of soil determine its use.

GLO: D5, E1

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ What Is a Natural Resource?

Provide students with the following description:

A *natural resource* is something found in the natural environment that humans can use to satisfy a need.

Have students indicate which of the following would be considered a renewable resource and provide justification for their responses. (As part of their discussion, students will need to generate a working definition of a renewable resource.)

- nickel
- water
- soil
- gold
- trees

Students may complete the task in small groups and share their responses with the class.

➢ Soils in Manitoba

Have students use a strategy such as Highlighting (see *5-8 ELA*, Grade 7, p. 216) to gain information from the reading selection "Soils in Manitoba" (BLM 7-K). Following the reading, ask students to answer the following questions in their science notebooks:

1. Why are soils important to ecosystems? Where does soil come from?
2. How is particle size used to classify soils?
3. What two factors play major roles in soil formation?
4. What similarities are found among the three maps (Soil Zones of Manitoba, Climate Changes in Manitoba, and Natural Vegetation in Manitoba) provided in BLM 7-K?
5. In which soil zone, climate region, and natural vegetation region are you located?

➢ Garden Plan

Have students identify

- characteristics of soil that are important for flower gardeners (e.g., drainage, acidity, loam)
- characteristics of local soil
- local planting zones

Gardening catalogues, local greenhouses/gardeners, and/or agricultural representatives are helpful sources of information.

Based on the information they collect, have students plan a flower garden containing a minimum of five different plants for a designated location (soil type, drainage, and amount of sun/shade would need to be determined), then sketch a plan of their garden and include a list of plants and their soil, light, and drainage requirements.

Suggestions for Assessment

Garden Plan

Provide students with the following tool for peer assessment of the garden plan:

Peer Assessment of Garden Plan	
Designer: ____________________	
Peer assessor: ____________________	
Rating Scale	
Criteria	**Poor** **Good** **Excellent** 1 2 3 4 5
The garden plan • is clear and aesthetically pleasing • includes a list of at least five different plants, with details regarding soil, light, and drainage requirements • features plants that are suited to the given soil type, lighting, and drainage	
Constructive comments:	

Teacher Notes

Background Information

Some agricultural methods of soil usage are like forms of "mining"—taking as much as possible out of the soil without replacing what is taken. The idea that soil is a renewable resource is part of the concept of sustainable agriculture.*

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* Source: *Senior 3 Agriculture: A Full Course for Distance Education Delivery, Field Validation Version.* Winnipeg, MB: Manitoba Education and Training, 1999. p. 63.

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 4.7-4.9)

Sciencepower 7 (Section 10.3)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 5.3-5.4)

Prescribed Learning Outcomes

Students will...

7-4-10 Describe methods used to control soil erosion, and recognize the importance of soil conservation.

Examples: economically important to the agri-food industry, important for controlling the flow of water, necessary for plant growth...

GLO: A5, B2, B5, E3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

Suggestions for Instruction

➢ Soil Conservation

Ask students to indicate whether they agree or disagree with the following statement, and to explain why:

Soil management is everyone’s responsibility.

Provide students with a copy of “Soil Erosion” (BLM 7-L). After students have read the information provided in the reading selection, have them

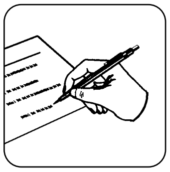
- reconsider the above statement
- indicate whether they now agree or disagree with it
- explain their thinking

➢ Dirty Thirties

The Midwest of North America was known as a dust bowl in the 1930s. The summers were hot, dry, and windy. Strong winds eroded the fertile topsoil, causing the sky to turn dark and visibility to lessen. Ultimately, the loss of nutrients in the soil resulted in crop failure.

Have students read texts or view videos or CD-ROM clips that describe the “Dirty Thirties.” Have them write a diary entry from the viewpoint of a farmer living during the 1930s, describing the conditions of that era and their impact on the lives of individuals and families.

Suggestions for Assessment



Restricted Response

Provide students with the following questions:

Controlling Erosion

1. What are two ways in which *water erosion* can be controlled?
2. What are two ways in which *wind erosion* can be controlled?

Look for:

See "Soil Erosion" (BLM 7-L) for possible responses.

Suggested Learning Resources

Nelson Science & Technology 7 (Sections 4.9-4.10)

Sciencepower 7 (Section 10.3)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 5.3-5.4)

Prescribed Learning Outcomes

Students will...

7-4-11 Identify environmental, social, and economic factors that should be considered in making informed decisions about land use.

GLO: B1, B5, D5

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-8g Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

7-0-9e Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

Suggestions for Instruction

➢ **Point of View on an Issue**

Provide students with the following scenario of a land-use issue (or a description of a local issue).

Land-Use Issue

A large city is running out of land in which to dump its garbage. The city is looking for possible places to build a landfill site. A large open-pit mine several hundred kilometres to the north has been closed down and is suggested as a possible dump site.

The community adjacent to the old mine is considering this proposal, taking into account a variety of related issues. The new state-of-the-art landfill project will provide needed jobs for the community, which is still feeling the effects of the closed mine. The community has recently focused on attracting tourists and new residents on the basis of a clean, quiet environment. Unless this proposed venture is successful, or another industry takes its place, the people who still live in the community will pack up and move elsewhere. Some scientists suspect that the community's drinking supply may be at risk of becoming contaminated because of aquifers located beneath the fissured rocks (rocks containing small cracks) that line the open-pit mine.

Part A: Letters to the Editor

Have students write letters to the editor regarding the above land-use issue, including substantiated reasons for their decision to back the proposal or to voice concerns about it. Ask students in the class to represent different interest groups, such as

- a city official in charge of garbage disposal
- a landfill company representative
- an unemployed person living in the community near the proposed landfill site
- a new community resident
- a long-term community resident
- a community official in charge of attracting tourists
- a geologist/scientist
- an official in a nearby city that extracts its drinking water from a river running through the area

Part B: Decision Making

Have teams of students represent the community council and use the letters to make and justify a decision related to the land-use issue. Have teams share their decisions and discuss any differences.

SUGGESTIONS FOR ASSESSMENT

Journal Reflection

Provide students with the following questions:

Decision-Making Reflection

1. Was it easy for the community council to come to a decision regarding the land-use issue? Why or why not?
2. Did you agree or disagree with the decision of the council? If you agreed, explain why. If you disagreed, how did your reasoning differ?
3. What further information would you like to obtain to help you feel confident about your decision?

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 4.10-4.11)

Sciencepower 7 (Section 10.3)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 5.3-5.4, 6.0-6.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

7-4-12 Describe evidence used to support the continental drift theory, and explain why this theory was not generally accepted by scientists.

GLO: A1, A2, A4, D5

7-0-7b Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

7-0-9a Appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural backgrounds. GLO: A4

SUGGESTIONS FOR INSTRUCTION

➢ **Continental Drift Theory**

Read the following mock news release to students:

New Theory Proposed (1912)

Scientist Alfred Wegener recently released a paper describing his theory that the continents were once part of one large continent called Pangea. He describes how the continents fit together like a giant puzzle. He believes that, over time, the continents moved apart in a process he calls *continental drift.* The scientific community does not accept Wegener's theory, as he is not able to explain how the continents could move or provide evidence showing they were once joined.

Have students answer the following questions in their science notebooks:

1. What are the major flaws with Wegener's continental drift theory? (He cannot explain how the continents could possibly move, nor can he provide evidence showing they were once joined.)
2. What evidence might a *geologist* look for to prove Wegener's theory? (Similar rocks found on the different continents.)
3. What evidence might a *biologist* look for to prove Wegener's theory? (Similar animals and/or fossils found on the different continents.)
4. Why is it difficult to get all scientists to support a theory? (Evidence to support a theory has to address every possible question.)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 7-4-14.

Suggested Learning Resources

Nelson Science & Technology 7 (Section 4.15)

Sciencepower 7 (Section 12.2)

Prescribed Learning Outcomes

Students will...

7-4-13 Describe evidence used to support the theory of plate tectonics, the role technology has played in the development of this theory, and reasons why it is generally accepted by scientists.

GLO: A1, A2, A5, D5

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)

7-0-4d ➲ Assume various roles to achieve group goals. GLO: C7 (ELA Grade 7, 5.2.2)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

7-0-8b Describe examples of how scientific knowledge has evolved in light of new evidence, and the role of technology in this evolution. GLO: A2, A5, B1

Suggestions for Instruction

➢ **Plate Tectonics Theory: Role-Play Trial**

Have students role-play a court scene in which the *theory of plate tectonics* as an explanation of the Earth’s structure is on trial. In preparation for this trial, have students

- research to gather evidence that proves the theory of plate tectonics, highlighting the role of technology in gathering evidence
- organize other students to come to the witness stand to provide evidence and answer questions that will substantiate the theory

Possible witnesses:

- a sonar operator on a research ship
- a seismograph expert who has recorded earthquakes occurring along the Mid-Atlantic Ridge
- a researcher who has used a magnetometer to measure the magnetism in rocks on the ocean floor
- an inventor of a submersible that collected rock samples and photographed geological activity at the ridges and trenches

SUGGESTIONS FOR ASSESSMENT

Plate Tectonics Theory: Role-Play Trial

Provide students with the following:

You Be the Judge

You were the judge of the trial just held. You must make point-form notes detailing the evidence for and against the acceptance of the *theory of plate tectonics*. Develop a verdict and substantiate it with evidence derived from the trial and the validity of the data.

Scoring Rubric

Score	Criteria
4	Point-form notes detail all evidence given for and against the theory. The verdict is logical, is well substantiated with the evidence provided, and discusses the validity of the data.
3	Point-form notes detail all evidence given for and against the theory. The verdict is logical and substantiated with the evidence provided.
2	Point-form notes detail most evidence given for and against the theory. The verdict is logical and substantiated with the evidence provided.
1	Point-form notes are missing several points of evidence for and against the theory. A verdict is made but not fully substantiated.

Also refer to the assessment strategy suggested for learning outcome 7-4-14.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 7 (Sections 4.15, 4.18)

Sciencepower 7 (Section 12.3)

Addison Wesley Science & Technology 7 (Chapter 5, Section 1.2)

Prescribed Learning Outcomes

Students will...

7-4-14 Explain geological processes and events using the theory of plate tectonics.

Include: mountain formation, earthquakes, volcanoes.

GLO: A1, A2, D5, E3

7-0-2a ➲ Access information using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)

7-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 7, 1.2.1)

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

Suggestions for Instruction

➢ **Modelling Folding and Faulting**

Have pairs of students

- use print or electronic resources to determine how the geological processes of *folding* and *faulting* of Earth's crust result in the formation of mountains
- use modelling clay or foam sheets to create a multi-layered section representative of the Earth's crust
- use their model to demonstrate to the class how folding and faulting occur and how mountains are formed

➢ **Analyzing Data**

Have students analyze maps depicting locations of earthquakes and volcanoes and have them compare these to the locations of the geological plates. Ask students to use the theory of plate tectonics to explain these phenomena.

7-4-15 Identify specialized careers involving the study of the Earth's crust or the utilization of geological resources, and give examples of technologies used in each.

Examples: geophysicist, seismologist, volcanologist, farmer...

GLO: A5, B4

7-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 7, 4.4.1)

7-0-9b Express interest in a broad scope of science and technology related fields and issues. GLO: B4

➢ **Job/Career Advertisement**

Have students create an advertisement for a job/career that involves the study of the Earth's crust or the utilization of the Earth's resources. The advertisement should include a description of the

- job/career
- education required
- possible job locations
- type of equipment or technology that the applicant may have to use to perform the job

Suggestions for Assessment

Suggested Learning Resources

Theory of Plate Tectonics

(Learning outcomes 7-4-12, 7-4-13, and 7-4-14)

Provide students with the following:

Predicting the Future

Predict whether or not the *theory of plate tectonics* will still hold true 100 years from now as the best explanation for geological phenomena that we observe. Justify your response.

Look for:

- a clearly stated opinion
- an understanding that scientific knowledge is ever-evolving
- an understanding that technology can help us gather even more information to support (or refute) the theory of plate tectonics

Nelson Science & Technology 7 (Section 4.2)

Sciencepower 7 (Sections 11.1-11.2)

Addison Wesley Science & Technology 7 (Chapter 5, Sections 1.3-1.4, 2.0-2.4)

Job/Career Advertisement

When assessing students' Job/Career Advertisements, look for indications of the following:

Checklist for Job/Career Advertisement

Criteria	Yes	No
The job/career advertisement • is presented in an appropriate format • uses appropriate language • includes a description of the — job/career — education required — job locations — technological skills required		

Nelson Science & Technology 7 (Section 4.18)

Sciencepower 7 (Sections 10.3, 12.3)

Addison Wesley Science & Technology 7 (Chapter 5, Unit 2: Careers & Profiles, Unit 3: Careers & Profiles)

Notes

Grade 7

Blackline Masters

- Aboriginal Perspectives (BLM 7-A)
- Photosynthesis and Cellular Respiration (BLM 7-B)
- Bean Seeds and Cellular Respiration (BLM 7-C)
- The Compound Microscope (BLM 7-D)
- The Barbeque (BLM 7-E)
- Anti-gravity in Pisa (BLM 7-F)
- How We Worked Together (BLM 7-G)
- Using a Rock Classification Key (BLM 7-H)
- The Rock Cycle (BLM 7-I)
- Word Splash: The Rock Cycle (BLM 7-J)
- Soils in Manitoba (BLM 7-K)
- Soil Erosion (BLM 7-L)
- Constructing a Prototype: Observation Checklist (BLM 7-M)
- Design Project Report (BLM 7-N)
- Design Project Report: Assessment (BLM 7-O)
- Conducting a Fair Test: Observation Checklist (BLM 7-P)
- Experiment Report (BLM 7-Q)
- Experiment Report: Assessment (BLM 7-R)

Aboriginal Perspectives on Sustainability

Traditionally, Aboriginal people have exemplified the qualities of good stewardship in their interactions with the environment.

Aboriginal environmental knowledge developed over centuries of observing and understanding seasonal changes—changes that were taken into consideration as a natural part of daily life and decision making.

Decisions were made with regard for the environment, which ultimately met the needs of individuals, families, and communities.

As food gatherers, Aboriginal people moved to areas where the land was bountiful. Each of the four seasons had a special time to hunt and trap animals for food and clothing, a time to catch fish, to harvest fruit and berries, and to pick roots and prepare medicines.

In conducting these activities, Aboriginal people considered the growth, reproduction, and regeneration cycles of plants, animals, and birds. To interrupt these natural cycles and patterns was considered to be an act against the laws of nature. This knowledge and understanding of the natural environment reflected the importance of sustaining Mother Earth for seven generations to come.

It is necessary for all peoples to embrace the concept of survival of the seventh generation, which is truly the heart of sustainability.

We must make decisions that ensure an equitable quality of life for all for seven generations to come.

Embedded within the Aboriginal world view is the concept of collective responsibility for tending the land and using only that which is needed for sustenance. Important, as well, is the interconnectedness and interdependence of all life forms—humankind, flora and fauna, and all that exists on the Earth. The concept of sustainability is not new to Aboriginal people; they are very aware of the growing need for all humans to show greater respect for the environment—respect for Mother Earth—if we are to continue to coexist in this world.

Aboriginal people are rich in environmental knowledge and can provide important perspectives when considering the impact of economic decisions on the environment.

Aboriginal people are also a source of sustainability strategies that can contribute to our collective well-being. Through ongoing communication and an understanding of traditional and environmental knowledge, education for a sustainable future can be achieved.

Aboriginal Perspectives: Reproduced from *Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators*. Winnipeg, MB: Manitoba Education and Training, 2000. pp. 49-50.

Photosynthesis and Cellular Respiration

Part A

Complete the statements below, using terms from the Word Bank provided. **Note:** Terms can be used more than once.

Word Bank

• water	• oxygen	• sugar
• photosynthesis	• carbon dioxide	• cellular respiration
• chlorophyll	• energy	• light energy

1. a. ____________________ is the process that green plants use to produce their own food.
   b. Plants must contain ____________________ to carry out this process.
   c. ________________+_______________+_______________➔_______________+_______________
   d. The substance considered to be a by-product of this process is ____________________.
2. a. ______________ is the process that plants and animals use to change food into useable energy.
   b. _______________+_______________➔_______________+_______________+_______________
   c. The substances considered to be by-products of this process are ____________________ and ____________________.

Part B

Answer the following questions:

3. What relationship do you see between the substances in the two word equations in 1.c. and 2.b.?
4. Why are green plants important to animals?
5. What do animals provide for plants?

Look for:

1. a. photosynthesis
   b. chlorophyll
   c. water, carbon dioxide, light energy, sugar, oxygen
   d. oxygen
2. a. cellular respiration
   b. sugar, oxygen, water, carbon dioxide, energy
   c. water, carbon dioxide
3. Products of one process are used in the other process.
4. Green plants give off oxygen, which animals require to live.
5. Animals give off carbon dioxide and water, which plants need to produce their own food.

Bean Seeds and Cellular Respiration

Proving That Germinating Bean Seeds Undergo Cellular Respiration

A scientist conducted four experiments to prove that bean seeds, as living things, undergo cellular respiration. The scientist summarized the experiments into four statements: the question, the hypothesis, the test, and the result. These statements were captured in an electronic format but a computer glitch caused the hypothesis statements, the test statements, and the result statements to become mixed up.

Using statements A to L from the Statement Bank below, fill in the blanks to match each of the following questions with its corresponding hypothesis statement, test statement, and result statement.

1. What substance provides the sugar portion of the cellular respiration equation?
   Hypothesis: ______ Test: ______ Result: ______
2. Is oxygen used in the germination of bean seeds?
   Hypothesis: ______ Test: ______ Result: ______
3. Do germinating bean seeds give off carbon dioxide?
   Hypothesis: ______ Test: ______ Result: ______
4. Are bean seeds able to transform stored chemical energy into usable energy?
   Hypothesis: ______ Test: ______ Result: ______

The following information may help you with this task:

- In order for something to burn, oxygen must be present.
- Limewater is a chemical indicator that becomes cloudy in the presence of carbon dioxide.
- When heated, Benedict’s solution turns reddish-orange in the presence of sugar.

Statement Bank

A. Add water to bean seeds. Observe for several days.
B. Test for the presence of oxygen before and after the germination of bean seeds by observing the effect of the air in a flask on a flame (burning wood splint test).
C. Crush bean seeds. Add Benedict’s solution and heat. Observe.
D. The bean itself provides the sugar.
E. When heated, Benedict’s solution changed to reddish-orange.
F. The limewater turned cloudy.
G. Oxygen is used during the germination of bean seeds.
H. Germinating seeds give off carbon dioxide.
I. A burning wood splint flames longer in a flask of dry new beans than in a stoppered flask in which beans were allowed to germinate.
J. Seeds were seen to grow, beginning stems and first leaves.
K. Put germinating seeds in a covered container and have the air given off by the seeds come into contact with limewater.
L. Bean seeds use some of the transformed chemical energy to carry out the life processes of growth.

Look for:

1. D, C, E
2. G, B, I
3. H, K, F
4. L, A, J

The Compound Microscope

Purposes:

- Identify and describe the function of the parts of a compound microscope.
- Demonstrate proper care and use of the microscope (i.e., carrying the microscope, cleaning lenses, focusing carefully).
- Demonstrate the ability to prepare wet mounts, focus, calculate magnification, estimate specimen size, and sketch specimens as they appear under magnification using a compound microscope.

Procedure:

A. Handling the Microscope

1. Clean lenses as needed using lens paper only. Normal tissue is too coarse and may scratch lenses.
2. Microscopes are fragile and must be handled with care. Carry the microscope with one hand under the base and one hand grasping the arm. Make sure the electrical cord is secured to prevent accidents.
3. Put the lowest power objective lens in place and cover the microscope with the dust cover when finished.
4. Never use direct sunlight as a light source.

B. Adjusting Light

The diaphragm regulates the amount of light passing through a specimen. Too much light results in flare, causing a lack of contrast or lost detail when viewing the specimen.

C. Preparing a Wet Mount

1. Place a drop of water on the slide.
2. Place a very thinly sliced specimen in the water.
3. Hold the cover slip against the water at a 45-degree angle, and then release. This will reduce the number of air bubbles, which may obscure portions of the specimen or the entire specimen. Gently pressing on the coverslip with a pencil eraser can eliminate some air bubbles.

D. Focusing

1. Always begin with the lowest power objective lens in position. This gives the largest field of vision and the greatest depth of field. It also reduces the chance of the lens striking the slide.
2. To avoid breaking the slide during focusing, move the lowest power objective lens as close as possible to the slide while watching from the side of the microscope. Centre the specimen and focus by moving the objective lens away from the slide.
3. Turn the adjustment dials to sharpen the image.
4. Adjust the diaphragm for optimum contrast.
5. When going from a lower power objective lens to a higher power objective lens:
   - centre the specimen in the field of view
   - change to the next power objective lens
   - use the adjustment dials to sharpen the image and adjust the diaphragm for optimum contrast

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E. Determining Total Magnification

Total magnification = ocular lens power x objective lens power (e.g., 5X x 4X = 20X)

Note: the units are times (X).

1. Determine the total magnification for each combination of ocular and objective lenses found on your microscope. Complete the table below:

	Ocular Lens Power (X)	Objective Lens Power (X)	Total Magnification (X)
Low Power			
Medium Power			
High Power			

2. Prepare a wet mount slide of the following letter: e (lower case). Use an "e" from a newspaper or magazine or draw your own.
   a. In the space below, draw the letter as it appears with the unaided eye on the stage of the microscope. To the right of this diagram, draw the letter as it appears in the field of view under low power.

   b. Compare the two drawings and describe what you see. (In your description, answer the following questions: What is the consistency of the ink or pencil lead? Describe the texture of the paper. Is the position or orientation of the letter in the two drawings the same or different?)

   c. Describe the movement of the specimen in the field of view when you move the slide to the left. Describe the movement of the specimen in the field of view when you move the slide away from you.

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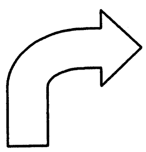
d. Make a general statement about the orientation and movement of objects viewed through a microscope.

e. What would you say to help a friend who is having trouble locating a specimen in the field of view?

f. The image below is drawn as viewed through the microscope. Draw what you would expect to see on the stage.



3. Prepare a wet mount slide of two overlapping hairs or thin threads.

a. Locate the hairs under low power. Is it possible to have both hairs in focus?

b. Locate the hairs under medium power. Is it possible to have both hairs in focus? Draw what you see. Indicate the total magnification.

c. Locate the hairs under high power. Is it possible to have both hairs in focus?

d. What happens to the depth of field (i.e., the ability to focus on more than one object when the objects are at different depths on the slide) as magnification increases?

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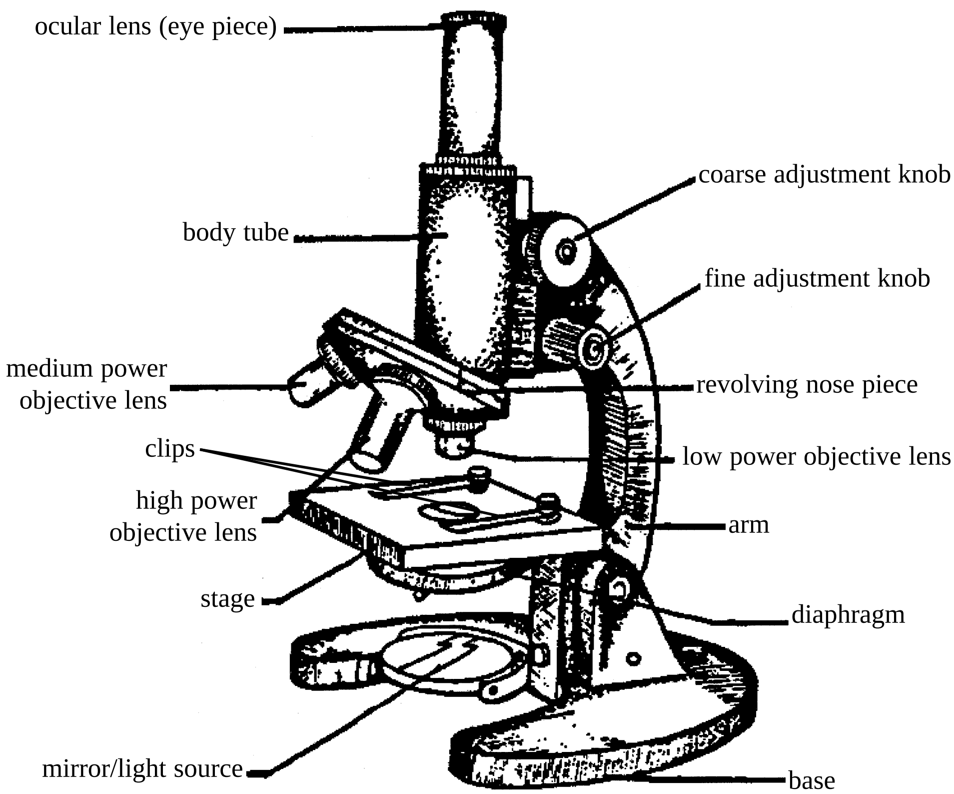
The Microscope



The Barbeque

A group of six friends get together on a hot July day for a barbeque and a game of baseball. Each person brings a different menu item. Sally brings potato salad (which contains mayonnaise made from eggs), Fred brings thick burger patties made from raw hamburger meat, Mary brings a tossed green salad and a bottle of oil and vinegar salad dressing to add later, Sam brings potato chips and frozen hot dogs in a cooler, Harry brings pop to drink and hamburger and hot dog buns, and Alice brings ketchup, mustard, and freshly washed strawberries. As Fred places his dinner contribution into Sam's cooler the group decides to play baseball.

After a 45-minute game the group begins to prepare supper. Fred is in charge of the barbeque and ensures that the hamburgers and hot dogs are well cooked. When the juices from the hamburgers are clear he places the meat on a clean plate. The table is set and the group finally sits down to eat, one hour and thirty minutes after they initially arrived at the site. Everyone has at least one hamburger and one hot dog except Sally, who has one hot dog only. Sally, Sam, Alice, Fred, and Mary eat the green salad. Alice does not eat the potato salad due to an allergy but she shares the strawberries she brought with Harry. Harry likes the potato salad so much he decides to have a second helping. After the meal the group cleans up and heads home.

The evening finds all the friends except Alice suffering from nausea and/or diarrhea. Sally also has a fever and Fred is suffering from stomach cramps. Harry is so ill he decides to go to the hospital.

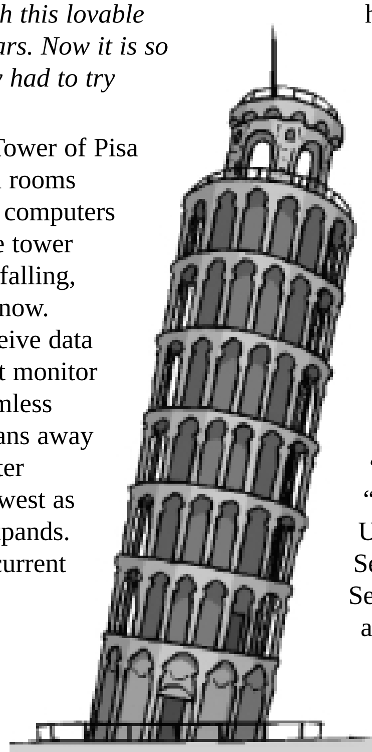
What's the Cause?

List all the food practices contained within the barbeque scenario and indicate whether they were safe. Use this information to identify and explain a possible cause for the illnesses, including an explanation of why Harry was extremely ill while Alice did not succumb to the illness her friends did.

Anti-gravity in Pisa

By Robert Kunzig

Engineers have been tinkering with this lovable leaning bell tower for hundreds of years. Now it is so close to actually falling over that they had to try something radical.



The control room of the Leaning Tower of Pisa is not very impressive, as control rooms go—just a handful of technicians and computers in a construction-site trailer. But if the tower ever decides to stop leaning and start falling, those technicians will be the first to know. Every five minutes the computers receive data from 120 sensors inside the tower that monitor its inclinations. The tower has its harmless daily moods. In the late morning it leans away from the sun, like some giant antimatter sunflower, tilting imperceptibly northwest as its southeastern side warms up and expands. At night the tower settles back to its current southward tilt of around 5.3 degrees.

It is that persistent angle that is alarming. It is bigger than it sounds or than it looks on postcards. When you walk the streets of Pisa, and the tower pops into view for the first time, it is shocking—the visual equivalent of a prolonged screech of brakes. For a split second you wait for the crash. People have been waiting for centuries, of course, and so you might reassure yourself that the crash can't really happen. After all, it is hard to imagine 177 feet and 32 million pounds of marble simply falling, in an instant, after 800 years. But some people have no trouble imagining it. "It is pretty terrifying," says John Burland, a specialist in soil mechanics at Imperial College in London. "The tower is literally on the point of falling over. It is very, very close."

Not quite as close as it was last year, though: Lately the tower has been moving ever so slightly in the right direction. From his London office Burland is supervising a delicate operation in which dirt is being extracted through thin drill pipes—the geotechnical equivalent of laboratory pipettes—from under the north, upstream side of the tower foundations, allowing it to settle toward the upright direction. The rate of soil extraction amounts to just a few dozen shovelfuls a day; anything faster might jolt the tower over the brink. Its condition is considered so precarious that it has been closed to visitors for a decade: The top leans a full 15 feet out of plumb. Burland and his colleagues on an expert committee appointed by the Italian government are hoping to bring it back 20 inches by next summer.

There are 13 members of the committee, but Burland, for this crucial operation, is the "responsible officer." Every day he gets faxes from the control room in Pisa telling him how the tower is doing; every day he sends back instructions on where to remove dirt next. He takes care to sign his messages. "That's absolutely essential," he says. "Someone's got to take responsibility. Unless you do that, you get another Black September." Burland is referring to September 1995, when it seemed for a while as if the committee, which was charged with saving the tower, might manage to knock it down instead.

In 1902 the campanile collapsed in St. Mark's Square in Venice, and the Italian government appointed an expert committee, the third, to consider what to do about the Leaning Tower of Pisa. In 1989 another medieval bell tower collapsed in Pavia, south of Milan, killing four people, and the Italian government appointed its 16th (or 17th, depending on who's counting) expert committee to consider what to do about the leaning bell tower of Pisa. Burland had never been to Pisa and little knew how his life was about to change when he took a phone call early in 1990 from his friend Michele Jamiolkowski, a geotechnical engineer at the Polytechnic in Turin. Burland remembers the conversation this way:

Burland: Michele! How are you?

Jamiolkowski: I was fine until this morning. Then I opened my newspaper and read that Prime Minister Andreotti has set up a commission to stabilize Pisa, and I'm chairman.

Burland: Oh, Michele, I'm sorry. What a terrible job!

Jamiolkowski: Keep your sympathy. Your name is there as well.

(continued)

There followed a telex—it all seems so long ago, Burland says; he and Jamiolkowski both are gray-haired now—a summons to a meeting in Rome. Thus began a decade during which Burland devoted much of his energy to Pisa. He was known in his profession for another delicate excavation, in which he built a below-ground parking garage alongside the Houses of Parliament without toppling Big Ben; he is still working for the London Underground on the extension of the Jubilee Line. But he has spent more time in recent years analyzing various models of the Italian tower. One morning last spring, in his office at Imperial, he demonstrated the simplest one. Taking a cardboard box from his bookshelf, he extracted some cylindrical plastic blocks and a two-inch-thick piece of foam rubber. “The problem of Pisa,” Burland said, laying the foam on his worktable and stacking the blocks on it, “is that it’s not built on rock. It’s built on soft clay.”

Under the Tower of Pisa, under all of Pisa, 1,000 feet of sediments cover the bedrock. The sediments come both from the Arno River, which flows through the town on its way to the Mediterranean, about six miles to the west, and from the sea itself, because as recently as the Roman period the area around Pisa was still a coastal lagoon. The tower sits on 30 feet of fairly dense river silts, below which lies a 100-foot-thick layer of marine clay. Called the Pancone Clay, it is made of flat, jumbled, loosely packed particles, and it is thus especially compressible. The tower, bearing down on a foundation just 65 feet wide and 10 feet deep, has compressed it.

The first three stories—the tall ground story and the first two loggias, or open galleries—were built between 1173 and 1178. The next four loggias were added between 1272 and 1278; the belfry was finished in 1370. In other words, there were two construction delays of nearly a century—and that was lucky, because otherwise the clay would have failed right then under the growing load. “In both cases the masons stopped just in the nick of time,” says Burland. “Because they left it, the weight of the tower squeezed a lot of the water out of the clay, and the clay became stronger.”

It’s possible they stopped because they were worried about the lean; it’s certain, anyway, that the tower was leaning, right from the beginning. When the new generations of masons resumed work, at the fourth story and then again at the belfry, they tried to correct the lean by building substantial northward kinks into the tower, thus giving it a banana shape. They were trying to curve the center line of the tower back over the center of the foundations, Burland thinks, just as a child would when faced with a leaning stack of blocks. Any child who has stacked blocks on a soft carpet knows, though, that sooner or later you add one block too many. At Pisa, the belfry was one block too many.

The tower had already sunk 10 feet into the soil, according to Burland’s calculations, but the belfry caused it to sink another few inches, which quickly caused a big jump in its tilt, to about four degrees. The tower tilts south because one of the shallow silt layers happens to be more compressible on that side—it has some soft clay mixed into it. Today that shallow layer has become the seat of the tower’s problem, Burland believes. Analyzing data collected by previous committees, he has found that the tower as a whole, even as its tilt continued to increase, had stopped sinking in the 20th century, apparently because the Pancone Clay strengthened again. Instead, the tower is rotating: As the south side of the skimpy foundation digs deeper into that soft shallow layer, the north side is moving up toward the surface, ready to pop out like the roots of a storm-felled tree.

Every little nudge moves the tower closer to that fate. According to Burland, ever since the addition of the belfry, it has been “metastable,” like a ball on a flat table. Give it a nudge and it does not come back, as it would if it were truly stable, like a ball at the bottom of a bowl. It just rolls along toward the edge of the table—toward what a geotechnical engineer calls “leaning instability.”

In 1838 the tower received a big nudge: An architect named Gherardesca decided that people should be able to see the base of the tower—which had disappeared into the dirt—and so he excavated a walkway around it. The tower jumped half a degree south. In 1934 an engineer named Girometti decided to stabilize the foundations by drilling 361 holes into them and injecting 80 tons of grout; the tower jumped another 31 arc seconds. (There are 3,600 arc seconds in a degree.) More recently, the gradual increase in the tilt has been caused, Burland thinks, by groundwater rising up under the base of the tower during the annual rainy season. For some reason it pushes up on the north side of the tower more than on the south. “It starts in September, and it ends in February,” Burland says. “The tower ratchets in one direction, and it never comes back. It’s just moving inexorably toward falling over, and accelerating as it gets closer.”

Burland and his colleagues have developed a computer model that reproduces the tower’s tilt history

(continued)

from the 12th century on. The one thing it can't quite reproduce is the tilt of 5.5 degrees, the angle it had reached before soil extraction. At any angle above 5.44 degrees, the computer tower refuses to remain standing—which suggests how close to the edge the real one has been. On the worktable in his office, Burland slowly adds blocks to his plastic tower. It teeters as it presses into the foam foundation. At block number seven it topples.

When Jamiolkowski's committee convened for the first time in 1990, the tower was increasing its tilt by around six arc seconds a year. An equally pressing danger, though, was that its masonry wall would fail first, causing the tower to collapse on itself, as the Pavia tower had. The wall is not solid; it consists of external and internal facings of marble encasing an infill of rubble and lime mortar. The stress exerted by the weight of the building is concentrated in these foot-thick facings—and the tilt has concentrated it dangerously at one point in particular: on the south side, at the bottom of the first loggia. That also happens to be where the wall suddenly shrinks from 13 feet to nine feet in thickness, and where it is hollowed by the internal stairway, which spirals around the tower inside the wall and arrives at the first loggia on the south side. In 1990 the external facing there was already badly cracked.

The tower was threatened with a hernia—and the first solution, says Jamiolkowski, was "like a belt for your belly." In 1992 the committee ordered the installation of 18 plastic-sheathed steel tendons around the first loggia and the ground story, pulled tight to hold it together. Early this year workers finally finished the rest of the committee's wall-strengthening program, which included injecting grout into the wall to fill air pockets in the infill and inserting stainless steel bars between the inner and outer facings to tie them together.

The committee also decided that they had to take some simple, temporary measures to stabilize the lean, to give themselves time to develop a long-range solution. If the north side of the foundation was rising, as Burland had found, there was an obvious option: Add a counterweight to stop it. In 1993, 600 tons of lead ingots were stacked on the north quarter of the tower, atop a concrete ring cast around the base. "For the first time in the history of the tower the tilt was stopped," says site engineer Paolo Heiniger. By the summer of 1994 the tower had moved some 50 arc seconds north, around two thirds of an inch.

The counterweight worked, but it was also very ugly. Six years later the ground floor of the tower remains obscured on the north side by that 15-foot pile of lead and concrete. The committee, which includes art restoration experts alongside its engineers, started to worry about this ugliness soon after creating it. In an effort to remove the pile, they came close to bringing the tower down.

By 1995 Burland had done much of the research to develop a permanent solution: soil extraction. It was not a new idea, having been suggested as early as 1962 by an engineer named Fernando Terracina. At Imperial, Helen Edmunds, a student of Burland's, had built a simple scale model of the tower on a bed of sand and sucked sand from under the model with a syringe. She found that, as long as she kept the point of the needle north of a certain line, there was no danger of the tower being inadvertently tipped into oblivion.

But a large-scale field test still needed to be done, and then a test on the tower itself, and it was all taking a long time. The committee had endured funding troubles and ministerial turf squabbles and periodic lapses in its mandate; the Italian parliament had never gotten around to ratifying the decree that had created the committee in the first place. Some members began to fear that the committee would go out of business, with the lead blight still in place as their one legacy to Pisa.

An idea for a new, temporary solution popped up: Why not replace the lead weights with 10 anchors buried 180 feet underground, in the firmer sand below the Pancone Clay? The anchors would hang from cables attached to yet another reinforced-concrete ring, this one hugging the foundations underneath Gherardesca's sunken walkway. To install it would require digging under the walkway and under the shallow water table. The committee knew that digging the walkway had caused the tower to lurch back in 1838, but they figured it would be safe to excavate their own trench in short sections. To avoid a groundwater escape that would flood the trench and possibly cause the tower to lurch again, they decided to freeze the ground first by injecting it with liquid nitrogen. The procedure worked on the north side of the tower. In September 1995, at the beginning of the rainy season, when the tower is at its most mobile, freezing started on the south side.

"The operation," says Heiniger, "had unexpected effects. The tower showed a tendency to move south, a tendency that developed quite suddenly." South was the wrong direction for the tower to be going.

(continued)

"It was hair-raising, really," says Burland, who rushed out of a conference in Paris to fly to Pisa. "As soon as they switched the freezing off, the tower began to move southwards at a rate of four to five arc seconds a day, which is the normal rate for a year. For three weeks we were watching the tower day and night." Burland suspects that by freezing the groundwater under the walkway on the south side, he and his colleagues had compressed the soil underneath—water expands when it freezes—creating a gap for the tower to settle into once the freezing stopped. Ultimately, though, another 300 tons of hastily added lead halted the southward excursion, and the tower shifted only seven arc seconds.

The committee now faced loud criticism. Piero Pierotti, an architectural historian at the University of Pisa, told *The Guardian*, a leading British newspaper, that Burland had done "incalculable damage" to the tower. "I just hope for the sake of the good people of Britain," he added, "that he doesn't do to your Big Ben what he has managed to do to the Leaning Tower." James Beck, a professor of art history at Columbia University, compared the Pisa committee to the Keystone Kops—and also to Mussolini, for the committee's supposedly authoritarian disregard of outside criticism.

Meanwhile, Jamiolkowski was finding he had plenty of internal dissension to deal with. The government disbanded the committee for most of 1996, and when it was finally reconstituted with many new members, there was heated debate on how best to proceed. "To keep together a large group of university professors is quite a difficult task, especially when these university professors must make important decisions," says Jamiolkowski. "I believe after this experience I will come to New York and open a psychoanalytic practice."

For the moment, the argument seems to be over; what the committee is doing now is working. In 1998 they added one more ugly prophylactic to the tower, intended to catch it should anything go drastically wrong while soil is being extracted. Two steel cables looped round the second loggia were attached to giant anchors partially concealed behind a neighboring building. The final underexcavation program began in February. "There are no more polemics at the moment," Pierotti says. "People have accepted this solution."

Forty-one drill pipes are now arrayed around the north quadrant of the tower. They enter the soil at different points along an arc about 40 feet from the tower and at an angle of 30 degrees; their tips lie about 12 feet under the north edge of the foundation. Inside each eight-inch-diameter pipe is an augur, a corkscrewlike bit that traps soil between its blades and channels it to the surface. The tower then settles into the resulting yard-long cavities. Burland steers the tower, and tries to keep it on an even northward course, by deciding how much soil to remove through each pipe on any given day. As of late May, Heiniger's crew had removed more than 10 tons of soil. The tower had rotated 513 arc seconds north, and the crew was one third of the way to its goal. There had been no ominous lurches.

Every day now the workers wind the tower's tilt clock back by months or even as much as a year. By next summer the committee hopes to restore the tower to five degrees, an angle it last saw early in the 19th century. That should buy the tower roughly two centuries of stability. Visitors are not likely to notice a half-degree decrease in tilt. The mayor of Pisa hopes to reopen the tower next year on June 17, the feast of San Ranieri, the city's patron saint.

But they are not there yet, the tower-savers. Jamiolkowski is looking forward to closing the work site, disbanding his fractious committee, enjoying life—but he balks superstitiously when you mention how well things seem to be going. Heiniger points out that the greatest threats to the tower have always come from people trying to give it a friendly nudge. "I hope it won't happen this time," he says. Burland, in the driver's seat, has perhaps the most reason to carry a rabbit's foot. Everywhere he goes these days the faxes from the control room follow him—two a day telling him how the tower has responded to the latest gentle suctioning underneath it. Every night Burland sends back the next day's instructions, signed.

"It's kind of taxing," he said recently, scanning the first fax of the day as he rode the elevator up to his office at Imperial. "It's like trying to ride a bicycle by fax. It's such a dangerous structure, and so many people have come unstuck on it. But yesterday was very good. We got the biggest north movement yet: four arc seconds in a single day."

How We Worked Together

Name: ______________________________

Date: ______________________________

Task: ______________________________

Group Members:

____

____

____

	Yes	**Sometimes**	**No**
Everyone participated.			
We listened to each other.			
We encouraged each other.			
We took turns sharing ideas.			
The group stayed together.			
We accomplished our task.			

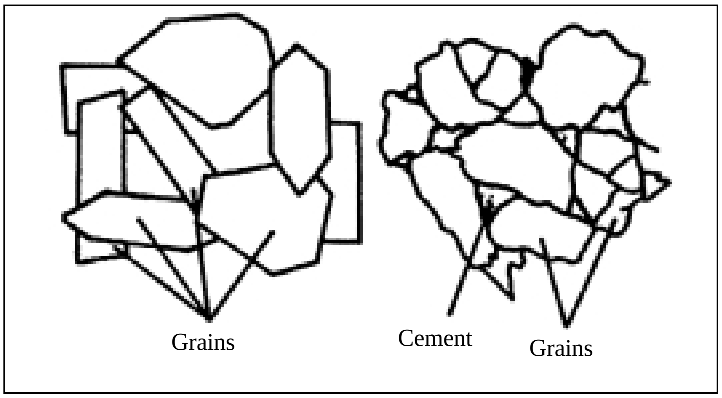
How We Worked Together: Reproduced from *Grades 5 to 8 Mathematics: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1997. Appendix.

Using a Rock Classification Key

To use the key, start with #1 and move through the key until you have identified the rock type: igneous, sedimentary, or metamorphic.

1a. The rock is made up of distinguishable minerals. If so, go to 2a.
1b. The rock is not made up of distinguishable minerals. Go to 5a.

2a. The rock is made up of minerals that are interlocking. If so, go to 3a.
2b. The rock is made up of minerals that are non-interlocking. Go to 6a.



Interlocking and non-interlocking minerals

3a. The minerals in the sample are of the same kind. The rock is *metamorphic*.
3b. The minerals in the sample are of two or more different types. Go to 4a.

4a. The minerals in the sample are distributed in a random pattern. The rock is *igneous*.
4b. The minerals in the sample are not distributed randomly but show a preferred arrangement, or banding. The rock is *metamorphic*.

5a. The rock is either glassy or frothy (has small holes). The rock is *igneous*.
5b. The rock is made up of strong, flat sheets that look as though they will split off into sheet-like pieces. The rock is *metamorphic*.

6a. The rock is made of silt, sand, or pebbles cemented together. It may have fossils. The rock is *sedimentary*.
6b. The rock is not made of silt, sand, or pebbles but contains a substance that fazes when dilute HCl (hydrochloric acid) is poured on it. The rock is *sedimentary*.

The Rock Cycle

Igneous Rock

Rock begins as a molten mass of magma in the mantle of the Earth. Magma can ooze into already formed rock in the Earth's crust and cool to create *intrusive igneous rock*. If there is enough pressure, or if there are cracks in the crust, the magma itself comes to the surface of the Earth. Now known as lava, it flows out of volcanoes both on land and under the sea, creating *extrusive igneous rock* as it cools and hardens.

There are several things that could happen to igneous rock:

- It could be worn away in the process called weathering. Weathering breaks down the igneous rock, and sediment is created. This sediment may be transported elsewhere or it may collect layer upon layer (sedimentation). As the layers build up, their combined weight compresses the sediments, and sedimentary rock is formed. In many forms of sedimentary rock, layers may be seen, particles may be separated easily, or fossils (shells or bones of long-dead organisms) may be preserved.
- Besides being worn down and changed into sedimentary rock, igneous rock can be pushed lower and closer to the hotter mantle region of the Earth. Pressure and high heat can change igneous rock into metamorphic rock. Metamorphic rock can find its way back to the surface of the Earth by the movement of lower or neighbouring rock or by the weathering of the rock above. If igneous rock is pushed so low that it joins the hot mantle, it will become magma and eventually create new igneous rock.

Sedimentary Rock

Sedimentary rock can result from the wearing away of igneous rock. Sediment that forms sedimentary rock can also come from the breaking down of pre-existing sedimentary or metamorphic rock. Just as weathering can occur in igneous rock, so wind, water, ice, gravity, other rocks, and animals can break down sedimentary and metamorphic rock.

Sedimentary rock, in turn, could become metamorphic rock if enough heat and pressure were applied to it. It could even find itself turning back into igneous rock if it were forced back toward the Earth's mantle and allowed to melt. It may eventually return closer to the Earth's crust and become igneous rock.

Metamorphic Rock

Metamorphic rock could weather and provide sediment to create sedimentary rock or, if enough force were applied, metamorphic rock could be transformed into magma in the Earth's mantle.

Summary

All rock starts off as magma and hardens into igneous rock. Sedimentary rock is made as a result of the weathering of igneous and metamorphic rock. High heat and pressure applied to sedimentary or igneous rock can change them into metamorphic rock. These three types of rock continue to change from one form to another and back again. This process of change is called the *rock cycle*.

Create and Label Diagrams

Draw and label three diagrams to illustrate changes that can happen to igneous rock, sedimentary rock, and metamorphic rock.

Word Splash: The Rock Cycle

lava

weathering

hotter

magma

layer upon layer

process of change

pressure and heat

sedimentary

mantle

volcanoes

igneous

metamorphic

breaks down

sedimentation

extrusive

compresses

fossils

Soils in Manitoba

Like water, soil is a valuable resource for many forms of life. Green plants derive their energy from sunlight. Water, gases, and mineral nutrients are absorbed by plant organs and are incorporated into plant bodies. Plants that are consumed by animals or humans are eventually converted into animal tissue. Decomposition of plant and animal bodies and their waste products in soil allows matter to be used again and again by living organisms. In this way, soil serves as an important link between the living and non-living worlds.

Soils are made up of different compounds. Rocks are eroded by rain or wind and are broken down by physical or chemical processes to form tiny mineral particles. The sizes of the mineral particles are important in determining the characteristics and classifications of soils.

- *Clays* have the finest particles, the largest total air space, and the ability to soak up and hold much water.
- *Sands* and gravels have the largest particles and large pores, but less total air space. They hold little water and allow water to pass through easily.
- *Loams* have particles of intermediate size and space. They have the ability to hold water more easily than sands and gravels.

Irregular spaces between the mineral particles allow *atmospheric gases*, water, and water vapour to enter the soils. Atmospheric gases include oxygen, carbon dioxide, and nitrogen.

The decaying *organic matter* within the soil is added over many thousands of years. This organic matter provides many nutrients for plants and is responsible for aerating and loosening soil and helping with water absorption.

Also present in “dirt” are millions of *living organisms*. Bacteria, fungi, protozoans, and larger organisms are instrumental in determining the characteristics of soils.

Soil Zones

A *soil zone* is an area of relatively uniform soil colour and composition. In Manitoba, provincial soil maps generally identify from three to five soil zones. The soil zones shown on the Soil Zones of Manitoba map on the following page include

- bog and subarctic
- peat and podzolic
- lime-rich forest (grey)
- grey brown
- black soils

Brown soil zones are found in warmer and drier regions that may experience drought. Lack of moisture is usually the main factor limiting crop production. This short grass prairie soil zone has less organic matter than black soils. It has lower than average provincial yields and a higher chance of crop failure.

Black soil zones are much more favourable to good crop production. They are found in areas with slightly cooler temperatures and more effective moisture levels. This tall grass and parkland prairie soil zone has more organic matter than brown or grey soil zones.

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Soils in Manitoba: Reproduced from *Senior 3 Agriculture: A Full Course for Distance Education Delivery, Field Validation Version*. Winnipeg, MB: Manitoba Education and Training, 1999. pp. 17, 86-90.

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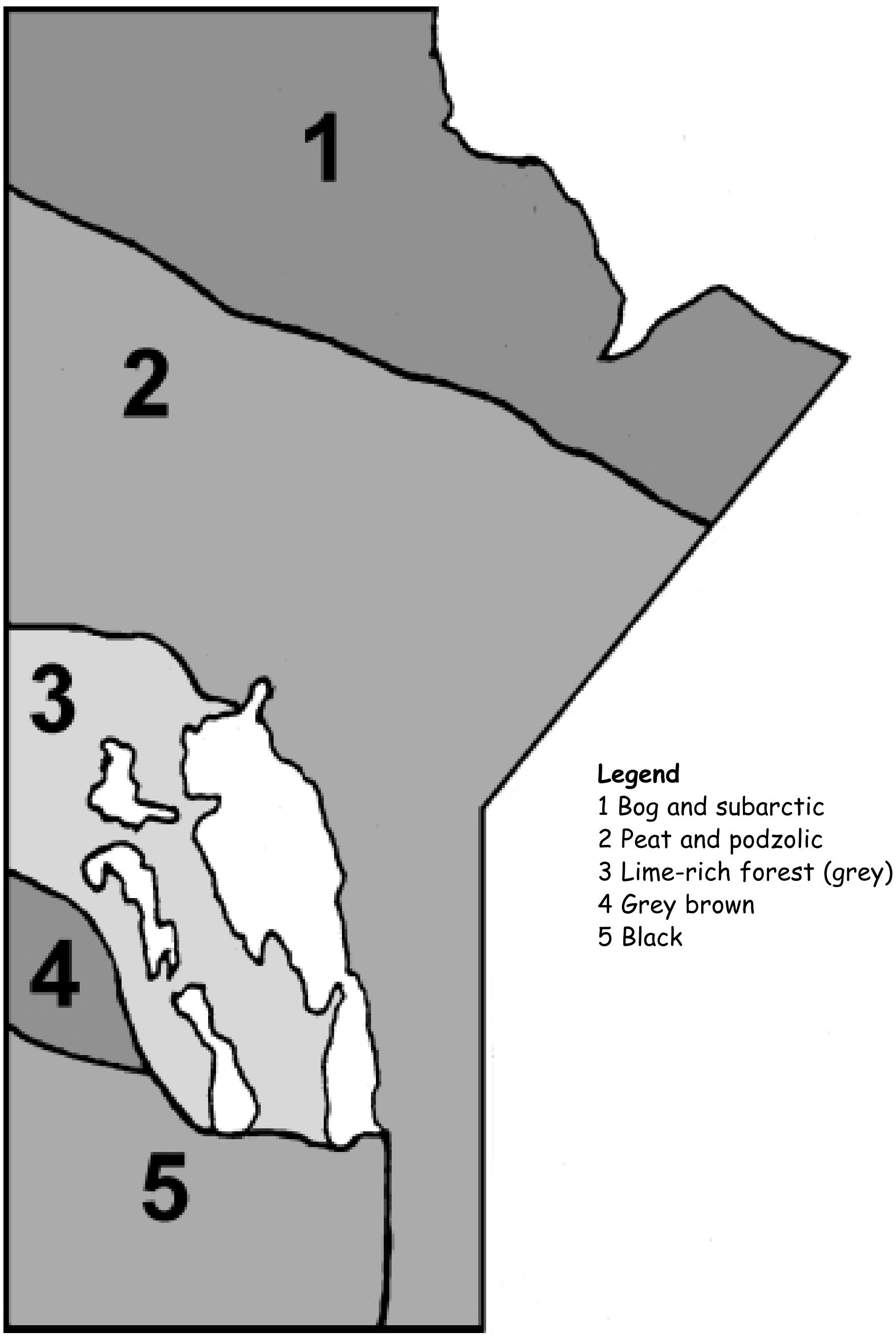
Grey soil zones experience less decomposition of plant matter. This soil type is located farther north, where cooler temperatures result in increased soil moisture. These higher moisture levels leach minerals and nutrients out of the upper layers at a faster rate. As a result, the grey topsoils tend to be more shallow and less fertile than black or brown soils.

Climate and vegetation play major roles in soil formation. The boundaries of the soil zones are similar to the boundaries for climatic and vegetation belts. All have significant effects on the farming operations of their areas. About 12 percent of Manitoba's land area is considered to have soils suitable for agriculture. Compare the following three maps: Soil Zones of Manitoba, Climatic Regions in Manitoba, and Natural Vegetation in Manitoba. Notice the similarities.

Soil Zones of Manitoba



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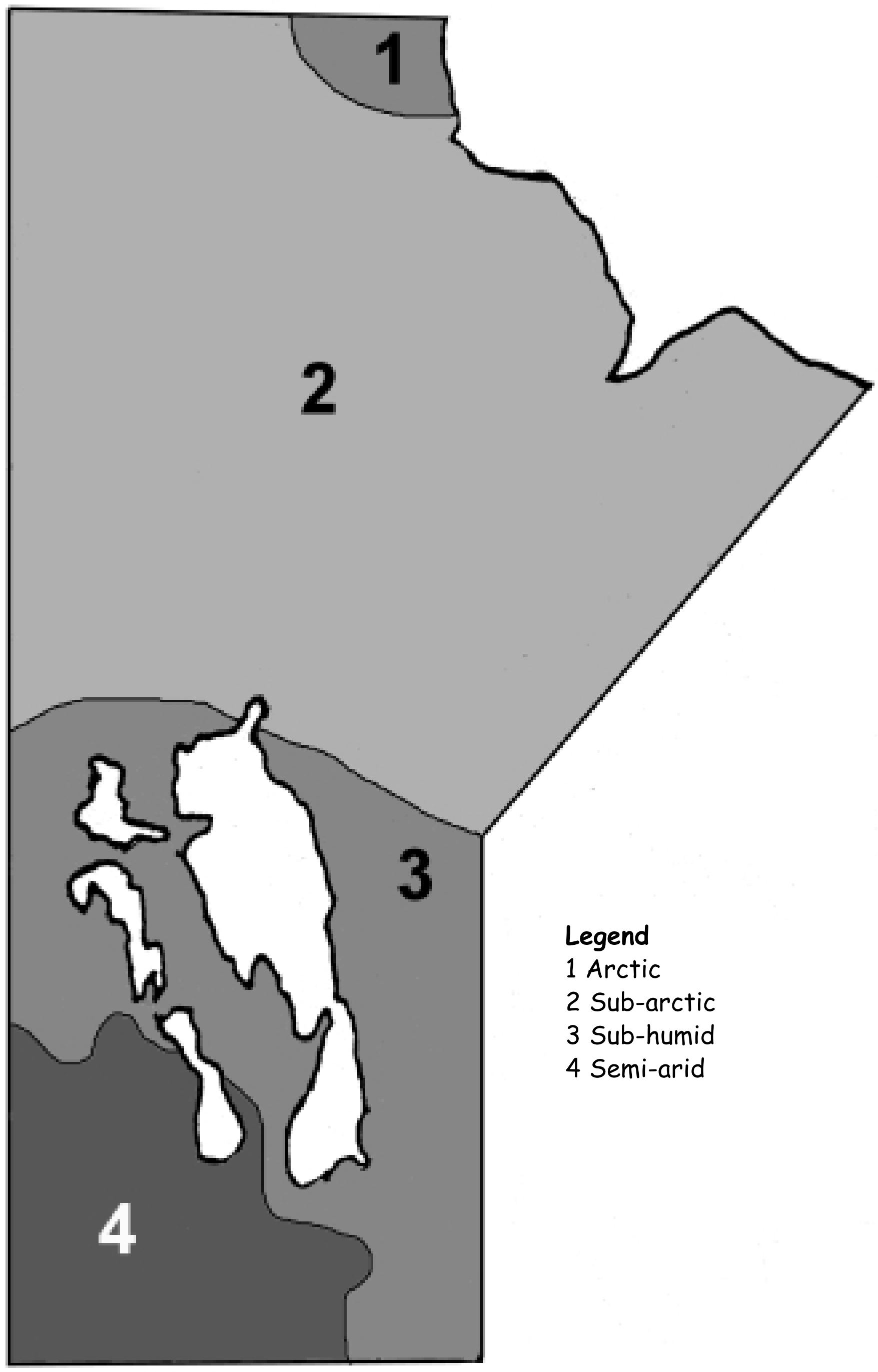
Climatic Regions in Manitoba



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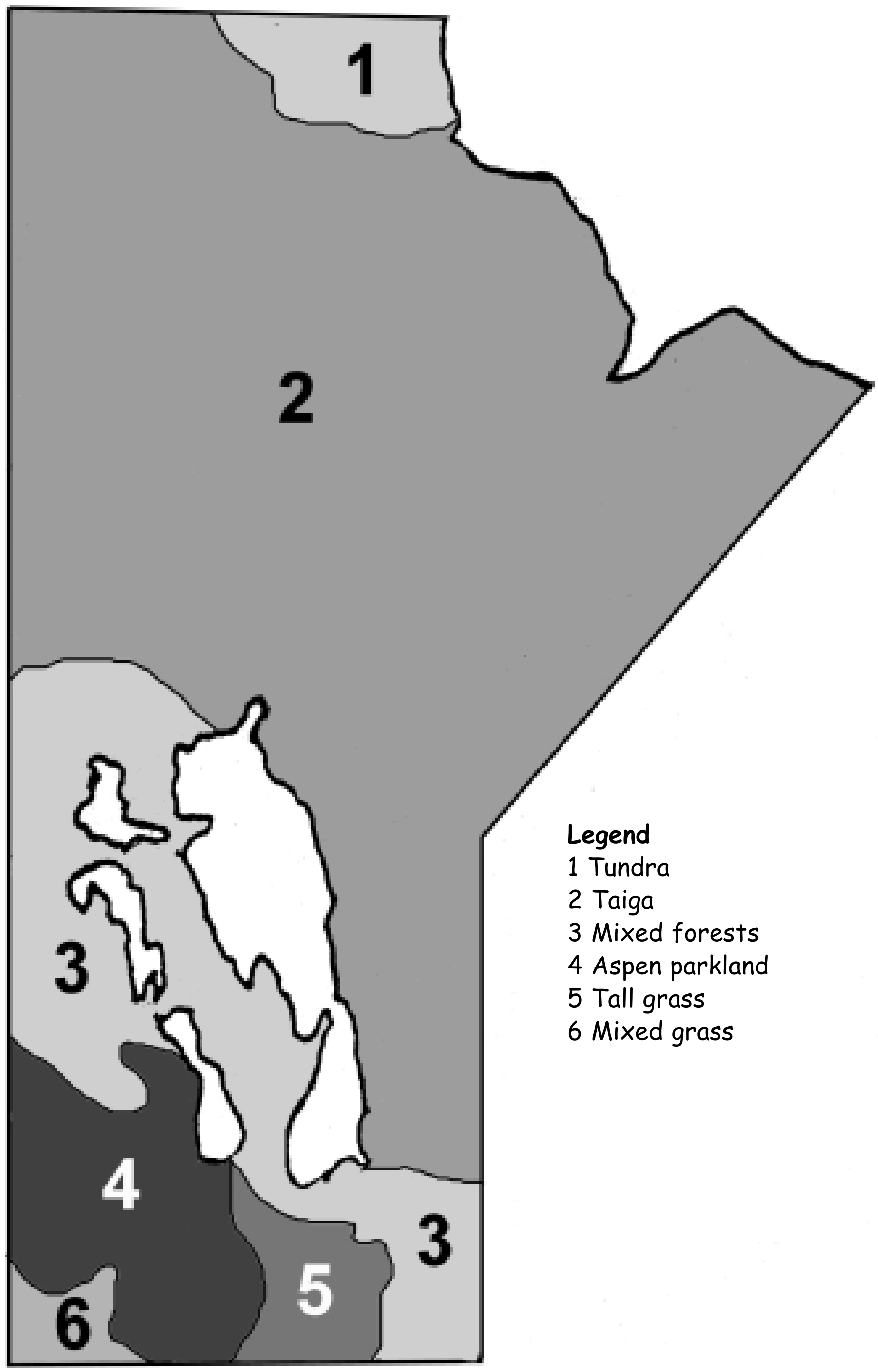
Natural Vegetation in Manitoba



Soil Erosion

Erosion is a naturally occurring process that can be either escalated or diminished by agricultural practices. With the disappearance of natural grass cover and the reduction of anchoring material in cultivated topsoil, erosion occurs. Drought conditions and an overextension or expansion of cultivation into regions of light soils resulted in tremendous losses of topsoil to winds in the 1930s.

The loss of mineral particles and organic matter to *wind erosion* continues today. Dry, windy conditions are common to many areas at spring seeding time and clouds of dust can still be seen in certain areas. Treatments to replace topsoil include the use of fertilizer, manure, and irrigation. Some Alberta studies have shown improved yields through these practices. However, those yields were still not as good as those in test plots where natural topsoil remained.

Water erosion occurs frequently. On sloping land, rill erosion of *tiny channels* that are several centimetres deep can eventually lead to gulley erosion characterized by *deep-cut channels* that can be measured in metres.

On bottomlands, especially along rivers, *sheet erosion* can take place in times of high water. When water covers large areas of relatively flat land, it will dissolve matter from the upper soil layers and carry it away when the land finally drains.

Solving Soil Problems

Problems created by water erosion and wind erosion can be reduced by specific soil management techniques that are in keeping with the principles of sustainable development.

Water erosion has been reduced by

- hillsides or slopes that are *contour-cultivated* or worked across the slope to create furrows, ridges, or plant strips that oppose the downward movement of water
- *gullies* or pathways for water movement that have been shaped and seeded to grasses or grass-legume mixtures
- areas of frequently submerged lowlands that have been *grass-seeded* to prevent *sheet erosion*
- crops (such as rye or winter wheat) seeded in the fall as crop cover to prevent spring water erosion

Wind erosion has been reduced by

- *shelter belts* around farmyards, around fields, or along roadsides that reduce wind speed
- tillage and seeding equipment *(cultivators)* that leaves straw stubble upright to hold soil in place
- maintaining a *trash cover* on the soil surface to keep the soil moist for a longer period, reducing the amount of loose, dry soil available to the wind
- *swathing* so that alternate strips are at different heights
- planting fall cover crops (winter wheat or rye) in areas of light, sandy soil that are prone to wind erosion
- planting perennial grass or legumes (for animal forage or grazing lands)

(continued)

Soil Erosion: Reproduced from *Senior 3 Agriculture: A Full Course for Distance Education Delivery, Field Validation Version*. Winnipeg, MB: Manitoba Education and Training, 1999. pp. 17, 60, 64, 65, 73.

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Organic Matter: Did You Know?
It is estimated that it has taken anywhere from 200 to 1 000 years for organic matter to form. This is why the loss of several centimetres of topsoil to wind or water erosion is considered serious.

Trends in Sustainable Agriculture

Some soil management practices that have been in use for many years are still being used today. Others are being modified, and still others are being abandoned. Decisions to adapt to new methods are influenced by the following factors:

- costs of new method
- availability of specialized equipment
- time involved
- availability of information
- size of farming operation
- type of farming operation
- values and beliefs

Conclusion

Producing, purchasing, and eating foods are all actions that directly relate to agriculture and ultimately relate to soils. Therefore, either directly or indirectly, your actions have effects on soil management. In the past, not much attention was paid to the way soil was handled as a resource. Land deterioration often went unnoticed because the process was slow and fairly widespread. Problems that were recognized received minimal attention. Even though most management practices that led to soil degradation were directly carried out by agricultural producers, the responsibility for good soil conservation techniques lies with us all—from the home gardener to the crop producer. Sustainable agriculture is more frequently becoming standard practice, and is supported by increased research, knowledge, and public awareness.

Constructing a Prototype: Observation Checklist

Date: ________________________________ Problem/Challenge: _______________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Constructing a Prototype: Observation Checklist *(continued)*

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Design Project Report

Name: ___________________________________ Date: __________________________________

Problem/Design Challenge:

Criteria:

Brainstorming (What are all the different ways . . .):

Planning:

Steps to Follow:

Materials:

Safety Considerations:

(continued)

Design Project Report *(continued)*

Testing:

Criteria	Test Used

Test Results: Attach Data Summary

Evaluating and Improving:

- Justification of changes to original design:

- Strengths and weaknesses of final design:

- Comment/Reflection (Next time . . . , A New Problem . . . .):

(continued)

Design Project Report *(continued)*

Prototype Sketch 1 (Plan):

Prototype Sketch 2 (Final):

Design Project Report: Assessment

Prototype: ______________________ Date: ______________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Identifying the Practical Problem and Criteria for Success • the problem is clearly stated • class and/or group criteria are identified • criteria address all or some of the following: function, aesthetics, environmental considerations, cost, efficiency			
Planning • all steps are included and clearly described in a logical sequence • all required materials/tools are identified • safety considerations are addressed • a three-dimensional sketch of the prototype is included (Sketch 1)			
Testing the Prototype • tests are described and align with criteria (e.g., each criterion has been tested) • test results are presented in an appropriate format (data sheet is attached)			
Evaluating and Improving the Design • a final sketch of the prototype is included (Sketch 2) • changes to the original plan are justified • strengths and weaknesses of the final prototype are presented • suggestions for "next time" are included and/or "new problems" are identified			
Total Points			

Comments:

*__Note:__ The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Conducting a Fair Test: Observation Checklist

Date: ___________________________________ Experiment: _________________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (workspace, handling equipment, goggles, disposal)	Ensures Accuracy/ Reliability (e.g., repeats measurements/ experiments)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Conducting a Fair Test: Observation Checklist) *(continued)*

Names	Has Safe Work Habits (workspace, handling equipment, goggles, disposal)	Ensures Accuracy/ Reliability (e.g., repeats measurements/ experiments)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Experiment Report

Name: ______________________________ Date: ______________________________

Experiment: ____

Testable Question:

Independent Variable:

Dependent Variable:

Prediction/Hypothesis: (Identify a cause and effect relationship between independent and dependent variables.)

Planning for a Fair Test

- **Apparatus/Materials:**
- **Variables to Control:**
- **Method:** (Include steps to follow, safety considerations, and plan for disposal of wastes.)

(continued)

Experiment Report *(continued)*

Observation: (Include data tables/charts on a separate sheet, if required.)

Analysis of Data: (Identify patterns and discrepancies.)

Note: Attach graph on a separate page, if required.

(continued)

Experiment Report *(continued)*

Strengths and Weaknesses of Approach/Potential Sources of Error:

Conclusion: (Support or reject prediction/hypothesis; pose new question(s).)

Applications/Implications: (Link to daily life or area of study.)

Experiment Report: Assessment

Experiment Title: ______________________________ Date ______________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Creating a Testable Question • the question is testable and focused (includes a cause and effect relationship)			
Making a Prediction/Hypothesis • independent and dependent variables are identified • the prediction/hypothesis clearly identifies a cause and effect relationship between independent and dependent variables			
Planning for a Fair Test • required apparatus/materials are identified • major variables to be controlled are identified • steps to be followed are included and clearly described • safety considerations are addressed • a plan for disposing of wastes is included			
Conducting a Fair Test/Making and Recording Observations • evidence of repeated trials is provided • detailed data are recorded, appropriate units are used • data are recorded in a clear/well-structured/appropriate format			
Analyzing and Interpreting • graphs are included (where appropriate) • patterns/trends/discrepancies are identified • strengths and weaknesses of approach and potential sources of error are identified • changes to the original plan are identified and justified			
Drawing a Conclusion • cause and effect relationship between dependent and independent variables are explained • alternative explanations are identified • prediction/hypothesis is supported or rejected			
Making Connections • potential applications to or implications for daily life are identified and/or links to area of study are made			
Total Points			

***Note:** The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Grade 8 Science

Manitoba Education and Training
2000

Grade 8

Cluster 1: Cells and Systems

Overview

In this cluster, students investigate living things through a focus on cells and systems. Cell theory provides the basis for exploring cells and unicellular and multicellular organisms. Students identify major events and technological innovations that have enabled scientists to increase our understanding of cell biology. Microscopes are used to observe and compare the general structure and function of plant and animal cells. Students examine important processes that take place within the cell, including the movement of nutrients and wastes across cell membranes. The need for specialization of cells and tissues in multicellular organisms is discussed, as are the structural and functional relationships among cells, tissues, organs, and systems. Investigations of the circulatory and respiratory systems highlight their importance to the body and lead to an understanding of how body systems function interdependently. Students identify components of the body's primary and secondary defense systems. They examine medical advances that enhance the human body's defence mechanisms, and research disorders and diseases that can affect body systems.

Prescribed Learning Outcomes
Students will...
8-1-01 Use appropriate vocabulary related to their investigations of cells and systems. Include: cell theory, osmosis, diffusion, selective permeability, unicellular, multicellular, specialized cells and tissues, organs, systems, arteries, veins, capillaries, terms related to cell structure, heart structure, components of blood, and primary and secondary defense systems. GLO: C6, D1

Suggestions for Instruction

Teacher Notes

Students have had previous learning experiences related to this cluster in Grade 7, Cluster 1: Interactions within Ecosystems, and in Grade 5, Cluster 1: Maintaining a Healthy Body.

Refer to *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* (2000) for related learning outcomes and teacher support.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Three-Point Approach**

Have students, working in groups, use the Three-Point Approach (Simons, 1991) to research one or more of the identified terms related to types of vertebrates and invertebrates. Provide students with opportunities to share their findings with the class. Have students update this information throughout the study of this cluster.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-02 Identify characteristics of living things, and describe how different living things exhibit these characteristics.

Include: composed of cells; reproduce; grow; repair themselves; require energy; respond to the environment; have a lifespan; produce wastes.

GLO: D1, E1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

SUGGESTIONS FOR INSTRUCTION

➢ **Characteristics of Living Organisms**

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to answer the following question: What characteristics are shared by all living things?

When gathering student responses, group them into categories (e.g., living things are composed of cells, reproduce, grow, repair themselves, require energy, respond to the environment, have a lifespan, and produce wastes).

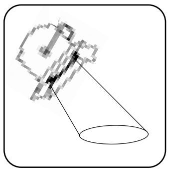
Have students research a variety of resources (using the Internet, print texts, CD-ROMs, videos, and/or viewing material through a microscope) to find examples of how a plant, a paramecium, and a human exhibit each of the life functions. Also provide students with opportunities to view plant or paramecium specimens/slides. Ask students to organize their information in chart form.

Example:

Characteristics of Living Organisms

Characteristics	Plant	Paramecium	Human
retrieves/uses energy	photosynthesizes	scoops up food in the gullet	ingests food in the mouth and processes it in the digestive system
grows and reproduces	reproduces by means of seeds, cuttings, and runners	splits into two new paramecia	reproduces by sexual means
responds to the environment	grows toward light	swims to catch food	uses the nervous system to receive information from outside the body and to send messages to other parts of the body
produces wastes	gives off extra water through transpiration	squirts out wastes and extra water through vacuoles and gives off carbon dioxide	gives off carbon dioxide and urea
has a lifespan	lives from months to hundreds of years (annual, biennial, perennial)	lives from hours to a few days	lives approximately 80 years
is made of cell(s)	consists of more than one cell	consists of only one cell	consists of more than one cell

Suggestions for Assessment



Is It Living?

Provide students with the following question:

Is fire a living thing, according to a scientist's perspective? Explain.

Scoring Rubric	
Score	**Criteria**
4	The response is correct, complete, and detailed, indicating that fire is not a living thing because it does not exhibit all life characteristics (does not contain cells). It contains examples and/or elaboration to support the answer. It includes evidence of higher-order thinking.
3	The response is correct and complete, indicating that fire is not a living thing because it does not exhibit all life characteristics (does not contain cells). It contains examples and/or elaboration to support the answer.
2	The response is generally correct and complete. It may contain minor errors. It contains examples and/or elaboration to support the answer.
1	The response is partially correct but is incomplete and/or contains errors. It contains no examples or elaboration to support the answer.

Teacher Notes

The Western scientific view of the characteristics of living things may be in conflict with other views. Encourage students to discuss and respect other views and recognize that individuals can hold multiple views.

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.1)

Sciencepower 8 (Sections 1.3, 2.3)

Native Science: Natural Laws of Independence (Teacher Reference)

Igniting the Sparkle: An Indigenous Science Education Model (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-03 Describe cell theory.

Include: all living things are composed of one or more cells; cells are the basic unit of structure and function of any organism; all cells come from pre-existing cells; the activity of an organism as a whole depends on the total activity of all its cells.

GLO: A2, D1, E2

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Cell Theory News Release**

Have students research information about the *cell theory*. Then have them use their findings to create a newspaper article that announces the discovery of the cell theory, discusses its major points, and identifies the scientists who are credited with its discovery.

Sample News Release:

Schleiden, Schwann, and Virchow Vow
Cell Is the Basic Building Block of Life

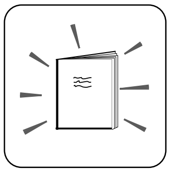
Scientists Schleiden, Schwann, and Virchow have studied living organisms for several years. With the help of the microscope they have determined that all living things are made of cells.

According to Matthias Schleiden and Theodor Schwann, these cells seem to be the basic structural units within organisms. The two scientists also note that the well-being of the organism depends on the well-being of its cells.

Due to the numerous and varied experiments and studies they have conducted, Schleiden and Schwann are confident in their hypothesis and have laid out the points in what they call the *cell theory*. Schleiden and Schwann have incorporated into the cell theory experimental observations and conclusions of the famous scientist Rudolf Virchow, who has observed that cells reproduce themselves.

(For strategies to aid students in using a variety of information sources, determining the usefulness of information, constructing meaning, recording information, and referencing and evaluating sources, refer to *5-8 ELA*, learning outcomes 3.2.2–3.2.5 and 3.3.2–3.3.3.)

SUGGESTIONS FOR ASSESSMENT



Cell Theory News Release

When assessing students’ news releases, look for indications of the following:

Rating Scale					
Criteria	**Poor**		**Good**		**Excellent**
The news release					
• identifies main scientists and their contributions	1	2	3	4	5
• includes major points of the cell theory	1	2	3	4	5
• uses a format/approach suited to a news release	1	2	3	4	5

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 1.1)

Sciencepower 8 (Section 1.1)

Science and Technology Breakthroughs (Teacher Reference)

World of Scientific Discovery, 2nd ed. (Teacher Reference)

Prescribed Learning Outcomes

Students will...

8-1-04 Identify major events and technological innovations that have enabled scientists to increase our understanding of cell biology.

Examples: invention of the light and electron microscopes, works of Robert Hooke, Anton van Leeuwenhoek, Matthias Schleiden and Theodor Schwann...

GLO: A2, A4, B1, B2

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-8a ➲ Distinguish between science and technology. Include: purpose, procedures, products. GLO: A3

8-0-8b ➲ Describe examples of how scientific knowledge has evolved in light of new evidence, and the role of technology in this evolution. GLO: A2, A5, B1

8-0-8d ➲ Describe examples of how technologies have evolved over time in response to changing needs and scientific advances. GLO: A5, B1, B2

8-0-8e ➲ Provide examples of Canadian institutions and individuals who have contributed to science and technology, and describe their contributions. GLO: A1, A4, B1, B4

8-0-8g ➲ Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

Suggestions for Instruction

➢ **Timeline of Developments in Cell Biology**

Have students gather research from the Internet, multimedia resources, and/or print texts to create a timeline of the major events and technological advancements that have enabled scientists to increase our understanding of cell biology. Ask students to include the following people and discoveries, as well as at least three other notable discoveries/people involved in cell biology: Robert Hooke, Anton van Leeuwenhoek, Matthias Schleiden, Theodor Schwann, Rudolf Virchow, cell theory, light microscope, electron microscope.

Note: Discuss with students why there is an absence of women who are associated with discoveries in cell biology.

Once the timeline is completed, have students use their science notebooks to reflect on the role technology has played in allowing scientists to increase their understanding of cell biology, and the impact of this increased understanding on society.

➢ **Science or Technology**

Challenge the class to distinguish between science and technology in terms of purpose, procedure, and product, using information and examples from their timelines created in the previous learning activity.

(Refer to Figure 1: Science and Technology: Their Nature and Relationship, *Grades 5 to 8 Science: Manitoba Curriculum Framework of Outcomes*, p. 2.5.)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.5)

Sciencepower 8 (Section 1.1)

Science and Technology Breakthroughs (Teacher Reference)

World of Invention, 2nd ed. (Teacher Reference)

World of Scientific Discovery, 2nd ed. (Teacher Reference)

Medical Discoveries (Teacher Reference)

Prescribed Learning Outcomes

Students will...

8-1-05 Identify and compare major structures in plants and animal cells, and explain their function.

Include: cell membrane, cytoplasm, mitochondria, nucleus, vacuoles, cell wall, chloroplasts.

GLO: D1, E1

8-0-1c Identify practical problems to solve. *Examples: How can I make water flow uphill? Which type of bottled water should I buy?…* GLO: C3

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

8-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow. GLO: C3, C6

8-0-4b ➲ Construct a prototype. GLO: C3

8-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

8-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

8-0-6e ➲ Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

Suggestions for Instruction

➢ Comparing Plant and Animal Cells

Have students view videos or CD-ROM clips that show greatly magnified pictures of the cell and its parts. Provide students with a Compare and Contrast Frame (Matchullis and Mueller, 1994) and have them use it to identify the similarities and differences between plant and animal cells.

(For a BLM of a Compare and Contrast Frame, see *SYSTH*, Attachment 10.4, or *Success*, p. 6.103.)

➢ Cell Model Construction

Using the design process, have students create a model of a plant, animal, or protist cell. As a class, determine criteria for success (e.g., the model is three-dimensional, includes a key). Have students

- plan their model by creating a sketch of their chosen cell type, labelling the diagram with the major cell structures
- indicate the materials to be used in the construction of their model (e.g., modelling clay, polystyrene balls, paper, gelatin)
- present their finished model to the class

Students may use the "Design Project Report" (BLM 8-O) to record their work.

➢ What Is My Function?

Have students create flash cards for the structure and function of plant and animal cells, writing the function or job description of the cell structure on one side and the name of the cell structure on the other. The cards may also include a diagram. Pairs of students can use these cards to play the game, What Is My Function? They either state the function first and ask for the name of the cell structure or vice versa. Have students rotate around the room and play the game with different students.

This game may also be played in two teams. Show a card with the name of a cell structure or the description of the cell's function to one student from each team and then have both students draw the correct cell structure on the board.

Suggestions for Assessment

When assessing students' cell model construction, refer to "Design Project Report: Assessment" (BLM 8-P).

Job Advertisements

Have students create job advertisements that incorporate a job description for a plant or an animal cell.

Scoring Rubric	
Score	**Criteria**
3	The advertisement includes all key features of a plant or animal cell. It includes a realistic job description.
2	The advertisement includes the majority of the key features of a plant or animal cell. It includes a realistic job description.
1	The advertisement includes some of the key features of a plant or animal cell. The job description is not realistic.

Teacher Notes

Background Information

The cell consists of the following structures:

- The *nucleus* is the control centre of the cell.
- The *cell membrane* is a living structure that surrounds a cell and allows certain materials in and out.
- *Cytoplasm* is a fluid-like material within a cell that supports the internal structure of the cell.
- *Mitochondria* are the location of energy production, converting nutrients and oxygen into useable energy.
- *Vacuoles* are storage structures for water, minerals, nutrients, and wastes.
- The *cell wall* (in a plant cell only) is the non-living cellulose structure that surrounds a cell and provides support.
- *Chloroplasts* (in a plant cell only), containing chlorophyll, are structures that convert light energy into usable chemical energy.

Both plant and animal cells have mitochondria, a cell membrane, cytoplasm, and a nucleus. The differences between plant and animal cells include the following:

- Plant cells have thick outer cell walls that provide support, large vacuoles for water and mineral storage, and chloroplasts for food production.
- Animal cells have a thin, flexible membrane, have many small vacuoles, and lack chloroplasts.

Suggested Learning Resources

Nelson Science & Technology 8 (Sections 1.3, 1.6)

Sciencepower 8 (Sections 1.2, 1.3)

Cells and Tissues (Video)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-06 Demonstrate proper use and care of the microscope to observe the general structure of plant and animal cells.

Include: preparing wet mounts beginning with the least powerful lens; focusing; drawing specimens; indicating magnification.

GLO: C1, C2, D1

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

SUGGESTIONS FOR INSTRUCTION

➢ Activating Prior Knowledge

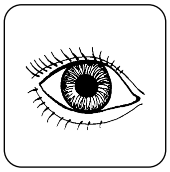
Note: The microscope was introduced in Grade 7, Cluster 1: Interactions within Ecosystems. Have students identify parts of a microscope on a diagram and list as many points related to the proper use and care of microscopes as they are able to. Then, as a class, identify all the parts and review proper use and care information. (Refer to “The Compound Microscope,” BLM 8-A.)

As a class, review basic skills of diagramming what students observe through a microscope and discuss how to determine the power of magnification used in viewing a slide.

➢ Viewing Cells with a Microscope

Have students view and diagram prepared slides of a typical plant cell and a typical animal cell (e.g., epithelial cell), as well as a live specimen of a plant cell (e.g., geranium leaf). Ask students to indicate the power of magnification used for each diagram. (Refer to “The Compound Microscope,” BLM 8-A.)

SUGGESTIONS FOR ASSESSMENT



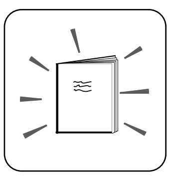
Use and Care of a Microscope

When assessing students' use and care of a microscope, look for indications of the following:

Checklist:

The student

- ❑ carries the microscope by the arm and base
- ❑ cleans the objective and ocular lenses with lens paper only
- ❑ places the slide on the stage and lowers the objective lens carefully (watches from the side of the microscope to ensure that the objective lens does not crush the slide) and focuses while looking through the ocular lens and raising the objective lens
- ❑ lowers the stage before changing from a lower objective lens to a higher objective lens and then watches from the side to ensure that the objective lens does not hit the stage
- ❑ properly cleans up work area and stores equipment as directed



Drawing Diagrams of Plant and Animal Cells

When assessing students' diagrams, look for indications of the following:

Checklist:

The student

- ❑ includes titles
- ❑ prints labels
- ❑ connects labels to the object with a straight line
- ❑ indicates the power of magnification used when viewing a slide

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 1.4)

Sciencepower 8 (Section 1.1)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-07 Describe the movement of nutrients and wastes across cell membranes and explain its importance.

Include: osmosis, diffusion, selective permeability.

GLO: D1

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-4f ➲ Identify WHMIS hazard symbols that provide information on the safety of substances. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ High and Low Concentration

Ask a group of students to stand close together in one corner of the classroom and have the remaining students spread throughout the room. Have students identify which part of the room has the highest concentration of students. (The corner with the group of students has the highest concentration.)

Show students the following diagram and have them decide which portion of the oval has a higher concentration of squares. (Part A has the higher concentration.)

Part A Part B

➢ Diffusion

Have students investigate diffusion, following these steps:

- Place a few of drops of food colouring in a Petri dish or a beaker of water. Record your observations in your science notebook, using three diagrams: one at the start, one after a minute, and one at the completion of the observation period of several minutes.
- *Diffusion* is the movement of a substance. Using the words *high concentration* and *low concentration*, describe the movement of the food colouring in the Petri dish or beaker. (The dye moved from an area of high concentration to an area of low concentration.)

➢ Osmosis

Have students investigate *osmosis*, following these steps:

- Put dried raisins in a beaker and add just enough water to cover them.
- Cover the beaker with a Petri dish or plastic wrap.
- Observe what happens over time (one to two days).
- Record your observations in your science notebook, using diagrams that show the raisins at the start and at the completion of the observation period. (The raisins expand as the water crosses through the outer skin or membrane.)
- Indicate on your diagrams the direction the water moved. Include evidence to support your answer. (Water moved into the raisins. Less water in the beaker and fuller raisins provide evidence.)

(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Background Information

- *Diffusion* is the movement of particles from an area of high concentration to an area of low concentration.
- *Osmosis* is the movement of a solvent (commonly water) through a selectively permeable membrane.
- *Selective permeability* refers to a membrane that allows some substances to pass through it but not others.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Sections 1.7-1.10)

Sciencepower 8 (Section 2.1)

Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions (Teacher Reference)

PRESCRIBED LEARNING OUTCOMES
Students will...
8-1-07 *(continued)*
(continued)

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **A Challenge**

Pose the following problem to students:

- How is it possible to get granulated sugar into a beaker that is covered by filter paper? (Dissolve the sugar in water and pour it through the filter.)
- Why was the sugar not able to go through the filter initially? (Its particles were too big.)

➢ **Osmosis and Selectively Permeable Membranes**

To observe how Lugol's iodine solution (a chemical indicator) reacts with starch, have students, wearing rubber gloves, place a few drops of iodine solution on a gram of starch. (The starch turns blue/black.)

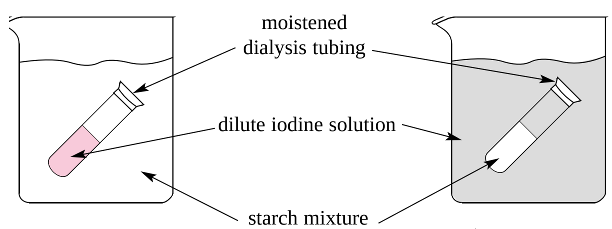
Safety Precaution: Concentrated iodine is corrosive. Ensure that students are familiar with the WHMIS (Workplace Hazardous Materials Information System) symbols and information provided on chemicals. Check WHMIS Material Safety Data Sheets for further details related to safe handling of iodine. For general safety information, including information on WHMIS symbols, see *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions*, 1997.

Part A

Have students perform the following investigation:

- Pour dilute iodine solution into a test tube and cover the end with a moistened piece of single-layered dialysis tubing, using a rubber band to keep the tubing in place.
- Place the test tube into a beaker of corn starch and water mixture.
- Set up a second test by putting dilute iodine solution into a beaker and a corn starch mixture into a test tube whose end is covered with dialysis tubing.

Sample A Sample B



(continued)

Suggestions for Assessment

Suggested Learning Resources

Prescribed Learning Outcomes
Students will...
8-1-07 *(continued)*
(continued)

Suggestions for Instruction

(continued)

After students have observed the reactions of the two mixtures, have them answer the following questions in their science notebooks:

1. Using the words *high concentration* and *low concentration*, explain the movement of the iodine solution. (In both samples, the iodine solution went from an area of high concentration to an area of low concentration: Sample A—from the test tube to the beaker; Sample B—from the beaker to the test tube.)
2. What was the proof of the direction of movement? (In Sample A, proof of the movement of the iodine solution from the test tube to the starch mixture in the beaker was that the starch mixture turned black but the iodine solution did not. In Sample B, proof of the movement of the iodine solution from the beaker into the starch mixture in the test tube was that the starch mixture turned black.)
3. What is a possible reason why the starch did not move into the iodine solution? (The starch particles were bigger than the pores in the dialysis tubing.)

Part B

To observe how Benedict's solution reacts with sugar, demonstrate the following:

- Pour 400 mL of distilled water into a 600 mL beaker.
- Fill half a test tube with the water and add several drops of Benedict's solution.
- Gently heat the solution over a flame or in a water bath. A positive indication of sugar is given when the colour of the solution changes to a reddish-orange.

> **Safety Precaution:**
> Ensure that the test tube has a "spurt cap" on it to prevent the hot liquid from escaping. Hold the test tube a safe distance away from students.

The following part of the experiment can be done as a teacher demonstration or as an investigation by groups of students:

- Fill a 6 cm length of dialysis tubing with corn syrup and tie it off, leaving about 10 cm of string.
- Tie the dialysis tubing to a pencil in such a way that it hangs in the water. Leave it set up overnight.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION
Students will...	

8-1-07 *(continued)*

(continued)

- The next day, observe differences in the dialysis tubing. (It looks “bloated.” Water has moved into the tubing.)
- Test the water for glucose by using a glucose indicator slip or Benedict’s solution (as per earlier directions). If the test is negative, with no sugar present, wait one more day and then retest, recording your observations.

Have students answer the following questions in their science notebooks:

1. *Osmosis* is the movement of water across a membrane. Using the words *high concentration* and *low concentration*, explain the movement of water in the above experiment. (The water moved from an area of high concentration to an area of low concentration.)
2. Why was the corn syrup not able to cross the dialysis tubing, a semipermeable membrane, at first? (Its particles were too large to go through the pores in the membrane.)
3. What eventually enabled the sugar to cross the dialysis tubing membrane? (The sugar dissolved in the water that moved into the tube and then was able to pass through the semipermeable membrane.)
4. Identify which substance *diffused* in this experiment. (The corn syrup diffused.)
5. Was equilibrium achieved in the concentration of corn syrup inside and outside the tubing? Support your answer with evidence from your observations. (Equilibrium was achieved. The solution in and out of the dialysis tubing was the same colour.)
6. Using your analysis of diffusion and osmosis, explain how nutrients and wastes move into and out of a cell. Include a description of water’s role in the movement of certain substances. (Nutrients move into a cell by diffusion. They move from an area of high concentration to an area of low concentration. Wastes diffuse out of the cell. They move from an area of high concentration to an area of low concentration. Water helps some nutrients move across a membrane by first dissolving the substance so that the nutrients may cross the semi-permeable membrane.)

SUGGESTIONS FOR ASSESSMENT

Extended Response

Provide students with the following:

Osmosis and Diffusion

Predict the direction of the movement of substances in the following situations. Indicate whether each situation illustrates *osmosis* or *diffusion* and explain why. Use diagrams.

1. dried prunes soaking in a bowl of water
2 a carrot in rain-soaked ground
3. a drink mix poured into a container of water
4. perfume being sprayed in a corner of a room

Look for:

1. osmosis
2. osmosis
3. diffusion
4. diffusion

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-08 Differentiate between unicellular and multicellular organisms.

GLO: D1, E1

8-0-2a Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…*
GLO: C6 (ELA Grade 8, 3.2.2)

SUGGESTIONS FOR INSTRUCTION

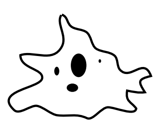
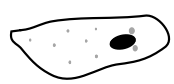
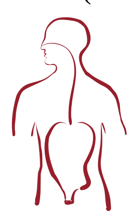
➢ Comparison of Unicellular and Multicellular Organisms

Have students observe examples of unicellular and multicellular organisms by viewing videos, live specimens (e.g., using pond water as a source), CD-ROM clips, and other media. Ask students to draw or paste pictures of unicellular organisms on one half of a piece of paper and pictures of multicellular organisms on the other half. Have students place a title on each side, along with a brief statement that describes the differentiation between the two types of organisms (i.e., single celled, many celled).

Safety Precaution: Pond water, especially water from a fish or turtle tank, may contain harmful bacteria and/or protists. Discuss with students the importance of keeping hands and writing utensils away from their mouths when dealing with pond water. Ensure that students wash their hands with soap and warm water after handling water samples.

Example:

Unicellular and Multicellular Organisms

Unicellular (single celled)		**Multicellular** (many celled)	
			
amoeba	paramecium	human	tree

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 8-1-09.

Suggested Learning Resources

Nelson Science & Technology 8 (Sections 1.12, 1.13)

Sciencepower 8 (Section 1.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-09 Describe why cells and tissues are specialized in multicellular organisms, and observe examples.

Include: specialization is needed because all cells in a complex organism do not have access to the external environment.

GLO: C2, D1

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Where Is the Water?**

Spruce, elm, aspen, and poplar trees are examples of trees that grow several metres high. Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to determine which part of the tree takes in water for the whole tree to use. (root)

Have students discuss what might be needed to transport water to the very top of the tree.

➢ **Transport in Plants**

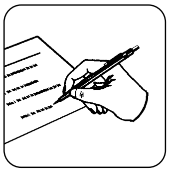
Have students observe transport in plants, following these steps:

- Cut off the bottom 2 cm of the root tip of a carrot.
- Place the carrot into a beaker with 5 mL of coloured water.
- Wait overnight.
- Remove the carrot from the dyed water and cut the carrot lengthwise.
- Draw a diagram of your observations in your science notebook.

Have students answer the following questions in their science notebooks:

1. Did the coloured water go up evenly through all the cells in the carrot or did it travel only in some cells? (some cells)
2. Using research, identify the specialized cell structure that allows the transport of water to cells that are not near the water at the root tip of a carrot. (xylem)
3. Why do multicellular organisms need to have specialized cells? (Specialization is needed because not all cells in a complex organism have access to the external environment. All cells need to receive nutrients and oxygen and get rid of wastes.)
4. What are some specialized cells within the human body? (blood, nerve, muscle)
5. Using a microscope, view some prepared slides of specialized cells and diagram them. (Examples: muscle, blood, bone, nerve, epithelial.)

Suggestions for Assessment



Extended Response

Provide students with the following:

Cell Specialization

Explain why cells and tissues are specialized in multicellular organisms. Use examples to support your answer.

Scoring Rubric	
Score	**Criteria**
4	The response is correct and detailed. It contains examples to support the answer. It includes evidence of higher-order thinking.
3	The response is correct and complete. It contains examples to support the answer.
2	The response is generally correct and complete, but may contain minor errors. It contains limited examples to support the answer.
1	The response is partially correct but is incomplete and/or contains major errors. No examples are provided.

Teacher Notes

Further investigation into osmosis and the transport of water in plants can be done by observing a stalk of celery or a white carnation with the cut stem ends placed in coloured water. After a day or two, the celery may be cut at intervals and xylem tubes may be seen. In the case of the carnation, the colour of the flower itself will change. Students may also inquire about the cause of the water rising up the tube. Direct students to further research topics such as transpiration in plants, osmotic pressure, and capillary and adhesive properties of water.

Suggested Learning Resources

Nelson Science & Technology 8 (Sections 1.12, 1.15)

Sciencepower 8 (Section 2.4)

Cells and Tissues (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-10 Describe structural and functional relationships among cells, tissues, organs, and systems.

GLO: D1, E2

SUGGESTIONS FOR INSTRUCTION

➢ **Levels of Organization**

Show students slides or pictures of cells, tissues, organs, and systems. Highlight the progression in levels of organization from cell to system.

Example:

1. Cells (e.g., muscle cells) have a particular structure and function.
2. Groups of similar cells form tissues (e.g., muscle tissue) that perform a specific function.
3. Groups of different tissues form organs (e.g., heart) that work together to perform a particular function.
4. Groups of different organs work together in organ systems (e.g., cardiovascular system) to perform a specific function.
5. Groups of different systems work together in an organism to perform all life processes.

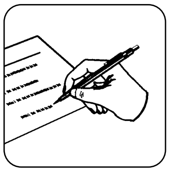
➢ **Analogy**

Have students develop and describe an analogy for the levels of organization (from cells to systems).

Example:

1. Individual students play specialized positions (e.g., quarterback, defensive lineman) on a football team. (cells)
2. Groups of players form the offensive line with the function of scoring a goal. (tissue)
3. The offensive and defensive lines work together as a team. (organ)
4. Two teams play each other as part of a game. (system)
5. All the games are part of a league. (organism)

Suggestions for Assessment



Extended Response

Have students complete a Word Cycle (Szabos, 1984) showing the relationships among the following: *cell, tissue, organ, organ system, cell structure, unicellular organism, multicellular organism, and cell theory*.

(For a BLM of a Word Cycle, see *SYSTH*, Attachment 10.1, or *Success*, p. 6.99.)

Scoring Rubric

Score	Criteria
3	All connecting phrases succinctly and accurately explain the relationships among terms.
2	Most connecting phrases accurately explain the relationships among terms.
1	Several connecting phrases are missing or show a lack of understanding of the relationships among terms.

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.12)

Sciencepower 8 (Section 3.1)

Cells and Tissues (Video)

Prescribed Learning Outcomes

Students will...

8-1-11 Describe the structure and function of the heart and the path of blood to and from the heart through its four chambers.

Include: atria, ventricles, septum, valves, aorta, pulmonary artery, pulmonary veins, superior vena cava, inferior vena cava.

GLO: D1, E1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…*
GLO: C6 (ELA Grade 8, 3.2.2)

8-0-9e ➲ Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.
GLO: B5

(continued)

Suggestions for Instruction

➢ The Heart

Have students view videos, virtual dissections, and/or CD-ROM clips about the heart. Ask them to label a diagram of the heart with the following terms: *atria, ventricles, septum, valves, aorta, pulmonary artery, pulmonary veins, superior vena cava,* and *inferior vena cava.*

Have students answer the following questions in their science notebooks:

1. The heart acts like a _________ to push blood through the circulatory system. (pump)
2. What type of tissue is the heart made of? (muscle)
3. _________ open and close entryways into the ventricles and the pulmonary artery and aorta. (valves)
4. Which ventricle pumps the blood to the body? (left)
5. What is the name of the largest artery? (aorta)

Teacher Notes

Heart Observation Stations

Learning outcome 8-1-11 does *not* require students to participate in dissecting a heart. However, the following suggested learning activities provide students with opportunities to examine the parts of a heart by viewing a previously dissected pig heart.

Provide alternative learning experiences for those students who do not wish to view an actual heart. Various Internet sites (such as <http://www.heartlab.rri.on.ca/dissect/dissection.html>) show pictures of pig or sheep heart dissections, along with dissection instructions.

Preparation

To set up the heart observation stations, obtain and dissect a pig heart. Review safety precautions with students and stress the importance of treating the pig heart in a respectful manner.

- *Heart Specimens:* Pig hearts can be obtained for a nominal fee at a meat packing plant. These specimens often have clots of blood in them and may have part of the aorta and/or an atrium removed. Pig hearts from a scientific supplier are cleaned and intact. If using prepared specimens, be sure to rinse hearts to remove some of the chemical preservatives.
- *Heart Dissection:* One suggested method of dissection is cutting across the apex of the pig heart and observing the differences in the muscle thickness of each ventricle.
- *Safety Precautions:* Discuss with students the importance of lab safety when dealing with dissected materials (see *Science Safety: A Kindergarten to Senior 4 Resource Manual for Teachers, Schools, and School Divisions*, 1997, pp. 11.5-11.6).

(continued)

Suggestions for Assessment

Refer to the assessment strategy suggested for learning outcome 8-1-12.

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.22)

Sciencepower 8 (Sections 3.3-3.4)

Prescribed Learning Outcomes
Students will...
8-1-11 *(continued)*

Suggestions for Instruction

(continued)

➢ **Heart Observation Stations**

Work with small groups of students at the following heart observation stations.

Station 1: Observing a Pig Heart

Have students, using their diagrams from the previous learning experiences, make labelling flags by putting dissection pins through small pieces of paper. Have them flag/label as many of the parts of the previously dissected pig heart as they can.

OR

Have students, using their diagrams, make labelling flags from small pieces of paper and tape them to the corresponding parts of a commercially purchased heart model.

Station 2: Pathway of Blood through the Heart

Have students trace the pathway of blood through the heart, beginning with the vena cava (superior or inferior) and ending with the aorta, and record its path in their science notebooks. Ask students to indicate where the blood is oxygenated (high in oxygen) and where it is deoxygenated (low in oxygen).

Station 3: Listening to the Heart

Have students listen to their own heartbeats and those of a classmate. (Having a partner of the same sex usually prevents any uneasiness with a stethoscope.) Have students attempt to discern between the sounds of the atria contracting (soft beat-lub) and the sounds of the ventricles contracting (harder beat-dub). Ask students to determine their heart rate by counting the number of beats per minute.

Safety Precaution: Remind students to exercise extreme caution when using a stethoscope. They should not talk into stethoscopes or bang them while someone is using them. This could lead to serious ear damage.

Station 4: Heart Puzzles

Have students complete heart and circulatory system puzzles. Puzzles, worksheets, and information pamphlets can be obtained from the Heart and Stroke Foundation of Manitoba (telephone: 204-949-2000).

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-12 Compare and contrast the structure and function of arteries, veins, and capillaries.

GLO: D1, E1

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ Blood Vessels

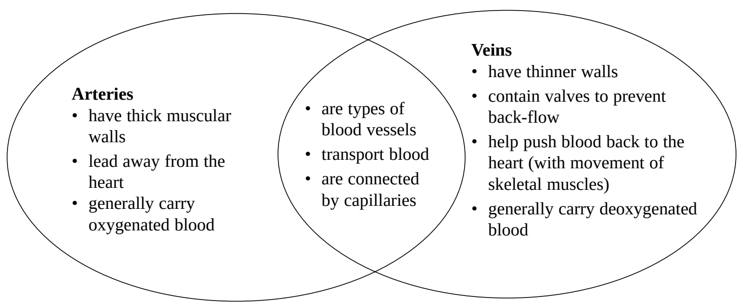
Use explicit instruction to

- introduce the concept that blood vessels are the passageways in the transport (circulatory) system
- describe the structure and function of the three main types of blood vessels (arteries, veins, and capillaries)

Have students use a Compare and Contrast sheet or a Venn diagram to illustrate their understanding of the similarities and differences between veins and arteries and ask them to include a cross-section diagram for each.

(For a BLM of a Compare and Contrast sheet, see *SYSTH*, Attachment 10.4, or *Success*, p. 6.103.)

Example:



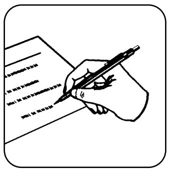
Have students answer the following questions about capillaries in their science notebooks:

1. Describe the characteristics of a capillary. (It is one cell thick and links arteries to veins.)
2. What is the role of the capillary? (It is the location of diffusion/osmosis of nutrients, gases, and wastes.)

Teacher Notes

Links can be made to Grade 8, Cluster 3: Fluids, as well as to learning outcome 8-1-07.

SUGGESTIONS FOR ASSESSMENT



Restricted Response

(Learning outcomes 8-1-11 and 8-1-12)

Provide students with the following:

Circulatory System

Name the

1. smallest blood vessel where gas and nutrient/waste exchange occurs ◯ _ _ _ _ _ _ _ _
2. blood vessel that has a thin wall, has valves, and carries blood back to the heart _ _ ◯ _
3. blood vessel that has thick muscular walls and carries blood away from the heart _ ◯ _ ◯ _ _
4. thick muscular portion of the heart that pumps blood into arteries _ _ _ _ _ _ ◯ _ _
5. type of tissue of which the heart is made _ ◯ ◯ _ _ _
6. the sound that is heard through a stethoscope when listening to the heart ◯ _ _   _ _ _
7. structures within the heart that close off the passageways between ventricles, atria, and blood vessels _ ◯ _ _ _ ◯
8. group of organs working together to perform a function _ ◯ _ ◯ _ _
9. largest artery in the body _ ◯ _ _ _
10. upper chambers of the heart _ ◯ ◯ _ _
11. artery and vein that transports blood to and from the lungs _ _ _ ◯ _ _ _ _ ◯

Use the circled letters to form hidden words:

_ _ _ _ _ _ _ _ _ _ _   _ _ _ _ _ _

Look for:

1. capillary
2. vein
3. artery
4. ventricle
5. muscle
6. lub dub
7. valves
8. system
9. aorta
10. atria
11. pulmonary

Hidden words: circulatory system

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 1.22)

Sciencepower 8 (Section 3.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-13 Identify components of blood and describe the function of each.

Include: red blood cells carry oxygen; white blood cells fight infection; platelets clot blood; plasma is the liquid part of blood that transports blood cells, dissolved material, nutrients, and waste products.

GLO: D1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…*
GLO: C6 (ELA Grade 8, 3.2.2)

SUGGESTIONS FOR INSTRUCTION

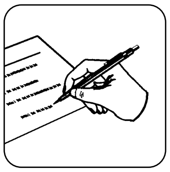
➢ **Viewing Components of Blood**

Provide students with a list of the major components of blood (*red blood cells, white blood cells, platelets,* and *plasma*) and have them use print and/or electronic resources to obtain information about the function of each component. This would be an opportunity for students to practise using search tools on the Internet.

In addition, have students use a microscope to view prepared slides of blood cells. Ask them to organize their information and observations for each component of blood using the Three-Point Approach (Simons, 1991).

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success,* p. 6.101.)

Suggestions for Assessment



Restricted Response

Note: This learning activity may be used as an Exit Slip. Provide students with the following:

Vocabulary Review

Choose the word or phrase from the list below that best describes the definition.

red blood cell	white blood cell	platelets	plasma

1. ________________ the fluid portion of blood that transports blood cells, nutrients, wastes, dissolved gases, hormones, and antibodies.
2. ________________ contain(s) hemoglobin and carries oxygen.
3. ________________ combat(s) infections.
4. ________________ clot(s) blood.

Look for:
1. plasma
2. red blood cell
3. white blood cell
4. platelets

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.15)

Sciencepower 8 (Section 3.4)

Prescribed Learning Outcomes

Students will...

8-1-14 Describe, using examples, how individual systems in the human body function interdependently.

GLO: D1, E2

8-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

Suggestions for Instruction

➢ **Web of Life**

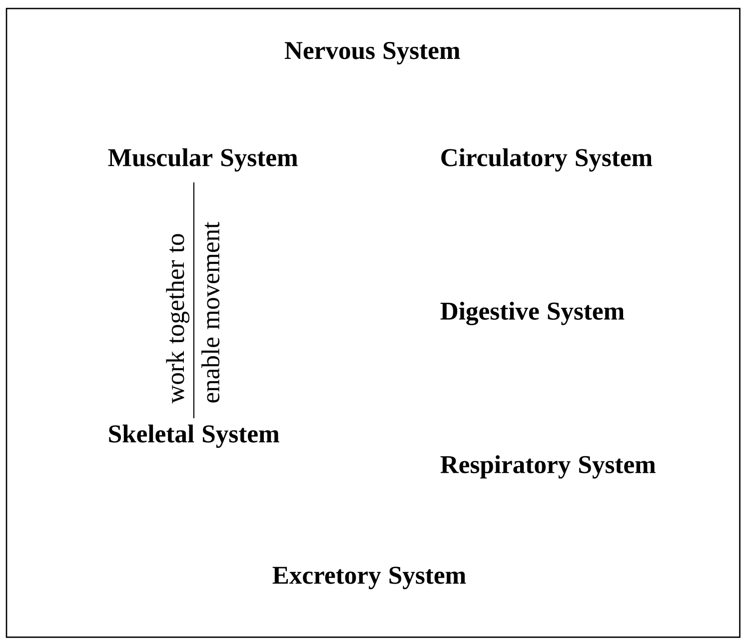
Have students place the names of the major body systems in a circle around the edge of a blank piece of paper. Ask them to make as many connections as possible among the systems by joining them with lines and writing on the lines how the systems are related.

Example:

Teacher Notes

Background information on the body systems can be found in Grade 5, Cluster 1: Maintaining a Healthy Body.

Word Web



Suggestions for Assessment

Journal Reflection

Have students reflect on the following in their science journals:

Interdependence

1. Why is it important for you to be aware of how your body systems are interdependent?
2. Why is it important for your doctor to be aware of how body systems are interdependent?

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.21)

Sciencepower 8 (Section 3.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-15 Compare heart rate and respiratory rate before, during, and after various physical activities; explain the observed variations; and discuss implications for overall health.

GLO: B3, C2, D1, E3

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-1b ➲ Select and justify a method to be used in finding the answer to a specific question. GLO: C2 (ELA Grade 8, 3.2.3; Math: SP-II.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I-1.8)

8-0-3b Identify the independent and dependent variables in an experiment. GLO: A2, C2

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Effects of Activity Level on Heart and Respiratory Rates**

Part A: Finding a Pulse

Have students find their pulse using their index and middle fingers, not the thumb. Good locations for finding the pulse include the underside of the left wrist (down from the thumb to the wrist area), the carotid arteries in the neck (just below the jawbone), and the temple. Students can calculate their pulse rate by counting their pulse for 10 seconds and then multiplying by six.

Part B: Designing an Experiment

Have students plan and conduct an experiment to answer the following question: How does activity level affect heart rate and respiratory rate? Ask students to graph their data.

Sample Data Table:

Heart and Respiratory Rates

Activity	Sitting	Standing	Running on the spot for two minutes	Four minutes after running
Heart Rate				
Respiratory Rate*				

*Calculate the respiratory rate by counting how many breaths are taken in 10 seconds and then multiplying by six.

For instructional and assessment suggestions to aid students in understanding the process of collecting data, grouping data, displaying data, and drawing conclusions from data, refer to *Grades 5 to 8 Mathematics: A Foundation for Implementation*, Statistics and Probability, pp. C26-C43, and Appendix (Teacher Information: Venn, Tree, and Carroll Diagrams; and Graphs, Tables, and Lists).

Have students answer the following questions in their science notebooks:

1. Why does your respiratory (breathing) rate increase as your activity level increases?

   (Muscles need oxygen to create energy to move. When your activity level increases, your breathing rate increases so that you can get more oxygen.)

(continued)

Suggestions for Assessment

Teacher Notes

This learning activity provides an opportunity to demonstrate the link between the respiratory and circulatory systems. Emphasize that the harder the body works, the greater the demand for oxygen and "nutrients" from the cells will be. Therefore, the respiratory system will need to work faster to provide more oxygen and dispose of increased amounts of carbon dioxide. In order for the respiratory system to achieve this, the circulatory (transport) system also must work faster. Both of these can be measured by recording pulse rate and respiratory rate.

Allow students with health concerns to opt out of the physical portion of Part B of the suggested learning activity and provide them with another student's data or fictitious data.

Refer to *Kindergarten to Senior 4 Physical Education/Health Education: Manitoba Curriculum Framework of Outcomes for Active Healthy Lifestyles* (2000) for related learning outcomes and teacher support.

Suggested Learning Resources

Sciencepower 8 (Section 3.0)

Prescribed Learning Outcomes

Students will...

8-1-15 *(continued)*

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6a Construct graphs to display data, and interpret and evaluate these and other graphs. *Examples: circle graphs…* GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.7; TFS: 4.2.2–4.2.6)

8-0-6b ➲ Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

8-0-6c ➲ Identify strengths and weaknesses of different methods of collecting and displaying data, and potential sources of error. GLO: A1, A2, C2, C5 (ELA Grade 8, 3.3.3)

8-0-6f ➲ Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 8, 3.3.4)

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

8-0-7b ➲ Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

Suggestions for Instruction

(continued)

2. Why does your heart rate increase as your activity level increases?

   (As your activity level increases, your cells need more oxygen and nutrients to fuel your muscles. This means that the circulatory system has to transport more oxygen and nutrients to the muscle cells and, therefore, the heart has to beat faster.)

3. What are some factors, other than increased activity level, that might affect your breathing rate?

   (Breathing rate can be affected by a variety of factors: respiratory system illnesses such as colds, asthma, pneumonia, and emphysema; other illnesses that require more oxygen for cells; smoking, which may cause passageways to work less effectively and, therefore, work harder to acquire oxygen; stress and anxiety.)

4. What potential sources of error may have occurred while you were collecting data?

   (Perhaps you could not find your pulse, were taking your pulse with your thumb, the pulse became weak and you lost sensation of it, or you lost count.)

5. The heart rate you recorded while sitting is called your basal or resting heart rate. Why might not everyone have the same basal heart rate?

   (Differences in basal heart rate may be due to factors such as physical condition, health, and metabolism.)

6. Why might heart rates differ from student to student after they run for two minutes?

   (Heart rates may vary, depending on the physical condition, health, running pace, etc. of the individual runners.)

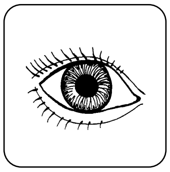
7. How soon your heart rate returns to normal depends on your physical condition. What are some things you can do to keep your heart healthy and in good condition?

   (You can exercise, maintain a healthy diet, avoid smoking, and so on.)

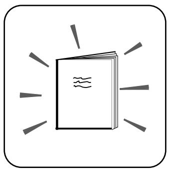
Suggestions for Assessment

Suggested Learning Resources

Refer to the following BLMs for assessing Part B: Designing an Experiment.



"Conducting a Fair Test: Observation Checklist" (BLM 8-Q)



"Experiment Report: Assessment Checklist" (BLM 8-S)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-16 Identify components of the primary and secondary defence systems of the human body, and describe their roles.

Include: primary defence system—skin, tears, ear wax, saliva, gastric juices, cilia hairs; secondary defence system—white blood cells, antibodies.

GLO: D1, E2

8-1-17 Identify medical advances that enhance the human body's defence mechanisms and describe their effects on society.

Examples: vaccines, antibiotics...

GLO: A5, B1, B2, B3

8-0-1c Identify practical problems to solve. *Examples: How can I make water flow uphill? Which type of bottled water should I buy?…* GLO: C3

8-0-1d ➲ Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.8)

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

8-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow. GLO: C3, C6

8-0-4b ➲ Construct a prototype. GLO: C3

8-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

8-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

SUGGESTIONS FOR INSTRUCTION

➢ Research Project

Have students brainstorm ways in which the body defends itself and ways in which medical advances enhance the body's defence mechanisms. (Students have had cluster-related experience in Grade 5, Cluster 1: Maintaining a Healthy Body.) Compile student responses into a class chart. Add other applicable components (see the "Include" portion of learning outcome 8-1-16 and the "Examples" portion of learning outcome 8-1-17).

Have students work in groups to research an assigned component of the body's defence system or a medical advance that enhances the body's defence mechanism. Have students share their findings and compile them into a class reference resource (to be used in conjunction with the following learning experience).

➢ Creating a Board Game: Defend Your Health

Using the design process, have students create a board game that incorporates information derived from the class research findings (about the body's defence system and medical advances related to this system) from the previous learning experience. As a class, develop criteria to assess the game (e.g., type of game, number of players).

8-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

8-0-7e ➲ Identify new practical problems to solve. GLO: C3

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

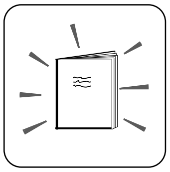
8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

8-0-8b ➲ Describe examples of how scientific knowledge has evolved in light of new evidence, and the role of technology in this evolution. GLO: A2, A5, B1

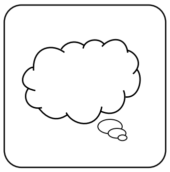
8-0-8d ➲ Describe examples of how technologies have evolved over time in response to changing needs and scientific advances. GLO: A5, B1, B2

8-0-8g ➲ Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

Suggestions for Assessment



Refer to "Design Project Report: Assessment" (BLM 8-P) when assessing students' Defend Your Health board games.



Peer Assessment: Defend Your Health Board Game

Provide students with the following tool for peer assessment of board games:

Peer Assessment of Board Game

Board game developers: ____

Peer assessors: ____

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
• game instructions are clear and easy to follow	1	2	3	4	5
• game shows creativity	1	2	3	4	5
• game is aesthetically pleasing	1	2	3	4	5
• game content includes reference to — all primary defense systems (skin, tears, ear wax, saliva, gastric juices, and cilia hairs) — secondary defense systems (white blood cells and antibodies) — vaccines and antibodies	1	2	3	4	5

Constructive comments:

Suggested Learning Resources

Nelson Science & Technology 8 (Section 1.16)

Sciencepower 8 (Chapter 3—Ask an Expert)

Prescribed Learning Outcomes

Students will...

8-1-18 Research and describe disorders/diseases that affect body systems, and identify possible preventative measures.

Examples: liver disease, diabetes, multiple sclerosis, heart attack, stroke, high/low blood pressure, leukemia, anemia, high cholesterol...

GLO: B3, C6, D1

8-0-2a Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-4c Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4d Identify and assume various roles to achieve group goals. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-7g Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

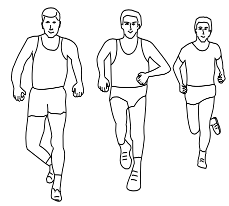
8-0-7h Identify and evaluate potential applications of investigation results. GLO: C4

Suggestions for Instruction

➢ **Synectics**

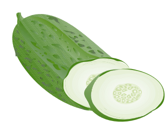
Place each of the following pictures on a separate card. Have students form small groups and give one picture to each group, asking students to list some qualities/characteristics about their picture (e.g., identify what it is made of, its use), make a connection between their picture and the human defense system, and share their findings with the class.

castle



sports team

sunscreen



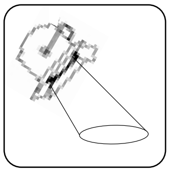
cucumber

➢ **Research Project**

Have students, working in groups, use various forms of research materials (e.g., videos, health pamphlets, Internet resources, print texts, interviews) to obtain information about a disorder/disease that affects body systems. Ask students to present their findings in a short class presentation that incorporates visuals (e.g., a short film/video clip, pictures, audio/video clips of an interview, computer-generated presentation, pamphlets, sphygmomanometer [blood pressure cuff], stethoscope).

(For instructional and assessment suggestions to aid students in developing appropriate delivery skills for use in presentations, as well as public listening and viewing behaviours, refer to *5-8 ELA*, learning outcomes 4.4.2–4.4.3.)

Suggestions for Assessment



Peer Assessment: Oral Presentation

Provide students with the following tool for peer assessment of research report presentations:

Peer Assessment of Research Report					
Presenters: ____________					
Topic: ____________					
Peer Assessor: ____________					
Rating Scale					
Criteria	**Poor**		**Good**		**Excellent**
The speaker					
• spoke so that everyone could hear	1	2	3	4	5
• described the condition/ disease	1	2	3	4	5
• described factors that caused the condition	1	2	3	4	5
• described possible preventions	1	2	3	4	5
• used visuals	1	2	3	4	5
• kept the interest of the group	1	2	3	4	5
Constructive comments:					

Suggested Learning Resources

Sciencepower 8 (Sections 2.3, 3.3-3.4, Chapter 3—Ask an Expert)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-1-19 Describe functional similarities and differences of comparable structures and systems in different groups of living things.

Examples: movement, food intake, and digestion of a unicellular organism, an invertebrate, and a vertebrate; gas exchange in plants versus animals...

GLO: D1, E1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

SUGGESTIONS FOR INSTRUCTION

➢ **Comparing Living Things**

Ask students to research print and electronic texts for information on how systems and structures in different organisms compare to each other. Have them organize their information in chart form.

Example:

Comparison of Structures and Systems in Living Organisms

	Paramecium	**Frog**	**Geranium Plant**	**Human**	**Invertebrate**
Movement					
Food Intake					
Digestion					
Gas Exchange					

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8 (Sections 1.13, 1.18-1.19, 1.21-1.23)

Sciencepower 8 (Sections 3.2-3.3)

Notes

Grade 8

Cluster 2: Optics

Overview

In this cluster, students broaden their understanding of how light is produced, transmitted, and detected. Students identify colours as different wavelengths of light, and explore why objects appear to have colour. Various types of electromagnetic radiation are compared. The potential positive and negative impacts of technological devices that use electromagnetic radiation are discussed. Students explore the principles and properties of reflection and refraction, and their application in everyday situations. Students investigate the characteristics of concave and convex mirrors and lenses. They enhance their understanding of how these devices function in a variety of optical tools. Students also demonstrate the formation of images using lenses and compare the function of the human eye to that of a camera lens.

Prescribed Learning Outcomes

Students will...

8-2-01 Use appropriate vocabulary related to their investigations of optics.

Include: spectrum, additive theory; subtractive theory; frequency; wavelength; refraction; concave and convex mirrors and lenses; terms related to types of light sources, types of electromagnetic radiation, and the law of reflection.

GLO: C6, D3

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 4, Cluster 2: Light.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Three-Point Approach**

Have students use the Three-Point Approach (Simons, 1991) to write a definition of a term in their own words, represent it with a picture/diagram, and give an example or synonym.

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-02 Differentiate between incandescent and luminescent sources of light.

Include: fluorescent, phosphorescent, chemiluminscent, bioluminescent.

GLO: D3, D4, E1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Incandescent Versus Luminescent Light Sources**

Part A: Observing Light Sources

Provide students with samples of

- *incandescent light* sources such as a candle and a lamp with an incandescent bulb
- *luminescent light* sources such as a fluorescent light and a glow stick

Have students observe the two types of light sources, noting distinctions and relationships between them. Ask students to fill out a Concept Relationship Frame (Matchullis and Mueller, 1994), including examples. Students should leave spaces beside the examples to classify them as fluorescent, phosphorescent, chemiluminescent, or bioluminescent after completing Part B below.

(For a BLM of a Concept Relationship Frame, see *SYSTH*, Attachment 11.1, or *Success*, p. 6.104.)

Part B: Identifying Types of Luminescent Light

Have pairs of students identify which of the following terms and definitions best suits each example cited in their Concept Relationship Frame (begun in Part A above) and explain why. Have two sets of pairs compare and discuss their answers and reach a consensus. Following a class discussion, ask students to return to their Concept Relationship Frame and identify the type of luminescent light each example represents.

Terms and Definitions

Luminescent light is divided into four categories:

- *Fluorescent light* gives off light only while it is supplied with electrical energy. Generally, fluorescent bulbs are in the shape of a tube. The electricity reacts with the chemicals within the tube. Because fluorescent bulbs are highly energy efficient, smaller tube bulbs have been manufactured to be used in home lighting.
- *Phosphorescent light* continues to give off light even after the initial source of energy is taken away.
- *Chemiluminescent light* occurs when a chemical reaction between substances gives off light without creating heat.
- *Bioluminescent light* is a form of chemiluminescence that occurs in living organisms.

SUGGESTIONS FOR ASSESSMENT

Extended Response

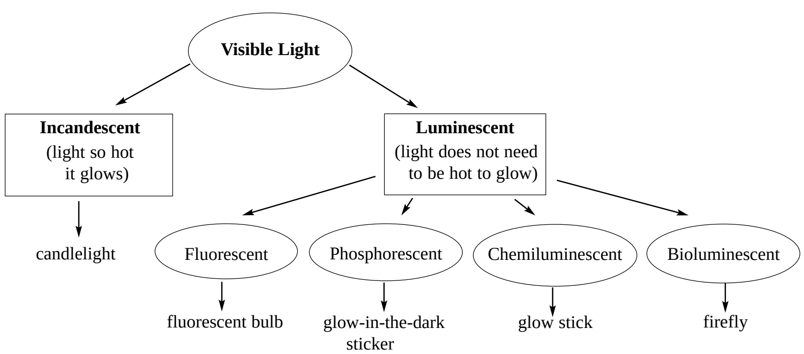
Provide students with the following:

Light Concept Map

Create a concept map to show the relationships among the following terms: *visible light*, *incandescent*, *luminescent*, *fluorescent*, *phosphorescent*, *chemiluminescent*, *bioluminescent*, *hot*, *not hot*, *candlelight*, *glow stick*, *fluorescent bulb*, *glow-in-the-dark sticker*, and *firefly.*

Look for:
- visible light is divided into two types: incandescent (hot) and luminescent (not hot)
- incandescent light is described as a light source that burns so hot it glows, whereas luminescent light is not hot
- luminescent light is divided into four types: fluorescent, phosphorescent, chemiluminescent, and bioluminescent
- examples of each type of incandescent and luminescent light are given

Example:



SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 5.1)

Sciencepower 8 (Section 7.1)

Prescribed Learning Outcomes

Students will...

8-2-03 Demonstrate that light is a form of energy, that light travels in a straight line, and can be separated into the visible light spectrum.

GLO: A1, C1, C2, D4

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

(continued)

Suggestions for Instruction

➢ Activating Prior Knowledge

Have students fill out a Knowledge Chart (Matchullis and Mueller, 1994) indicating what they know about light energy. Ensure that students revisit the chart throughout the study of this cluster or as a culminating learning activity at the end of the cluster.

(For a BLM of a Knowledge Chart, see *SYSTH*, Attachment 9.2, or *Success*, p. 6.96.)

➢ Light Is a Form of Energy

Remind students that *energy* is the ability to make things move or produce a change in materials.

Place a radiometer on an overhead projector and have students observe the motion of the vanes within the radiometer. (Radiometers are commonly found in Senior Years science labs. The black vanes and white vanes of the radiometer begin moving as light energy is absorbed by the black side of the vanes.) Ask students to describe in their science notebooks how the radiometer proves that light is a form of energy.

➢ Pinhole Camera

1. Have students build a pinhole camera out of an empty shoe box or tissue box, following these directions:
   - Cut out one end of the box and place wax paper on the newly opened end.
   - On the other end, cut out a 4 cm^2 hole and then cover it with smooth tinfoil. (If students are using a tissue box, the top opening should be covered with cardboard. Students could also use two cylindrical chip containers taped together end to end.)
   - Create a tiny hole in the centre of the tinfoil using the point of a pin.
2. Before students look at a lit candle or an object with their pinhole camera, have them predict what the image will look like on the wax paper of their cameras.
3. Ask students to aim their cameras toward a candle. They can stand two to three metres away from the candle and look at (not through) the wax paper end. If the classroom has a window through which trees or buildings are visible, turn off the lights in the room and have students aim the cameras at the window. Students can then draw the object they see on the wax paper and compare it to what they predicted they would see. (The image will appear upside down.)

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8 (Section 5.2)

Sciencepower 8 (Sections 7.1, 9.1)

Addison Wesley Science & Technology 8: *Optics* (Sections 1.0, 6.3)

The Electromagnetic Spectrum (Video)

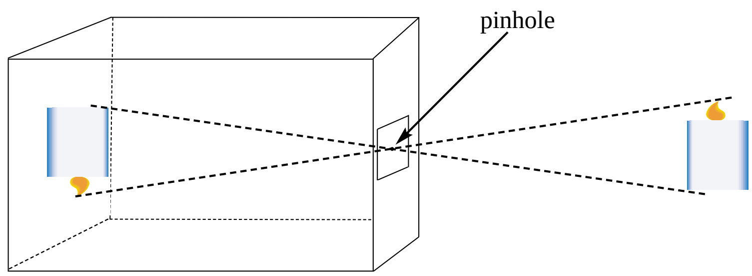
Prescribed Learning Outcomes
Students will...
8-2-03 *(continued)*

Suggestions for Instruction

(continued)

4. Have students draw the camera and the object in their science notebooks. Remind students that light travels in straight lines. Have them draw lines in their illustrations to show how the light is travelling to create the image they saw.

   Example:



➢ **Visible Light: A Spectrum of Colours**

Have students, using a powerful flashlight, shine a white ray of light through a prism and observe the colours of light that appear. Inform students that these colours make up what is called the *visible light spectrum*, and the separating of white light into a spectrum is called *dispersion*. Have students record the colours of the spectrum in their science notebooks.

Discuss with students the concept of mnemonics as a tool for remembering ideas (e.g., using the first letter of a term as the first letter of a word in a catchy phrase). Have students create a mnemonic that will assist them in remembering the order of colours in a spectrum.

Teacher Notes

Background Information

The colours that make up the visible light spectrum are: red, orange, yellow, green, blue, (indigo), and violet. There has been some recent debate in the science community with respect to the inclusion of the colour indigo. Some texts may include it, while others may not.

Suggestions for Assessment

Extended Response

Provide students with the following:

Light

You have been asked to prove to a younger student that the following statements are true. Write a position paper clearly indicating what proof you have to offer. (Use recent learning experiences, as well as any other examples you can think of.)

1. Light is a form of energy.
2. Light travels in a straight line.
3. Light can be seperated into different colours.

Look for:

- explanations are clearly stated
- examples (proof) are provided

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-04 Explain, using the additive theory, how colours are produced, and identify applications of this theory in daily life.

GLO: A1, A2, B1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6b ➲ Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Additive Theory of Colour**

Use explicit instruction to introduce to students the *additive theory of colour.* Have students experiment with colour combinations to determine what colours of light can be produced using only the three primary additive colours and light rays:

- Using three ray boxes/flashlights (one with a red gel or transparency film on it, one with a blue transparency on it, and one with a green transparency on it), shine different combinations of light onto a light-coloured surface.
- Record information on a chart, listing the colour combinations and the subsequent new colour created. (An overhead projector may be used instead of light boxes.)

  Example:

Additive Colour Combinations

Primary Additive Colours	**Secondary or Resulting Additive Colours**
blue + red + green	white
blue + red	magenta
blue + green	cyan
green + red	yellow

The following websites allow students to manipulate primary additive colours to demonstrate the resulting colour mixes, or secondary colours.

<*http://micro.magnet.fsu.edu/primer/java/light/primaryadd.html*>
<*http://mc2.cchem.berkeley.edu/Java/emission/Java%20classes/emission.html*>

Have students answer the following questions in their science notebooks:

1. The three initial colours used are called the primary additive colours. What are they? (blue, red, and green)
2. What secondary colours were created when only two of the primary colours were blended? (magenta, cyan, yellow)
3. What colour was created when all three primary colours were combined? (white)

(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Background Information

Visible white light is made up of a spectrum of colours; however, colours of light can also be perceived in other ways. The illusion of a particular colour of light can be created by combining specific coloured light rays. This adding of colours to create a second colour is called the *additive theory of colour.*

The primary additive colours are blue, red, and green. The secondary (or resulting) colours produced when two of the primary colours are mixed are magenta, cyan, and yellow. When all three primary colours of light are combined, they produce white light.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 5.18)

Sciencepower 8 (Section 9.1)

Addison Wesley Science & Technology 8: *Optics* (Sections 5.2-5.3)

The Electromagnetic Spectrum (Video)

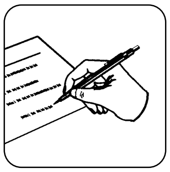
PRESCRIBED LEARNING OUTCOMES
Students will...
8-2-04 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

4. A colour television screen utilizes the three primary additive colours and the additive theory of colour to create the illusion of an array of colours. Each primary colour is in a separate row of lit dots. What combination of lit dots would be needed to create the colour of snow on television? (blue, red, and green)
5. Stage lighting also uses the concept of the additive theory of colour. Spotlights covered with gels or transparency film of the three primary colours may shine toward a light-coloured background. If a director wanted to create the illusion of a bright sunny day that progresses into a beautiful sunset and then into a restful evening, what types of colour combinations would be used and why? (The bright part of day may be represented by using all three colours to create a white light, or by combining red and green to create a yellow light. As the Sun sets, blue and red may be used to create a magenta sunset. Finally, blue and green may be used to create cyan, giving the illusion of evening.)

Suggestions for Assessment



Extended Response

Provide students with the following:

Light Colour Combinations

White light can be created by combining two complementary colours such as blue and yellow. The yellow contains the green and red that would complete the colour combination that creates white light. Explain why the following light colour combinations are able to create white light.

1. red + cyan = white
2. green + magenta = white

Look for:

1. Blue, green, and red are needed to create white light. Cyan is made of blue and green light. Therefore, all three primary colours are present to create white light.
2. Blue, green, and red are needed to create white light. Magenta is made of red and blue light. Therefore, all primary colours are present to create white light.

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-05 Explain how the human eye detects colour, and how the ability to perceive colour may vary from person to person.

GLO: A2, E1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

The retina of the human eye has *cone cells* that perceive colour. Some cone cells are sensitive to red, some to green, and some to blue.

➢ The Human Eye and the Perception of Colour

To enable students to broaden their understanding of the ability to perceive colour, have them

- use a variety of resources to obtain information on how the eye perceives colour and on the nature and causes of colour-blindness
- summarize this information in their science notebooks
- use this information and the additive theory of colour to identify the colour of the cone cells that would need to be activated for them to see the flame of a burning candle
- identify the colour that is perceived (red + green = yellow)

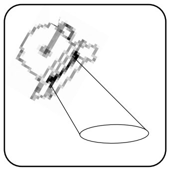
➢ What Colour Is It?

Darken the classroom and show students three different coloured objects (e.g., blue, red, and green balls). Have students note what colour they perceive each object to be. Slowly add more light to the classroom and, with each addition of light, have students record the colour of the objects. When the lighting has returned to normal, have students identify what affected their perception of the colour of each object. (The amount of light present affected the perception of colour.)

➢ Colour-Blindness

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to identify some situations where perception of colour is important, and where adaptive skills would have to be learned to cope with the challenge of colour-blindness (e.g., memorizing the order of lights on a traffic light, having clothes colour-coordinated).

SUGGESTIONS FOR ASSESSMENT



Evaluating Testimonies

Provide students with the following:

Evaluating Testimonies

Two witnesses were called to the stand to testify in a criminal case. Which of the following testimonies has a greater degree of validity, and why?

- *Witness A:* I saw two people running through the park around 10:00 p.m. The first one who ran by was wearing a bright red sweater. The second one wore a lime green sweater. It was dark and cloudy and there was no moon. The lights in the park were out due to a power failure.
- *Witness B:* I saw a person running through the park at approximately 10:00 p.m. Then a minute later another person ran by. I was unable to tell the colour of their clothes, although both wore sweaters. Both sweaters appeared dark but different shades. It was dark and cloudy and there was no moon. The lights in the park were out due to a power failure.

Scoring Rubric

Score	Criteria
4	The response is correct, complete, and detailed, indicating that Witness B's testimony has greater validity because light is needed to detect shades of colours. It contains examples and/or elaboration to support the answer (according to both witnesses the area was dark because of the time of day, weather conditions, and power failure; therefore, Witness A should not have been able to detect the correct colour of the sweaters worn). It includes evidence of higher-order thinking.
3	The response is correct and complete, indicating that Witness B's testimony has greater validity because light is needed to detect shades of colours. It contains examples and/or elaboration to support the answer.
2	The response is generally correct and complete. It may contain minor errors. It contains examples and/or elaboration to support the answer.
1	The response is partially correct but is incomplete and/or contains major errors. It contains no examples or elaboration to support the answer.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 5.18)

Sciencepower 8 (Section 9.1)

Addison Wesley Science & Technology 8: *Optics* (Section 5.3)

The Electromagnetic Spectrum (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-06 Demonstrate, using the subtractive theory, how colours are produced, and identify applications of this theory in daily life.

GLO: A2, B1

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

(continued)

SUGGESTIONS FOR INSTRUCTION

➢ What Colour Is It?

Investigate the mixing of pigments (magenta, cyan, and yellow) from paints or highlighter pens. Have students

- determine what colour results from mixing any two of the pigments, and from mixing all three
- record their information on a chart

Example:

Creating Colours

Colour Combinations	Resulting Colours
magenta + cyan	blue
magenta + yellow	red
yellow + cyan	green
magenta + cyan + yellow	black

Have students use a Compare and Contrast Frame (Matchullis and Mueller, 1994) to compare this method of creating new colours with the additive theory of colour (the mixing of coloured light).

(For a BLM of a Compare and Contrast Frame, see *SYSTH*, Attachment 10.4, or *Success*, p. 6.103.)

Example:

- Both methods mix primary colours to create secondary colours.
- One method uses coloured lights, whereas the other uses coloured pigments.

➢ Subtractive Theory of Colour

1. Use explicit instruction to introduce the *subtractive theory of colour* and to relate this theory to the previous learning activity. Demonstrate the subtractive theory by shining a blue light on a blue object, on a red object, and on a green object in a dark classroom. Ask students to state what colour each object is. (They should readily see the blue as blue but they will identify the other two as black.) Turn on the classroom lights and have students attempt to explain why they identified the red and green objects as black. (Only the blue object reflects blue light. The red and green absorb the blue. Since there was no red or green light available, the red and green objects absorbed the blue, thereby creating black.)

(continued)

SUGGESTIONS FOR ASSESSMENT

Teacher Notes

Background Information

If objects do not give off their own light, they are seen because light reflects off them. White light is actually made up of a spectrum of colours. Some substances only allow certain colours to be absorbed and whatever is not absorbed is reflected, thus determining the perceived colour of the object. The colour of the object is thus determined by subtracting all the colours that have been absorbed. This is referred to as the *subtractive theory of colour*.

The chemical that absorbs certain colours of light, but reflects others, is a *pigment*.

- The primary pigment colours are: yellow, cyan, and magenta (these are also the secondary light colours).
- The secondary pigment colours produced when two primary pigments are mixed are: red, green, and blue (the primary light colours).

Filters contain pigments and absorb some colours of light. For example, a blue filter absorbs red and green light and transmits blue. Students can investigate the effect of coloured light on pigments, but this is not required to meet the learning outcomes.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Section 5.21)

Sciencepower 8 (Section 9.1)

Addison Wesley Science & Technology 8: *Optics* (Section 5.3)

Prescribed Learning Outcomes

Students will...

8-2-06 *(continued)*

Suggestions for Instruction

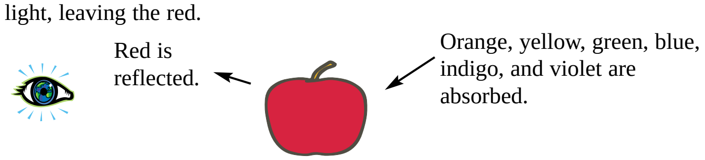
(continued)

2. Based on this information, have students use the terms *reflected* and *absorbed* to explain, in their science notebooks, why a red apple appears red in daylight. Ask them to include the colours that had to be subtracted/absorbed and draw a diagram depicting this phenomenon.

Example:

Why a Red Apple Appears Red in Daylight

A red apple only reflects red. The rest of the light spectrum is absorbed by the pigments in the skin of the apple. In order for the colour red to be seen, orange, yellow, green, blue, indigo, and violet are subtracted from the white light, leaving the red.



3. Have students add to their Compare and Contrast Frame (started in the previous learning activity) to include the primary and secondary colours for both the additive and subtractive theory of colour.

➢ **Consolidating Knowledge**

Have students answer the following questions in their science notebooks:

1. What is the resulting colour when yellow and cyan pigments are mixed? (green)
2. What primary pigments need to be mixed to create the secondary pigment blue? (magenta and cyan)
3. Why is black not a colour? (Black results when *no* colour is reflected.)
4. How are the primary pigment colours related to the secondary light colours? (They are the same.)

➢ **Applications of the Subtractive Theory of Colour**

Have students investigate the workings of a colour printer or invite a photographer to the class to explore the subtractive theory of colour at work in printers and/or photography.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Restricted Response

Provide students with the following:

Subtractive Theory of Colour

Circle the best answer to each of the following questions:

1. White light contains all the colours of the spectrum. According to the *subtractive theory of colour,* which colour is not being absorbed by a red apple?
   a. blue
   b. green
   c. magenta
   d. red
2. A white T-shirt
   a. absorbs all colours in the spectrum
   b. reflects all colours in the spectrum
   c. reflects only one colour and absorbs the rest
   d. absorbs only one colour and reflects the rest
3. What two pigment colours are needed to create the secondary pigment colour red?
   a. magenta and cyan
   b. magenta and yellow
   c. yellow and cyan
   d. blue and green
4. When combined, the three primary pigment colours create
   a. black
   b. white
   c. brown
   d. purple
5. A cyan filter absorbs which of the following colours?
   a. blue
   b. green
   c. red
   d. yellow

Look for: 1. d 2. b 3. b 4. a 5. c

Prescribed Learning Outcomes

Students will...

8-2-07 Compare and contrast various types of electromagnetic radiation, with respect to relative energy, frequency, wavelength, and human perception.

Include: radio waves, microwaves, infrared, radiation, visible light, ultraviolet radiation, X-rays, gamma rays.

GLO: D4, E1

8-0-2a ⊂ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7g ⊂ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

Suggestions for Instruction

➢ Introducing Waves

Introduce students to the concepts of *electromagnetic radiation* and the *electromagnetic spectrum*. Demonstrate how energy travels in waves by having students observe a still surface of water that is touched by a vibrating rod.

Have students describe what they saw and gain practical experience with determining wavelengths by completing “Waves” (BLM 8-B).

Teacher Notes

Background Information

Electromagnetic radiation describes a stream of massless particles, each travelling in a wave-like pattern at the speed of light, and containing a certain amount of energy. The *electromagnetic spectrum* is the term used to describe the whole range of different types of electromagnetic radiation, each with its own wavelength, frequency, and amount of energy. Types of electromagnetic radiation include: radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.

➢ The Electromagnetic Spectrum

Have students examine and represent various types of electromagnetic radiation, following these steps:

- Use print and/or electronic resources to identify and describe the various forms of electromagnetic radiation that make up the electromagnetic spectrum.
- For each type of radiation, include information on relative energy, wavelength, frequency, and human perception.
- Present information in a poster format that graphically illustrates the spectrum from long to short wavelength, with each type of radiation labelled in the appropriate location on the spectrum, along with associated details.

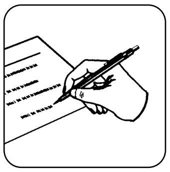
The following websites, for example, provide information regarding the electromagnetic spectrum:

<http://imagine.gsfc.nasa.gov/docs/science/>

<http://imagers.gsfc.nasa.gov/ems/waves3.html>

<http://radar.ou.edu/OK1/meteorology/Radiation.html>

SUGGESTIONS FOR ASSESSMENT



Extended Response:

Using a Concept Relationship Frame (Matchullis and Muller, 1994), have students compare and contrast two forms of electromagnetic radiant energy. (For a BLM of a Concept Relationship Frame, see *SYSTH*, Attachment 11.1, or *Success*, p. 6.104.)

Scoring Rubric	
Score	**Criteria**
4	The student describes both forms of electromagnetic radiation in terms of relative energy, frequency, wavelength, and human perception, and includes a summary statement that uses appropriate terminology and succinctly captures main ideas.
3	The student describes both forms of electromagnetic radiation in terms of relative energy, frequency, wavelength, and human perception, and includes a summary statement that uses appropriate terminology.
2	The student describes both forms of electromagnetic radiation, addressing at least three aspects of each, and provides a basic summary statement.
1	The student describes both forms of electromagnetic radiation, addressing at least two aspects of each.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Sections 5.15-5.16)

Sciencepower 8 (Sections 9.2-9.3)

Addison Wesley Science & Technology 8: *Optics* (Sections 6.1-6.2)

The Electromagnetic Spectrum (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-08 Provide examples of technologies that use electromagnetic radiation, and describe potential positive and negative impacts of their uses.

Examples: satellite dish, x-ray machine, light telescopes, motion sensors, microwave ovens…

GLO: A5, B1 D4

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

SUGGESTIONS FOR INSTRUCTION

➢ **Inquiry Project**

Using a Sample Inquiry Plan for Grade 8 (see *5-8 ELA*, Grade 8, pp. 184-185), have pairs of students research and develop a short written report (or an oral presentation) identifying

- a technology that uses electromagnetic radiation
- the type of electromagnetic radiation it uses
- the potential positive and negative effects of its use

Begin as a class by brainstorming technologies that use electromagnetic radiation and have students record the examples in the first box located on the Sample Inquiry Plan. Have each pair research a different type of technology, if possible, and work through the plan.

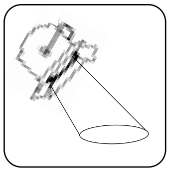
Provide direction with respect to type of audience. Lead a class discussion on evaluating information sources for accuracy, currency, usefulness, sufficiency (enough), and reliability (authority), and have students create criteria defining what is a good resource.

(For strategies to aid students in using a variety of information sources, determining the usefulness of information, constructing meaning, recording information, referencing, and evaluating sources, refer to *5-8 ELA*, learning outcomes 3.2.2-3.2.5 and 3.3.2-3.3.3.)

Possible Internet Sites:

- The website How Stuff Works provides information on how radio waves work and their many applications, ranging from baby monitors to deep space radio communications.
  <http://www.howstuffworks.com/radio-spectrum.htm>
- The fact sheet entitled "Are Electromagnetic Fields Hazardous to Your Health?" from Ohio State University contains information on electromagnetic radiation and its potential negative effects, as well as precautions to take.
  <http://www.ag.ohio-state.edu/~ohioline/cd-fact/0185.html>
- Washington State Department of Health has an informative site on Microwave Oven Radiation Safety.
  <http://198.187.0.42/ehp/rp/rp-oven.htm#microwaves>
- The article "Hung up on Mobile Phones" by an associate professor at the Department of Public Health and Community, University of Sydney, examines the issue of safety with electromagnetic radiation, particularly with cell phones.
  <http://www.studentbmj.com/back_issues/0999/editorials/307.html>

Suggestions for Assessment



Inquiry Project Oral Presentation

Provide students with the following tool for peer assessment of the oral presentations:

Peer Assessment of Research Report Presentation

Presenters: ____________________

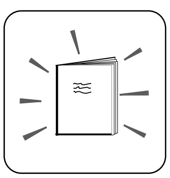
Technology: ____________________

Assessor: ____________________

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
The speaker					
• spoke so that everyone could hear	1	2	3	4	5
• described the technology	1	2	3	4	5
• identified the type of radiation used by the technology	1	2	3	4	5
• described possible positive and/or negative effects of its use	1	2	3	4	5
• used visuals	1	2	3	4	5
• kept the interest of the group	1	2	3	4	5

Constructive comment:



Written Report of Inquiry Project

When assessing students' inquiry projects, look for indications of the following:

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
The report					
• describes the technology	1	2	3	4	5
• identifies the type of radiation used by the technology	1	2	3	4	5
• describes possible positive and/or negative effects of its use	1	2	3	4	5
• includes pictures and/or diagrams	1	2	3	4	5
• is neat and legible	1	2	3	4	5

Constructive comment:

Suggested Learning Resources

Nelson Science & Technology 8 (Section 5.16)

Sciencepower 8 (Sections 9.2-9.3)

Addison Wesley Science & Technology 8: *Optics* (Section 6.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-09 Conduct experiments to determine the laws of reflection, and provide examples of the use of reflection in daily life.

Include: the angle of reflection is the same as the angle of incidence; the incident beam, the normal, and the reflected beam are all on the same plane.

GLO: A2, C1, C2, D4

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

8-0-6b ➲ Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

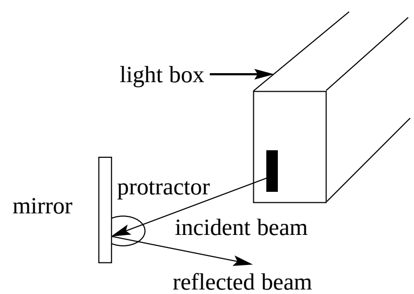
SUGGESTIONS FOR INSTRUCTION

➢ **Laws of Reflection Experiment**

Use explicit instruction to introduce students to the first *law of reflection*, which states that the incident beam (ray), the normal, and the reflected beam (ray) are all on the same plane (all occur on the same flat surface). As a result, the reflected beam will not bounce off in many directions but will follow a clear and predictable path.

Provide students with a commercial light box (or have them construct a light box), a flat/plane mirror, and a protractor. Have students plan and implement an experiment to determine the relationship between the angle of an incoming beam of light (incident beam) and the angle of an outgoing beam (reflected beam).

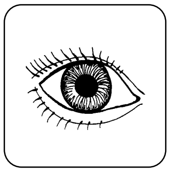
Example of possible set-up:



Ask students to record their observations as labelled beam diagrams, indicating measurements of the angles and including the following terms: *incident beam, reflected beam, angle of incidence, angle of reflection*, and *normal*. (The angle of incidence occurs between the incident beam and the normal, which is an imaginary line located at a 90° angle from the reflective surface, and the angle of reflection is between the reflected beam and the normal.)

Based on the data gathered, have students draw a conclusion that represents the *second law of reflection*. (The angle of incidence is equal to the angle of reflection.) Have students identify examples of the use of reflection in daily life. (cosmetology, rearview mirrors in cars, security mirrors, reflectors on jackets or bicycles, single-lens reflex cameras)

Suggestions for Assessment

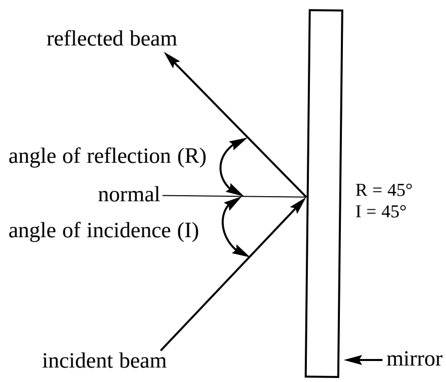


When assessing the Laws of Reflection experiment, refer to "Conducting a Fair Test: Observation Checklist" (BLM 8-Q).

Teacher Notes

For instructions on constructing a light box, refer to Grade 4, Cluster 2: Light. Use of a commercial light box is recommended to ensure that clear light beams are obtained for this learning activity and others.

Background Information - Laws of Reflection



Suggested Learning Resources

Nelson Science & Technology 8 (Sections 5.3-5.4)

Sciencepower 8 (Section 7.2)

Addison Wesley Science & Technology 8: *Optics* (Sections 2.0-2.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-10 Conduct experiments to compare the refraction of light through substances of different densities.

GLO: C1, C2, D4

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-1b ➲ Select and justify a method to be used in finding the answer to a specific question. GLO: C2 (ELA Grade 8, 3.2.3; Math: SP-II.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3b Identify the independent and dependent variables in an experiment. GLO: A2, C2

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6f ➲ Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 8, 3.3.4)

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

8-0-7c ➲ Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 8, 3.3.4)

SUGGESTIONS FOR INSTRUCTION

➢ Comparing Refraction through Substances of Different Densities

Have students plan and carry out an experiment to compare the *refraction of light* through substances of different densities (e.g., water, vegetable oil, shampoo, transparent acrylic), then identify the relative densities of the substances for students or have students identify them. For this experiment, students use their knowledge of angle of incidence and angle of refraction to develop a testable question, an hypothesis (that predicts a relationship between the dependent and independent variable), and record of procedures. They also make observations and draw conclusions.

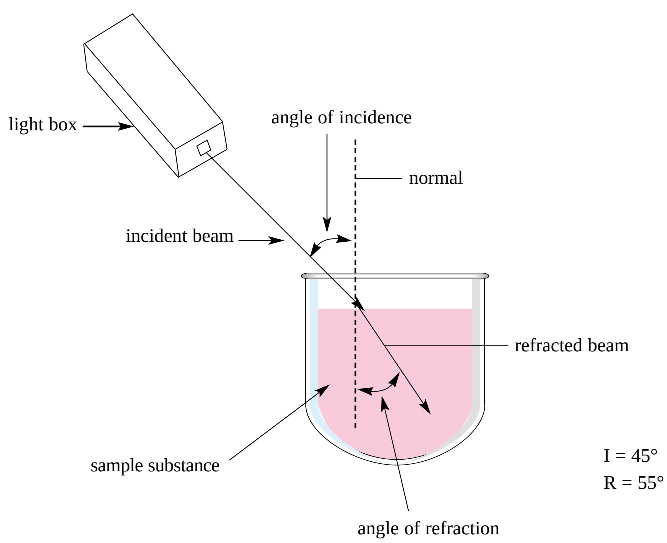
Note: this learning experience links to Grade 8, Cluster 3: Fluids, learning outcome 8-3-06.

Example:

- *Testable question:* What is the effect of the density (independent variable) of a substance on the size of the angle of refraction (dependent variable)?
- *Hypothesis/prediction:* The higher the density of a substance, the greater the size of the angle of refraction.

Have students draw labelled refraction beam diagrams for each substance tested, including the angle measurements.

Example:



Suggestions for Assessment

When assessing the Comparing Refraction through Substances of Different Densities, refer to "Experiment Report: Assessment" (BLM 8-S).

Refraction

Provide students with the following:

Refraction

You are cleaning out a large fish tank and you need to remove the fish inside the tank before emptying the water. When you place your net into the water, the fish are not where they appear to be. Why not? Include a labelled diagram with your explanation.

Scoring Rubric

Score	Criteria
4	The response is correct, complete, and detailed. It indicates that the light reflected off the fish has to travel through mediums of different densities, thus causing the light rays to refract (bend) and giving the appearance that the fish is in a different place than it actually is. The response contains example and/or elaboration to support the answer and includes an accurately drawn and labelled diagram. It includes evidence of higher-order thinking.
3	The response is correct and complete. It indicates that the light reflected off the fish has to travel through mediums of different densities, thus causing the light rays to refract (bend) and giving the appearance that the fish is in a different place than it actually is. The response contains examples and/or elaboration to support the answer and includes an accurately drawn and labelled diagram.
2	The response is generally correct and complete. It may contain minor errors. It contains examples and/or elaboration to support the answer and includes a labelled diagram which may contain a minor error or omission.
1	The response is partially correct but is incomplete and/or contains major errors. It contains no examples or elaboration to support the answer. The diagram is missing or contains major errors or omissions.

Suggested Learning Resources

Nelson Science & Technology 8 (Section 5.10)

Sciencepower 8 (Section 7.3)

Addison Wesley Science & Technology 8: *Optics* (Section 2.3)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-11 Explain how reflection and refraction produce natural phenomena.

Examples: sun dogs, rainbows, blue sky...

GLO: D4, D5

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Creating a Phenomenon**

Have students work in small groups to create the effect of a sunset, following these steps:

1. Add a teaspoon of powdered milk to a glass of water. Do not stir; let the powder settle on its own.
2. Shine a flashlight straight down into the glass and record the colour you detect. (bluish)
3. Stir the mixture. When the water calms, shine the light through the glass from the side onto a light-coloured wall or a piece of white paper. Record the colour detected. (reddish-orange)

Have students answer the following questions in their science notebooks:

1. What source of light was the flashlight intended to represent? (the Sun)
2. In what position in the sky would the Sun be when the sky is the colour you first detected in the glass? (overhead)
3. In what position in the sky would the Sun be during the second colour? (lower, sunset level)
4. What does the milk solution represent? (dust and sediment particles in the sky)

➢ **Word Wall and Poster**

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to generate examples of natural phenomena produced by light. Ask students to create a Word Wall (Cunningham, 1991) with the examples (e.g., sun dogs, rainbows, blue sky, mirage, northern lights, sunsets, harvest moon). (For a discussion of the Word Wall strategy, see *5-8 ELA*, Strategies, pp. 199-201.)

After conducting research, have each student develop a small poster that presents information, both in text and visual form, about how his or her chosen phenomenon is created, including the terms *reflection, refraction,* or *dispersion* where appropriate. To assist students in answering the following questions, have the class participate in a Gallery Walk (Brownlie and Close, 1992) of the various phenomena posters:

1. Which phenomena were created by the refraction of light and what medium caused the refraction?
2. Which phenomena were created by the reflection of light and off what material was light being reflected?
3. Were any phenomena created through any combination of reflection, dispersion, and/or refraction? If so, which?

Suggestions for Assessment

Natural Phenomena Poster

When assessing students' natural phenomena posters, look for indications of the following:

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
The poster					
• describes how a phenomenon is created	1	2	3	4	5
• illustrates the phenomenon with a labelled diagram	1	2	3	4	5
• identifies and explains how the phenomenon is an example of reflection, refraction, or dispersion	1	2	3	4	5
• is aesthetically pleasing	1	2	3	4	5

Suggested Learning Resources

Nelson Science & Technology 8 (Section 5.14)

Sciencepower 8 (Sections 7.3, 9.1)

Addison Wesley Science & Technology 8: *Optics* (Section 5.1)

The Electromagnetic Spectrum (Video)

Prescribed Learning Outcomes
Students will...
8-2-12 Investigate to determine how light interacts with concave and convex mirrors and lenses, and provide examples of their use in various optical instruments and systems. GLO: B1, C2, D3, D4
8-0-5a ⊃ Make observations that are relevant to a specific question. GLO: A1, A2, C2 **8-0-7a** ⊃ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4) **8-0-7f** ⊃ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

Suggestions for Instruction

➢ Lens Investigation

Provide students with a light box that divides light into several beams (rays). (Divided light beams can be created with materials such as a piece of thick paper with slits, a comb, and so on.) Have pairs or small groups of students use this light box to investigate the effect of different types of lenses on the direction of light beams, following these steps:

- Place a *double concave lens* and then a *double convex lens* in front of the light beams and observe what happens with each lens.
- Record observations on a Three-Point Approach sheet.
  (For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH*, Attachment 10.2, or *Success*, p. 6.101.)
- Create a definition of each lens, indicating whether light beams converge (come together) or diverge (spread apart).
- Draw a diagram of each lens and show the direction of the light beams after they leave the lens.
- Identify some examples of the use of each lens in optical instruments and systems.

➢ Investigating Mirrors

Have students look at themselves using convex and concave mirrors, record their observations, and explain why the images appeared as they did.

Teacher Notes

Background Information

A *convex mirror* produces a small image standing right side up. It reflects back a larger area than a concave mirror does. Convex mirrors are used for security purposes in stores.

A *concave mirror* can reflect in two different ways:

- If the object is close, the mirror will make it appear larger and right side up.
- If the object is farther away, the mirror will make it appear smaller and upside down. Concave mirrors are used for shaving.

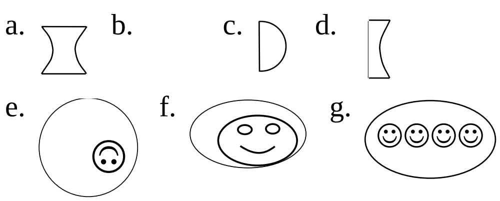
SUGGESTIONS FOR ASSESSMENT

Restricted Response

Provide students with the following:

Lenses, Mirrors, and Light Beams

Match the following pictures of lenses and mirrors with the applicable phrases below. Each picture may be used more than once.



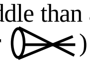
1. concave mirror ______________________________
2. double convex lens ___________________________
3. convex mirror ______________________________
4. double concave lens __________________________
5. lenses that cause light beams to diverge___________
6. lenses that cause light beams to converge _________
7. planoconvex lens______________________________
8. planoconcave lens _____________________________

Look for:

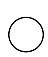
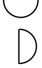
1. e, f 2. b 3. g 4. a 5. a, d 6. b, c 7. c 8. d

Teacher Notes

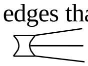
Background Information

A *convex lens* is thicker in the middle than at its edges and causes light beams to converge (come together )

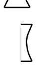
Examples:

- double convex lens 
- planoconvex lens 

Convex lenses are used in overhead projectors, cameras, movie projectors, and magnifying glasses.

A *concave lens* is thicker at its edges than in the middle and causes light beams to diverge (spread apart ).

Examples:

- double concave lens 
- planoconcave lens 

Concave lenses are often used in combination with convex lenses.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8 (Sections 5.8-5.9)

Sciencepower 8 (Sections 8.1, 8.3)

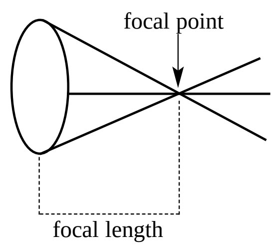
Addison Wesley Science & Technology 8: *Optics* (Sections 2.2, 4.1-4.2)

Prescribed Learning Outcomes
Students will...
8-2-13 Demonstrate the formation of images using a double convex lens, and predict the effects of changes in lens position on the size and location of the image. *Examples: magnify or reduce an image by altering the placement of one or more lenses...* GLO: C2, C5, D4
8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2 **8-0-5c** Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5 **8-0-5e** ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5) **8-0-7a** ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

Suggestions for Instruction

➢ Investigating Focal Points

Provide students with the following information: The *focal point* is the point where light beams meet. It is the point where an image would appear in focus. The distance from the mid-region of the lens to the focal point is called the *focal length*.



Have students compare the focal length of a planoconvex (flat on one side) lens to that of a double convex lens by light from a light box. Have students record their observations. (The planoconvex lens should have a longer focal length.)

Teacher Notes

A planoconvex lens is used here to provide a comparison in focal lengths and to provide background for the instructional strategies suggested for learning outcome 8-2-14, where students describe how the eye can focus an image.

➢ Investigating Lenses

Have students investigate the effects of

- changes in the position of a double convex lens on the size and location of an image
- changes in the number of lenses on the size and location of an image

For this investigation, students need to use a light box and a screen (a large piece of paper) and carefully measure and record the distances involved and the resulting size and location of the focused image.

After students have completed the investigation, have them answer the following questions in their science notebooks:

1. Did the image appear larger or smaller as the distance between the light source and the lens increased? (smaller)
2. Did the image appear larger or smaller as the distance between lenses increased? (larger)
3. If you were attempting to view something very far away, what combination of lenses would you use and how would you set them up? (You would use two double convex lenses placed far apart in order to obtain maximum magnification.)
4. What is an example of an optical device that uses two lenses to view distant objects? (a telescope)

Suggestions for Assessment

Extended Response

Provide students with the following:

Refracting Telescopes

Why are extremely large refracting telescopes used to study distant stars? Include in your explanation the science concepts used to develop this technology.

Scoring Rubric

Score	Criteria
4	The response is correct and complete and thoroughly explains the concept, including references to • the distance of stars and the subsequent small image seen with the unaided eye • the consequent need for the use of two double convex lenses situated a great distance apart • the resultant large size of the telescope The response contains examples and/or elaboration with reference to results of the investigations with lenses and the production of a focused and enlarged image. It includes evidence of higher-order thinking.
3	The response is correct and complete and thoroughly explains the concept, including references to • the distance of stars and the subsequent small image seen with the unaided eye • the consequent need for the use of two double convex lenses situated a great distance apart • the resultant large size of the telescope The response contains examples and/or elaboration with reference to results of the investigations with lenses and the production of a focused and enlarged image.
2	The response is generally correct and complete. It may contain minor errors. It contains examples and/or elaboration to support the answer.
1	The response is partially correct but is incomplete and/or contains major errors. It contains no examples or elaboration to support the answer.

Suggested Learning Resources

Nelson Science & Technology 8 (Sections 5.11-5.12)

Sciencepower 8 (Section 8.2)

Addison Wesley Science & Technology 8: *Optics* (Section 3.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-2-14 Compare the functional operation of the human eye to that of a camera in focusing an image.

GLO: A5, C4, D1, D4

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ Comparing the Eye and the Camera

Have students use various print, multimedia, and Internet resources to

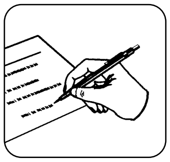
- identify the corresponding parts and functions of the eye and the camera and record these on a chart
- create a labelled diagram of the eye and the camera, colour coordinating similar-functioning components of the eye and the camera

➢ Focusing an Image

Have students, working in pairs, view distant and near objects with a single-lens reflex 35 mm camera (which allows the user to focus manually by pulling out or pushing in the lens) and answer the following questions in their science notebooks:

1. Predict whether the focal length (placement of lens in relationship to the film) would be short or long in order to bring a small distant object into focus. (long)
2. Test your prediction by looking through a single-lens reflex 35 mm camera and trying to focus on your partner. Have your partner note the length of the casing that holds the camera lens. Then look at a small distant object with your camera and record your observations about the length of the lens casing.
3. Was your prediction correct? Why or why not?
4. What does a camera do to produce a focused image of objects at varying distances? (It changes the focal length—the distance between the lens and the focused image on the film.)
5. Unlike the camera, the eye is not able to change focal length. How does the eye focus objects at varying distances? Research to find the answer, if necessary. (The eye can change the shape of its lens by the pull of certain muscles, making it thicker and thinner, allowing it to focus a variety of images.)

Suggestions for Assessment



Extended Response

Have students use a Compare and Contrast Frame (Matchullis and Mueller, 1994) to compare the major parts and functions of the human eye and the camera. (For a BLM of a Compare and Contrast Frame, see *SYSTH*, Attachment 10.4, or *Success*, p. 6.103.)

Look for:

- the points stated in the example provided for the Comparing the Eye and the Camera learning activity

Teacher Notes

Background Information

The Eye and the Camera

The following chart sumarizes the function of corresponding parts of the eye and the camera.

Function	Eye	Camera
Allows in light	pupil	aperture
Controls the amount of light allowed to enter	iris	iris diaphragm and shutter
Magnifies image	lens	lens
Serves as the focal point where image is received	retina	film
Provides the protective covering of lens	cornea	lens cap

Suggested Learning Resources

Nelson Science & Technology 8 (Section 5.13)

Sciencepower 8 (Section 8.2)

Addison Wesley Science & Technology 8: *Optics* (Section 4.1)

Notes

Grade 8

Cluster 3: Fluids

Overview

In this cluster, students investigate the properties of fluids, including viscosity, density, and compressibility. Students identify products in which viscosity is an important characteristic, and plan and conduct experiments to determine factors that affect flow. Students illustrate effects of temperature on density, and they compare the effects of fluids with different densities on the buoyant force of an object. They use the particle theory of matter to explain the relationships among pressure, volume, and temperature. Investigations of the relative compressibility of fluids are related to the ability of liquids and gases to transmit forces in hydraulic and pneumatic devices. Students apply their understanding of fluids within a practical context through the design, construction, and testing of a prototype that utilizes a hydraulic or pneumatic system.

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-01 Use appropriate vocabulary related to their investigations of fluids.

Include: fluid, viscosity, flow, density, particle theory of matter, buoyant force, pressure, compressibility, hydraulic, pneumatic.

GLO: C6, D3, E1

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 7, Cluster 2: Particle Theory of Matter, and in Grade 6, Cluster 2: Flight.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Vocabulary Hopscotch**

Provide students with approximately 20 terms that are addressed in the cluster. Have students

- choose 10 of these terms
- print the term with every other letter missing, and then write a definition for the term beside it
- exchange hopscotch papers with a partner and solve the vocabulary puzzles

Example:

_ y _ r _ u _ i _ _ y _ t _ m: a device that uses a liquid to multiply a force to move something. (hydraulic system)

Suggestions for Assessment

Suggested Learning Resources

Measuring Matter (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-02 Distinguish between fluids and non-fluids.

GLO: D3, E1

8-0-5a Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ **Accessing Prior Knowledge: Fluids**

Have students list the characteristics of fluids and provide examples of both fluids and non-fluids.

➢ **Demonstrating the Flow of Gases**

To demonstrate gases flowing, place a small piece of dry ice into a beaker of warm water and pour the carbon dioxide gas (given off as the dry ice sublimates) into another beaker.

Safety Precaution: Handle dry ice with mitts or tongs. Handling dry ice with bare hands can result in frostbite.

An alternative demonstration involves dissolving two antacid tablets in a flask of water and then pouring the gas over a burning candle. Have students explain what happened. (The flame went out because it is being smothered [not receiving the oxygen it needs to continue burning] due to the carbon dioxide produced by the tablets that is poured onto it.)

Teacher Notes

Background Information

A *fluid* is any substance that flows, spreads out evenly when poured, and exerts pressure.

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Section 2.1)

Sciencepower 8 (Section 4.1)

Prescribed Learning Outcomes

Students will...

8-3-03 Explore and compare the viscosity of various liquids.

Examples: time the fall of a steel ball through various liquids; time the flow rate of different liquids on an incline...

GLO: C2, D3, E1

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3b Identify the independent and dependent variables in an experiment. GLO: A2, C2

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6f ➲ Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 8, 3.3.4)

Suggestions for Instruction

Teacher Notes

Background Information

Viscosity, the opposite of fluidity, is the resistance of a fluid to a change in shape or movement. It is denoted by its opposition to flow or its opposition to have other matter flow through it. Viscosity is caused by the internal friction of a fluid's particles. Flow rate is determined by calculating the time a fluid requires to flow a certain distance.

➢ Comparing Viscosity

Use explicit instruction to introduce the concept of *viscosity* to students. Have students work in groups of two or three to plan and perform an experiment that compares the viscosity of several liquids (e.g., shampoo, hair cream rinse, cooking oil, liquid honey, molasses, water, vinegar, various types of engine oil). (Refer to the "examples" provided with the learning outcome 8-3-03 for suggestions.)

Students may record their work using the "Experiment Report" (BLM 8-R).

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

8-0-7c ➲ Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 8, 3.3.4)

SUGGESTIONS FOR ASSESSMENT

When assessing the Comparing Viscosity experiment, refer to “Experiment Report: Assessment” (BLM 8-S).

Conducting a Fair Test

Provide students with the following self-assessment tool:

Self-Assessment: Conducting a Fair Test
1. One problem I had was ________________________________
2. One thing I did well was ________________________________
3. As a group member, I ________________________________
4. I think our experiment ________________________________

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8: *Fluids* (Section 2.3)

Sciencepower 8 (Section 4.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-04 Identify products in which viscosity is an important property, and evaluate different brands of the same product, using the design process.

Examples: sauces, lubricating oil, paint, hand lotion...

GLO: A5, B2, C1

8-0-1c Identify practical problems to solve. *Examples: How can I make water flow uphill? Which type of bottled water should I buy?…* GLO: C3

8-0-1d ➲ Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.8)

8-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

8-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow. GLO: C3, C6

8-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

8-0-6e ➲ Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4

8-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

8-0-7e ➲ Identify new practical problems to solve. GLO: C3

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

8-0-8a ➲ Distinguish between science and technology. Include: purpose, procedures, products. GLO: A3

SUGGESTIONS FOR INSTRUCTION

➢ Useful Viscous Substances

Have students use the Think-Pair-Share strategy (Lyman and McTighe, 1992) to identify products in which viscosity is an important property.

Examples: ketchup, tomato sauce, vegetable oil, hand lotion, cream rinse, shampoo, paint, paint stripper, cough medicine, engine oil.

Have students use the design process to evaluate different brands of the same product, basing their evaluations on a class-created list of criteria.

Examples:

- Does the product have the correct viscosity to suit its specified function? (e.g., cough medicine: is it able to coat a sore throat and yet comes off a spoon easily?)
- Is the product cost effective? (e.g., does the product have a low viscosity and run off more quickly, thus causing you to use more?)

➢ Marketing a Product

Working in small groups, have students create a commercial that

- accentuates a product’s viscosity or compares it to that of other brands
- illustrates/demonstrates why the product is the most desirable, based on its viscosity

Students may videotape their commercials or present them live to the class.

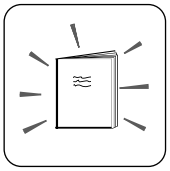
(For strategies and assessment suggestions to aid students in developing appropriate delivery skills for use in presentations, as well as public listening and viewing behaviours, refer to *5–8 ELA*, learning outcomes 4.4.2–4.4.3.)

➢ Science or Technology?

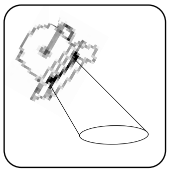
Have students reflect on “Comparing Viscosity” (learning outcome 8-3-03) and “Useful Viscous Substances” (learning outcome 8-3-04) to determine which investigation was science-based and which was technology-based. Students should justify their categorization.

(“Comparing Viscosity” is science-based, as it addresses a question and finds an answer. “Useful Viscous Substances” is technology-based, as it finds a solution to a practical problem. However, it also applies scientific understanding to the solving of a problem.)

Suggestions for Assessment



When assessing the Useful Viscous Substances learning activity, refer to “Design Project Report: Assessment” (BLM 8-P).



Commercial Presentations

Provide students with the following tool for peer assessment of the Marketing a Product commercials:

Peer Assessment of Commercial

Presenters:____________________________________
Topic: ______________________________________
Peer assessor: _________________________________

Rating Scale

Criteria	**Poor**		**Good**		**Excellent**
Speaking parts are clear and understandable	1	2	3	4	5
Commercial demonstrates why the product is most desirable based on its viscosity	1	2	3	4	5
Commercial shows a comparison with other brands	1	2	3	4	5
Good use of visuals	1	2	3	4	5
The commercial kept the interest of the group	1	2	3	4	5

Constructive comment:

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.3, 2.5)

Sciencepower 8 (Section 4.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-05 Plan and conduct experiments to determine factors that affect flow within a given system.

Examples: temperature, pressure, tube diameter...

GLO: C1, C2, D3, E2

8-0-1a ➲ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3b Identify the independent and dependent variables in an experiment. GLO: A2, C2

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

8-0-5f ➲ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6b ➲ Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

8-0-6c ➲ Identify strengths and weaknesses of different methods of collecting and displaying data, and potential sources of error. GLO: A1, A2, C2, C5 (ELA Grade 8, 3.3.3)

SUGGESTIONS FOR INSTRUCTION

➢ Investigating Factors That Affect Flow Rate

Have students brainstorm ways in which they could increase the flow rate of a liquid. Divide the class into groups and assign each group a factor to test.

Examples of variables to test:

- the effect of temperature (independent variable) on the flow rate of a fluid (dependent variable)
- the effect of different sizes of plastic straws (independent variable) on the flow rate of a fluid (dependent variable)
- the effect of adding pressure (squeezing a bottle) (independent variable) on the flow rate of a fluid (dependent variable)

Have students follow the scientific inquiry process to come to a conclusion regarding their testable question. Ask groups to present their findings to the class.

Teacher Notes

Background Information

Factors that can affect the *flow rate* of a fluid are

- the size of the fluid's particles
- the pressure exerted on the fluid
- the temperature of the fluid

Factors affecting the flow rate of fluid through a tube are the same as those listed above, as well as the surface material, straightness, and diameter of the tube and the difference in pressure from one end of the tube to the other.

8-0-6f ➲ Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 8, 3.3.4)

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

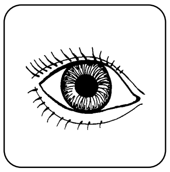
8-0-7b ➲ Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

8-0-7c ➲ Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 8, 3.3.4)

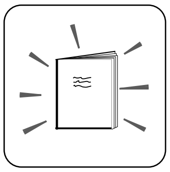
8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

Suggestions for Assessment

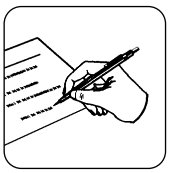
Refer to the following BLMs for assessment suggestions for the Investigating Factors that Affect Flow Rate learning activity:



"Conducting a Fair Test: Observation Checklist" (BLM 8-Q)



"Experiment Report: Assessment" (BLM 8-S)



Restricted Response

Provide students with the following:

Comparing Flow Rates

Which of the following would have a faster flow rate?

1. a straw with a narrow diameter or a straw with a larger diameter
2. a milkshake with a temperature of +5°C, or a milkshake with a temperature of –5°C
3. a milkshake with large chunks of ice cream or a milkshake that is smooth and has been thoroughly mixed

Look for:
1. larger diameter
2. +5°C
3. the one that is smooth and thoroughly mixed

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.1, 2.4)

Sciencepower 8 (Section 4.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-06 Measure, calculate, and compare densities of solids, liquids, and gases.

Include: different amounts of the same substance, regularly and irregularly shaped objects.

GLO: C2, C5, D3

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-5d ➲ Make conversions among commonly used SI units. GLO: C2, C5 (Math: SS-IV.3.7, SS-I.3.6, SS-III.3.7)

8-0-5e ➲ Estimate and measure accurately using SI and other standard units. Include: determining volume by displacement of water. GLO: C2, C5 (Math: SS-IV.1.6, SS-III.1.5, Math: SS-III.1.6, SS-I.1.5)

8-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

(continued)

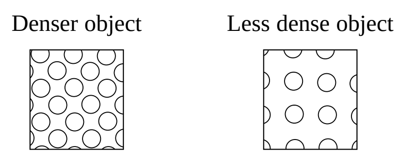
SUGGESTIONS FOR INSTRUCTION

➢ **Finding the Mass of a Solid and a Liquid**

Provide students with a balance scale and various solid objects/substances. Have students determine the mass (in grams) of the objects/substances. To find the mass of a liquid, have students find the mass of the container, then the mass of both the container and the liquid, subtracting the mass of the container from the combined mass to obtain the mass of the liquid.

➢ **Comparing Objects**

Select three objects that have the same volume but a different mass and have students calculate the volume and measure the mass for each. (Commercial density block sets or specific gravity block sets can be used for this learning experience.) Ask students to explain, using the particle theory of matter, why it is that the three objects have the same volume but different masses. Have students record their answers in the science notebooks, using a diagram in their explanations. (The object that had a greater mass had more particles in the same space.)



➢ **Finding Density**

Have students calculate the densities of several regularly and irregularly shaped solids and liquids.

Part A: Regularly Shaped Solids

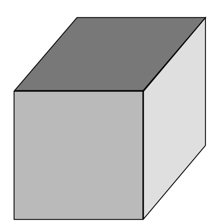
Have students use formulas to calculate the volume of regularly shaped objects. Have them use a balance scale to find the mass and then calculate the density using the formula m/v.

Example:

length x width (base) x height = volume
3 cm x 2 cm x 2 cm = 12 cm^3

mass = 24 g

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{24\text{ g}}{12\text{ cm}^3} = 2\text{ g/cm}^3$$



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Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.8-2.9, 2.13)

Sciencepower 8 (Section 5.2)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-06 *(continued)*

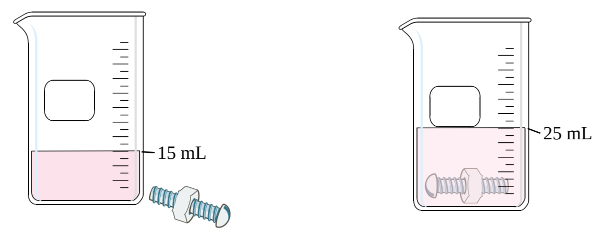
SUGGESTIONS FOR INSTRUCTION

(continued)

Part B: Irregularly Shaped Solids

Have students use displacement (placing the solid in a graduated cylinder of water, subtracting the water's initial volume from the new combined volume) to find the volume of an irregularly shaped solid. Have students use a balance scale to find the mass and then calculate density using the formula m/v.

Example:



volume = 25 mL – 15 mL = 10 mL

mass = 20 g

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{\text{mass}}{\text{volume}} = 2\ \text{g/mL}$$

Part C: Liquids

To calculate the density of a liquid, have students

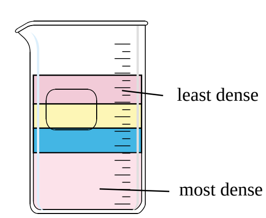
- use a balance scale to find the mass of a beaker
- pour 100 mL of a liquid into the beaker and find the combined mass of the beaker and the liquid
- determine the mass of the liquid by subtracting the mass of the container from the total mass of the liquid and container
- calculate the density of the liquid using the formula m/v

Example:

- Mass of empty container = 15 g
- Mass of container with 100 mL of liquid = 25 g
- Mass of liquid = 25 g – 15 g = 10 g

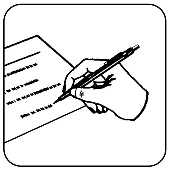
➢ **Comparing Densities**

Have students construct a density tower composed of the liquids and solids whose densities were previously calculated. The substances with the greatest density will be on the bottom, the substance with the least density will be on the top, with the range of densities in between.



SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



Restricted Response

Provide students with the following:

Density

Calculate the densities and solve the following problems. Show your work.

1. A gas has a mass of .05 g and fills a 100 mL container. What is its density?
2. Object B is a solid that has a mass of 20 g and a volume of 10 cm^3. What is its density?
3. Object C is a solid that has a volume of 15 cm^3 and a mass of 6 g. What is its density?
4. If objects B and C were placed in pure water, which has a density of 1.0 g/mL, what would happen? Why?
5. Objects D and E have the same volume. Object D has a greater mass. Identify which has a greater density and explain your reasoning.

Look for:

1. $m/v = \frac{.05\ g}{100\ mL} = .0005\ g/mL$
2. $m/v = \frac{20\ g}{10\ cm^3} = 2\ g/cm^3$
3. $m/v = \frac{6\ g}{15\ cm^3} = .5\ g/\ cm^3$
4. Object B would sink because it has a greater density than water. Object C would float because it is less dense than water. The water is denser than object C and its particles are closer together and therefore are able to support object C.
5. Object D has a greater density. Although its volume is the same as object E, its mass is greater; therefore, its particles are packed closer together and there are more of them in the same space.

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-07 Illustrate, using the particle theory of matter, the effects of temperature change on the density of solids, liquids, and gases.

GLO: A2, C6, D3, E4

8-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

Teacher Notes

Background Information

The *particle theory of matter* states that there is an attraction between particles within a state of matter. When heat energy is added, the attraction between the particles weakens and the particles move more freely. As particles vibrate more freely, they move apart, and a change of state can occur if enough heat is added.

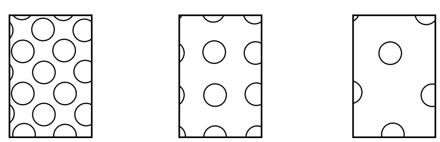
Solids have their particles most densely packed. Liquids are less densely packed (they have more space between particles), and gases are the least dense (they have large spaces between particles). Adding heat causes particles to be less tightly packed and less dense. Removing heat causes particles to be more tightly packed and denser.

Note: Water is an exception to the rule that solids are denser than the liquid state of the same type of matter. Water becomes less dense when it freezes. This allows ice to float on lakes in winter and organisms to live below.

➢ Activating Prior Knowledge: Particle Theory of Matter

Have students draw particle diagrams of the three states of matter.

Example:



solid liquid gas

Ask students to describe what happens to the particles when heat energy is applied to them. (When heat energy is applied to matter it causes the particles to vibrate faster and spread farther apart.)

➢ Illustrating Density

Have students draw diagrams representing the effects of temperature changes on the density of particles within a solid, a liquid, and a gas. Have them describe the relationship between heat and the density of matter. (Applying heat to an object changes its density.)

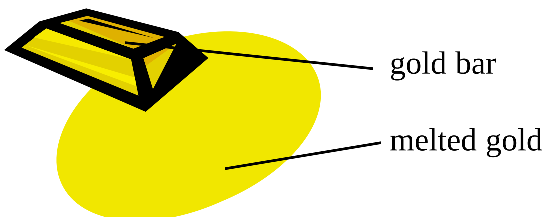
Suggestions for Assessment

Restricted Response

Provide students with the following:

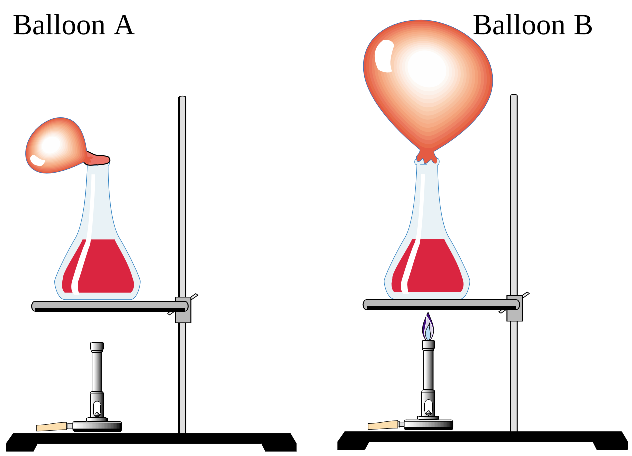
Density and the Particle Theory

1. Draw the particles in the diagram below.



   a. What two states of matter are seen in the above diagram?
   b. What type of energy was added to cause the change of state to occur?
   c. Which is less dense, the gold bar or the melted gold?

2. Draw the particles in Balloon B and describe the density of the air in Balloon B in comparison to Balloon A.



Look for:

1. a. solid and liquid b. heat energy c. melted gold (liquid)
2. Particles should be spread further apart in Balloon B. The air in Balloon B is less dense than the air in Balloon A.

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.16, 2.4)

Sciencepower 8 (Section 5.2)

Measuring Matter (Video)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-3-08 Compare fluids of different densities to determine how they alter the buoyant force on an object.

GLO: C2, D3

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-7f Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

SUGGESTIONS FOR INSTRUCTION

➢ Using a Hydrometer to Measure Densities

Have students use a hydrometer to measure the densities of various liquids, following these steps:

- Build a hydrometer by cutting a drinking straw in half and attaching a ball of modelling clay to one end.
- Mark a scale along the length of the hydrometer (with increments of 5 mm).
- Place the hydrometer in a glass of tap water and record the reading on the hydrometer according to the straw scale.
- Place the hydrometer in the following liquids and record the reading on the hydrometer for each: a glass of water with two tablespoons of salt dissolved in it, vegetable oil, and shampoo.

Have students answer the following questions in their science notebooks:

1. Did the hydrometer float higher in the salt water or in the fresh water? (The hydrometer floated higher in the salt water.)
2. Density refers to how closely packed particles of a substance are in relation to its volume. Dense liquids are able to support the mass of other, less dense materials. Based on this knowledge, which of the liquids do you think is more dense and what in the above investigation indicated this? (The salt water is denser. The salt water's closely packed particles were able to support the hydrometer and allow it to float higher up out of the water.)
3. What is the relationship between the buoyant force of a liquid and its density? (The denser the liquid is, the more buoyant force it has.)

➢ The Science of the Sinking Titanic

Have students use the Think-Pair-Share strategy (McTighe and Lyman, 1992) to identify the reasons why a large boat is able to float, considering that steel is denser than water. (Boats are hollow and there is air in the compartments. The average density of the boat is less than that of the water, and this allows the boat to float.)

Have students read "The Titanic" (BLM 8-C), and explain, in their science notebooks, why the Titanic was no longer able to float, using the term *density* in their explanation.

Suggestions for Assessment

Titanic Newspaper Article

When assessing students' newspaper articles, look for indications of the following:

Rating Scale					
Criteria	**Poor**		**Good**		**Excellent**
The student					
• identifies scientific flaws of the Titanic's specially made compartments	1	2	3	4	5
• suggests design modifications to improve the effectiveness of the compartments	1	2	3	4	5
• uses a format/ approach suited to a newspaper article	1	2	3	4	5

Teacher Notes

A *hydrometer* is an instrument that measures the density of a liquid and its subsequent buoyant force. Buoyant force is the fluid's ability to exert an upward-pushing force.

An instructional strategy suggested for learning outcome 8-4-03 asks students to make a hydrometer to compare the densities of fresh water and salt water.

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.10-2.13)

Sciencepower 8 (Section 5.2)

Measuring Matter (Video)

Prescribed Learning Outcomes

Students will...

8-3-09 Recognize that pressure is the relationship between force and area, and describe situations in which pressure can be increased or decreased by altering surface area.

Examples: wearing snowshoes instead of boots to decrease pressure, increase surface area, and stay on top of snow...

GLO: B1, B2, D4

8-0-1a ⊂ Formulate specific questions that lead to investigations. Include: rephrase questions to a testable form; focus research questions. GLO: A1, C2 (ELA Grade 8, 3.1.2; Math: SP-I.1.8)

8-0-3a ⊂ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3b Identify the independent and dependent variables in an experiment. GLO: A2, C2

8-0-3c ⊂ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ⊂ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-4e ⊂ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ⊂ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5f ⊂ Record, compile, and display observations and data, using an appropriate format. GLO: C2, C6 (ELA Grade 8, 3.3.1; Math: SP-III.2.8)

8-0-6b ⊂ Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5

8-0-6c ⊂ Identify strengths and weaknesses of different methods of collecting and displaying data, and potential sources of error. GLO: A1, A2, C2, C5 (ELA Grade 8, 3.3.3)

8-0-6f ⊂ Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 8, 3.3.4)

Suggestions for Instruction

➢ **The Race**

Have students race across a deep snowy field, with some students wearing snowshoes, some wearing skis, and some wearing boots. At the end of the race, ask students to explain what happened. (The people wearing boots sank, whereas the people wearing skis and snowshoes were able to go across the snow. Their footwear spread out their weight and reduced the amount of pressure in one spot.)

Alternatively, have students walk through sand or mud, with some wearing sneakers and others high heels.

➢ **Penny Boats**

Have students plan and conduct an experiment to determine whether the surface area of a boat affects the number of pennies it can hold before sinking. Students may use "Experiment Report" (BLM 8-R) to record their work. Ensure that students include potential applications of their findings related to surface area and pressure.

Examples:

- *Inventions:* The width of snowshoes allows users to spread out their weight and reduce pressure on one spot, which helps prevent them from breaking through the surface of snow.
- *Nature:* Snowshoe hares and polar bears have wide furry feet, allowing them to walk across snow without breaking through the surface.
- *Life-saving techniques:* When rescuers attempt to cross thin ice to rescue someone, they lie down and spread out their bodies. By increasing the surface area, they reduce pressure on the ice.

8-0-7a ⊂ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

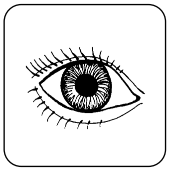
8-0-7b ⊂ Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

8-0-7c ⊂ Identify a new prediction/hypothesis based on investigation results. GLO: A1, C2 (ELA Grade 8, 3.3.4)

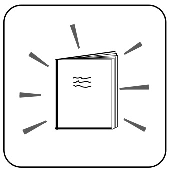
8-0-7h ⊂ Identify and evaluate potential applications of investigation results. GLO: C4

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Conducting a Fair Test: Observation Checklist" (BLM 8-Q)



"Experiment Report: Assessment" (BLM 8-S)

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Section 2.14)

Sciencepower 8 (Section 6.1)

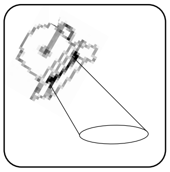
Prescribed Learning Outcomes
Students will...
8-3-10 Explain, using the particle theory of matter, the relationships among pressure, volume, and temperature of liquid and gaseous fluids. GLO: A2, D4
8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

Suggestions for Instruction

➢ **Pressure Problem**

Distribute copies of “A Tiring Story” (BLM 8-D). Have students read the story and identify what is causing the tire problem, describing it in terms of the particle theory of matter.

Suggestions for Assessment



Analyzing “A Tiring Story”

Provide students with the following:

1. Given the information in “A Tiring Story,” are you able to identify specifically which of Sam’s tires “blew out” on Sam? Why or why not?
2. What are the relationships among air pressure, volume, and temperature?
3. What recommendations would you make with regard to maintaining proper air pressure in automobile tires throughout the year?

Look for:

1. Yes. The back left tire blew out, because that was the one in which Sam probably put too much air when he was adding air without using a tire gauge. When it became hot, the tire expanded, and when Sam drove a lot, the friction from the road added to the increase in temperature and volume and caused the tire to burst.
2. The higher the temperature, the greater the air pressure and, subsequently, the greater the volume.
3. Check a tire’s air pressure regularly with a gauge. In particular, check a tire’s air pressure when there is a change in outdoor temperature.

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Section 2.19)

Sciencepower 8 (Section 6.1)

Prescribed Learning Outcomes

Students will...

8-3-11 Compare the relative compressibility of water and air, and relate this property to their ability to transmit force in hydraulic and pneumatic systems.

GLO: A5, C1, D4, E1

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4d Identify and assume various roles to achieve group goals. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-5c Select and use tools to observe, measure, and construct. Include: microscope, concave and convex mirrors and lenses, chemical indicators. GLO: C2, C3, C5

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

8-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

8-0-9d ➲ Value skepticism, accuracy, precision, and open-mindedness as scientific and technological habits of mind. GLO: C3

(continued)

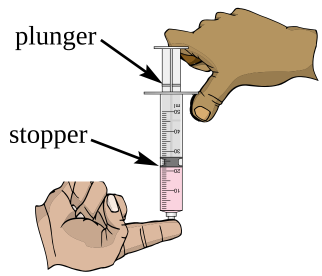
Suggestions for Instruction

➢ **Fluid Compressibility Comparison**

Part A: Comparing Compressibility

Have students use a syringe to compare the compressibility of several different fluids, including air, following these steps:

- Draw back the plunger and fill the syringe with specific fluid.
- Plug the hole and push in the plunger.
- Observe what happens. The change in volume represents the level of compressibility.
- Record your data in your science notebook and indicate whether the fluid is compressible or incompressible.



Part B: Observing Decompression

Some systems use the rebound of compressed fluids to move parts. Have students compress a fluid (used in Part A) as much as possible and then release the plunger and observe the distance the stopper rebounds. Ask them to record in their science notebooks which fluid rebounded more after decompression.

➢ **Pneumatic Versus Hydraulic Systems**

Have students, working in groups, set up and conduct the following experiments to compare how a pneumatic system, as compared to a hydraulic system, transmits force. Ensure that students work over a sink or plastic tub when filling their syringes with water. Glycerine may have to be added around the rubber stopper to ensure a complete seal and allow the plunger to move back and forth smoothly and easily.

Part A: Pneumatic System

- Push in the plunger completely on syringe A and then attach syringe A with rubber tubing to syringe B, whose stopper is at the last measurement indicator.
- Push in the plunger on syringe B.
- Record the distance the plunger on syringe B is moved and the distance syringe A's plunger moves.

(continued)

Suggestions for Assessment

Teacher Notes

Background Information

Compressibility is the ability of fluids to be squeezed into a smaller volume. Gases are compressible because their particles are far apart. Liquids are considered almost incompressible because their particles are much closer together and there is no visible change in volume when they are being compressed.

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Section 2.18)

Sciencepower 8 (Section 6.1)

PRESCRIBED LEARNING OUTCOMES
Students will...
8-3-11 *(continued)*

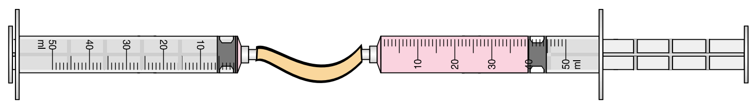
SUGGESTIONS FOR INSTRUCTION

(continued)

Part B: Hydraulic System

- Attach rubber tubing to syringe B and then, by pulling on the stopper of syringe B, fill the syringe and the tubing with water.
- Push in the plunger completely on syringe A and then attach it to the rubber tubing that is connected to syringe B, which is filled with water.
- Push in the plunger on syringe B.
- Record the distance the plunger on syringe B is moved and the distance syringe A's plunger moves.

syringe A **syringe B**



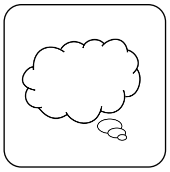
Have students answer the following questions in their science notebooks:

1. A system that transfers force efficiently would have the resulting movement of the load be equal or near equal to the distance the effort force travelled. An example of an efficient transfer of force would occur if the plunger on syringe A (providing the effort force) travelled five centimetres and the plunger on syringe B (load) travelled an equal distance. Based on this information, which fluid in your experiment transferred force more efficiently? (water)
2. A *hydraulic* system uses liquids for the transmission of force and a *pneumatic system* uses air for the same purpose. Based on the results you observed in your experiment involving pneumatic and hydraulic systems, which system would be more efficient to use if you were lifting a large load but did not have much force in the form of person power to lift the load? Why?

   (The hydraulic system would be more efficient because liquid transmits force more efficiently. You do not have to push as much with a hydraulic system as you do with a pneumatic system to have the object move an equal distance.)
3. What is the relationship between a fluid's compressibility and its ability to transmit force?

   (If a substance compresses little or not at all, it transmits force more efficiently.)

SUGGESTIONS FOR ASSESSMENT



Provide students with “How We Worked Together” (BLM 8-E) for self-assessment purposes.

SUGGESTED LEARNING RESOURCES

Prescribed Learning Outcomes

Students will...

8-3-12 Identify a variety of natural and constructed hydraulic and pneumatic systems and describe how they function.

Examples: heart, lungs, eyedropper, misting bottle, fuel pump, hydraulic lift...

GLO: D4, E2

8-3-13 Compare hydraulic and pneumatic systems, and identify advantages and disadvantages of each.

GLO: B1, D4, E1, E2

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

Suggestions for Instruction

➢ How Do They Compare?

Have students use a Compare and Contrast Frame (Matchullis and Mueller, 1994) to compare pneumatic and hydraulic systems. Provide students with numerous examples of hydraulic and pneumatic systems and have them research the topic using resources such as CD-ROMs, printed text, and/or the Internet.

(For strategies to aid students in using a variety of information sources, determining the usefulness of information, constructing meaning, recording information, referencing and evaluating sources, refer to *5–8 ELA*, learning outcomes 3.2.2–3.2.5 and 3.3.2–3.3.3.)

Teacher Notes

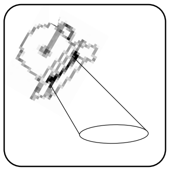
Background Information

Both *hydraulic systems* and *pneumatic systems* can multiply a force, are based on the transformation of energy, deal with pressure in fluids, and have many technological applications.

Characteristics of Hydraulic and Pneumatic Systems

Hydraulic systems are	*Pneumatic systems* are
• operated by liquid, which becomes more viscous in cold temperatures, thus causing the device to "stiffen" (and the liquid may freeze)	• operated by gas or air, which contracts but does not become more viscous in cold temperatures
• used to transmit force by compression	• used to transmit force by decompression (like a spring)
• self-lubricating	• not self-lubricating
• not self-cooling	• self-cooling
• less commonly found than pneumatic systems	• more commonly found than hydraulic systems
• used to transport fluids in pipes, which requires pumps to create pressure to keep fluid flowing, as well as valves to regulate direction of flow	
• both natural and constructed (examples: the heart and circulatory system, oil pipeline, water pipes, hair salon or dentists' chairs, Jaws of Life, car hoists)	• both natural and constructed (examples: the lungs and respiratory system, air brakes, large tampers, dentists' drills, air bags, tires)

Suggestions for Assessment



Engineering Challenge

Provide students with the following:

Engineering Challenge

An engineer is designing a machine to lift heavy pipes that are to be used for new sewer and water services in northern communities. Winter roads (frozen lakes and marshes) are the least expensive method of hauling equipment to these isolated communities. Workers often work in –30°C conditions. Should the engineer design a pneumatic or hydraulic system to lift loads at these sites? Explain your reasoning.

Look for:

The engineer should design a pneumatic system because air does not become more viscous in colder weather; however, a pneumatic system does not transfer energy as well as a hydraulic system does. A hydraulic system would work only if the engineer could find a liquid that did not become very viscous at low temperatures or a way to keep the liquid warm. Liquid transfers energy better than air does and a hydraulic system would be useful for lifting heavy pipes.

Scoring Rubric

Score	Criteria
4	The student expresses an opinion, logically justifies the answer, and elaborates. The response includes evidence of higher order thinking.
3	The student expresses an opinion, logically justifies the answer, and elaborates.
2	The student expresses an opinion and justifies the answer, but the answer may contain minor errors. The response contains elaboration to support answer.
1	The answer is incorrect and/or contains major erors. The answer is not elaborated.

Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Sections 2.19-2.23)

Sciencepower 8 (Sections 6.2-6.3)

Prescribed Learning Outcomes

Students will...

8-3-14 Use the design process to construct a prototype that uses a pneumatic or hydraulic system to perform a given task.

Examples: a prototype that can lift a load a specified distance...

GLO: C3, D4

8-0-1c Identify practical problems to solve. *Examples: How can I make water flow uphill? Which type of bottled water should I buy?…* GLO: C3

8-0-1d ➲ Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.8)

8-0-3d ➲ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

8-0-3e ➲ Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow. GLO: C3, C6

8-0-4b ➲ Construct a prototype. GLO: C3

8-0-5b ➲ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

8-0-6d ➲ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

8-0-7d ➲ Propose and justify a solution to the initial problem. GLO: C3

8-0-7e ➲ Identify new practical problems to solve. GLO: C3

Suggestions for Instruction

➢ **Design Project: Toy**

Present students with the following scenario:

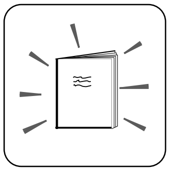
You are a designer at a toy company and your team specializes in designing the pneumatic and hydraulic components for toys. The list below indicates toys that need to be fitted with a hydraulic or a pneumatic system. Each toy has a part that requires movement, a load to be lifted, and/or a switch to be opened or closed.

Criteria should make reference to function, aesthetics, environmental considerations, cost and efficiency. Be prepared to present your design, test data and prototype to the toy company's board of directors (the class).

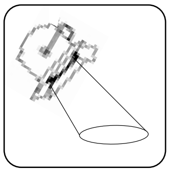
Design of Pneumatic/Hydraulic Devices for Toys

Possible toys:	**Design a pneumatic/hydraulic system or device that**
• jack-in-the-box	causes the doll to pop up. The toy can have a seasonal theme—a ghost pops up for Halloween, a chick pops out of an egg for Easter
• elevator in garage	lifts up a toy car from the ground floor to the second floor of a garage or car parkade. (Extension: Have the elevator platform tilt to send the car down a ramp and back down to the first floor.)
• dump truck	tilts the box to dump the load
• hairdresser's chair	lifts a salon chair that can hold a plastic doll
• fire-engine ladder	causes an extension ladder to lengthen

Suggestions for Assessment



When assessing the design of the pneumatic/hydraulic device, refer to "Design Project Report: Assessment" (BLM 8-P).



Design Presentation

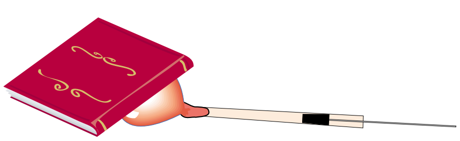
Provide students with the following tool for peer assessment of the pneumatic/hydraulic device presentation.

Presenter: ____________________ Peer assessor: ____________________		
The speaker	Yes	No
• spoke so all could hear		
• used visual aids or props		
• identified whether the device was a pneumatic or a hydraulic system		
• clearly explained how the device worked		
Constructive comment:		

Teacher Notes

Prototypes may be made from a variety of materials such as cardboard, shoeboxes, straws, and small or large syringes, depending on the size of the load and the distance it will be lifted.

If sufficient quantities of syringes are difficult to obtain, construct working models using a balloon, large hosing or rubber tubing, a cork stopper, and a knitting needle or other similar object. Connect a piece of hosing to a balloon and place some water in the hose and balloon. Insert a stopper plunger into the opposite end of the hose. (See diagram below.) Pushing the plunger causes the water to fill the balloon, which increases in size and is able to lift the load.



Suggested Learning Resources

Nelson Science & Technology 8: *Fluids* (Section 2.2, Design Challenge)

Sciencepower 8 (Section 6.2, Unit 2, Chapter 6 project)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Notes

Grade 8

Cluster 4: Water Systems

Overview

In this cluster, students investigate the properties of water, its global manifestations, and its impacts. They compare and contrast fresh and salt water, describe factors that affect ocean currents, and recognize the impact of large bodies of water and ocean currents on regional climates. Features of the North American drainage system are identified, and factors that influence erosion and deposition in streams and large bodies of water are examined. Students determine causes of flooding and examine methods and technologies used to contain or prevent damage from erosion and floods. Sources of drinking water are identified, methods for treating water are discussed, and waste-water disposal systems are compared. Students explore water pollution problems and identify environmental, social, and economic factors important to the management of water resources.

Prescribed Learning Outcomes

Students will...

8-4-01 Use appropriate vocabulary related to their investigations of water systems.

Include: heat capacity, fresh water, salt water, convection, Coriolis effect, global water cycle, drainage system, watershed, continental divide, erosion, deposition, flow rate, tides, terms related to water treatment.

GLO: C6, D5

Suggestions for Instruction

Teacher Notes

Prior Knowledge

Students have had previous experiences related to this cluster in Grade 7, Cluster 2: Particle Theory of Matter, and in Grade 7, Cluster 4: Earth's Crust.

➢ Introduce, explain, use, and reinforce vocabulary throughout this cluster.

➢ **Word Cycle**

Provide students with opportunities to use the Word Cycle strategy (Szabos, 1984) to develop their understanding of a term and how it relates to other terms within a general concept. To use this strategy, students must apply their knowledge of a word in order to create connecting words that show the relationship between terms.

(For a BLM of the Word Cycle, see *SYSTH*, Attachment 10.1, or *Success*, p. 6.99.)

Suggestions for Assessment

Suggested Learning Resources

PRESCRIBED LEARNING OUTCOMES

Students will...

8-4-02 Demonstrate that water, as compared to other substances, has a high heat capacity and is able to dissolve a wide variety of solutes.

GLO: C1, C2, C5, D3

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

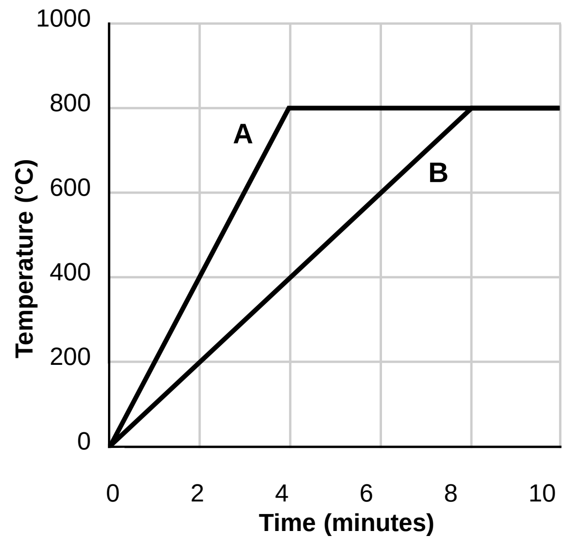
(continued)

SUGGESTIONS FOR INSTRUCTION

➢ **Heat Capacity**

Provide students with the following graph. Indicate that 1.0 kg of substance A and 1.0 kg of substance B were placed in an oven set at 800°C.

Heat Capacity of Substances



Have students refer to the graph to answer the following questions in their science notebooks:

1. How long did it take for substance A to heat up to 800°C? (Four minutes.) How long did it take for substance B? (Eight minutes.)
2. Which substance needed more heat energy to reach 800°C? (Substance B.)
3. Which variables were controlled in this experiment? (The controlled variables were the amount of substance—1 kg, and oven temperature.)
4. The heat capacity of an object indicates how much heat energy must be added to increase its temperature by 1º Celsius. If a substance has a large heat capacity, you must add a large amount of heat to increase its temperature just a little. You must also remove a large amount of heat to decrease its temperature just a little. High heat capacity often means a substance takes a long time to heat up or to cool down.

   Given this information, which substance has the higher heat capacity? (Substance B.)

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.13)

Sciencepower 8 (Section 12.1)

PRESCRIBED LEARNING OUTCOMES
Students will...
8-4-02 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

5. Imagine you are at the beach on a very hot day. You walk toward the water. The sand is extremely hot. When you reach the water, you find it is much cooler than the sand.
   a. Using the term *heat capacity*, explain why the sand is hot and the water is cool. (Sand has a lower heat capacity than water. It heats more quickly than water.)
   b. Predict what the air temperature would be relative to the sand and water temperatures. Explain your thinking using the term *heat capacity*. (The air would be hotter than the water but cooler than the sand because it has a higher heat capacity than sand, but a lower heat capacity than water.)

➢ **Accessing Prior Knowledge**

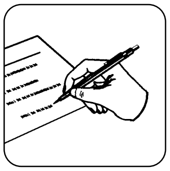
Have students review their knowledge of *solutions*, *solutes*, and *solvents* from Grade 7, Cluster 2: Particle Theory of Matter.

➢ **Universal Solvent**

Provide students with the following:

1. We rely on the fact that water is a universal solvent (dissolves numerous substances) in our day-to-day lives. Identify some ways in which water is useful to us as a universal solvent. (The ability of water to dissolve substances is useful in washing dishes, making coffee, tea, or carbonated drinks, processing foods, preparing hair care products, dissolving nutrients and gases in our blood, and mixing nutrients and chemicals.)
2. Sometimes we forget that water is able to dissolve substances. People add pollutants to soil, to the atmosphere, or to bodies of water without realizing the damage that could be done. Identify substances (all states of matter) that pollute water because of its trait as a universal solvent. (Phosphates from washing can dissolve and contaminate rivers. Agricultural fertilizers can dissolve and wash away during rains or run-off, causing algal blooms in lakes.)

Suggestions for Assessment



Restricted Response

Note: This learning activity could be used as an Exit Slip. Provide students with the following:

Heat Capacity Quiz

Indicate whether the following statements are true or false.

1. ______ Heat capacity indicates how much heat energy is needed to raise the temperature of a substance by 1° Celsius.
2. ______ If a substance has a high heat capacity you must add a small amount of heat energy to increase its temperature by 1° Celsius.
3. ______ If a substance has a high heat capacity you must remove a small amount of heat energy to decrease its temperature by 1° Celsius.
4. ______ Sand has a lower heat capacity than water, so it heats up more quickly on a hot day.
5. ______ If substance A has a higher heat capacity than substance B, substance A will heat up more slowly than substance B.

Look for:
1. true
2. false
3. false
4. true
5. true

Suggested Learning Resources

Prescribed Learning Outcomes

Students will...

8-4-03 Compare and contrast characteristics and properties of fresh water and salt water.

Examples: freezing point, density, dissolved materials, global distribution, relative amounts, biologically diverse components of each...

GLO: D3, D5, E1

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

(continued)

Suggestions for Instruction

➢ **Hydrometer**

A *hydrometer* is an instrument that measures the density of a liquid in comparison to other liquids. Have students

- make a hydrometer by cutting a drinking straw in half and attaching a small ball of modelling clay to one end
- mark a scale (with increments of 5 mm) along the length of the straw
- place the hydrometer (the straw, with modelling clay end down) in a glass of water
- record the measurement at the point where the surface of the water meets the straw

Have students repeat the experiment with a glass of water with two tablespoons of salt dissolved in it. Ask them to answer the following questions in their science notebooks:

1. Did the hydrometer float higher in the salt water or in the fresh water? (It floated higher in the salt water.)
2. *Density* refers to how closely packed particles of a substance are in relation to its volume. The denser the liquid is, the better it is able to support the mass of other materials. Based on this knowledge, which of the two liquids is more dense? What in the hydrometer experiment indicated this? (The salt water is more dense than the fresh water because it supported the hydrometer to a greater height out of the water.)
3. What are the implications of a denser body of water for the possible size of load-carrying ships moving in water? (Load-carrying ships can be larger and carry greater loads on salt water than on fresh water. A boat in salt water will float higher than one in fresh water, assuming both boats are the same size and are carrying the same type and amount of loads.)

Teacher Notes

Density is addressed in an instructional strategy suggested for learning outcome 8-3-06.

(continued)

Suggestions for Assessment

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.2)

Sciencepower 8 (Sections 10.3, 11.2)

Prescribed Learning Outcomes
Students will...
8-4-03 *(continued)*

Suggestions for Instruction

(continued)

➢ **Salt Water Versus Fresh Water**

Have students research and/or view films about salt water and fresh water. Ask students to use a Concept Relationship Frame (Matchullis and Mueller, 1994) to organize their information about the differences between salt water and fresh water in terms of dissolved materials, biological components, density, global distribution, and relative amounts.

(For a BLM of a Concept Relationship Frame, see *SYSTH*, Attachment 11.1, or *Success*, p. 6.104.)

Teacher Notes

Fresh water

- is less dense than salt water
- comprises 2.5 percent of the world's water, some of which is trapped in the form of ice
- contains relatively low levels of salt
- can be soft or hard, depending on the amount of calcium carbonate, magnesium, or ferrous oxide dissolved within the water (These substances change the taste of water, affect the ability of soaps to cleanse and produce suds, cause build-up of mineral deposits in kettles and other appliances, and produce rust-coloured stains on surfaces exposed to water.)

Salt water

- is more dense than fresh water
- makes up approximately 97 percent of the world's water (Oceans cover 71 percent of the Earth's surface.)
- contains approximately 33 grams of dissolved salts per litre (Most marine organisms have body fluids with salt content similar to that of seawater.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

The Cargo Ship

Provide students with the following:

The Cargo Ship

A large cargo ship loads up in Thunder Bay, Ontario, with prairie grain destined for European markets. It will travel through the Great Lakes and down the St. Lawrence River and then enter the Atlantic Ocean.

Using relative terms, describe where the waterline on the ship would be (how high or low the ship floats in the water) as it travels through each of the bodies of water. Explain why these differences occur.

Scoring Rubric

Score	Criteria: The response
4	• indicates that the ship will float lower in the Great Lakes and St. Lawrence River than in the Atlantic Ocean • contains supporting evidence for the answer (e.g., the Great Lakes and St. Lawrence contain fresh water that is less dense than the Atlantic salt water, which is more dense and has a greater buoyant force) • is complete and clearly stated • indicates that the ship will begin to float higher as it approaches the Atlantic Ocean and the fresh water and the salt water begin to mix
3	• indicates that the ship will float lower in the Great Lakes and St. Lawrence River than in the Atlantic Ocean • contains supporting evidence for the answer (see above explanation) • is complete and clearly stated
2	• indicates that the ship will float lower in the Great Lakes and St. Lawrence River than in the Atlantic Ocean • contains supporting evidence for the answer (see above explanation), but the evidence may be incomplete and/or unclear
1	• indicates that the ship will float lower in the Great Lakes and St. Lawrence River than in the Atlantic Ocean

Prescribed Learning Outcomes

Students will...

8-4-04 Identify factors that can work individually or in combination to affect ocean currents.

Include: convection, Coriolis effect, prevailing winds, position of continents.

GLO: D5, E2

8-0-1b ➲ Select and justify a method to be used in finding the answer to a specific question. GLO: C2 (ELA Grade 8, 3.2.3; Math: SP-II.1.8)

8-0-3a ➲ Formulate a prediction/hypothesis that identifies a cause and effect relationship between the dependent and independent variables. GLO: A2, C2 (Math: SP-I.1.8)

8-0-3c ➲ Create a written plan to answer a specific question. Include: apparatus, materials, safety considerations, steps to follow, and variables to control. GLO: C2 (ELA Grade 8, 3.1.4)

8-0-4a ➲ Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2

8-0-7a ➲ Draw a conclusion that explains investigation results. Include: explaining the cause and effect relationship between the dependent and independent variables; identifying alternative explanations for observations; supporting or rejecting a prediction/hypothesis. GLO: A1, A2, C2 (ELA Grade 8, 3.3.4)

Suggestions for Instruction

➢ Convection Current (Transfer of Heat through Water)

Demonstrate a *convection current* by completing the following as a class demonstration:

- Place a small stoppered jar of blue-coloured hot water at the bottom of a beaker of cold water. Have students predict what will happen to the blue-coloured hot water placed in the cold water when the stopper is removed.
- Remove the stopper. Have students establish a conclusion based on their observations. **Note:** If a commercial convection tube is available, use it for the demonstration and have students predict and draw conclusions. Have students document their predictions, conclusions, and the steps followed in their science notebooks. Ask them to draw a diagram of the demonstration.

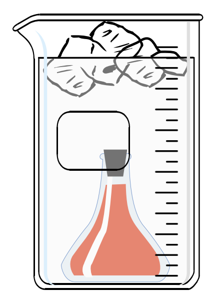
  Example:

Prediction: ______________________

Conclusion: The warm blue water rises and then sinks again as it cools.

Step 1. Place a small stoppered jar of blue-coloured hot water at the bottom of a beaker of cold water.

Step 2. Remove the stopper. (Dyed hot water will move upward and then downward again as it cools.)



Ask students how they could test whether their findings are accurate. Have the class select and carry out one (or more) method(s) to test their findings (e.g., have the water in the beaker the same temperature as the blue water).

➢ Ocean Currents

Have students view the “World Map: Ocean Currents” (BLM 8-F), read “Facts about Ocean Currents” (BLM 8-G), and answer the questions provided.

Suggestions for Assessment

Ocean Currents

Provide students with the following:

Self-Assessment of Reading Strategies

Describe the reading strategies you used to gain information from the text “Facts about Ocean Currents” (BLM 8-G) (e.g., Did you preview and skim, take notes, use a graphic organizer, read out loud, predict?).

(For reading strategies, refer to *5-8 ELA*, learning outcome 2.1.2, Comprehension Strategies.)

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.12)

Sciencepower 8 (Section 11.3, 12.1)

Prescribed Learning Outcomes

Students will...

8-4-05 Describe how the heat capacity of large bodies of water and the movement of ocean currents influence regional climates.

Examples: Gulf Stream effects, El Niño, lake effect...

GLO: D3, D5, E2

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

Suggestions for Instruction

➢ **El Niño**

Have students use the LINK (List-Inquire-Note-Know) strategy (Vaughan and Estes, 1986) to explore the El Niño current. To use the LINK strategy, provide students with the term *El Niño*, and then have students individually *list* everything that comes to mind. Compile their responses into a class chart. Have small groups of students *inquire* of each other (ask for clarification or more information) and make *notes* of what they have learned. Finally, have students read, view, or listen to confirm what they *know*.

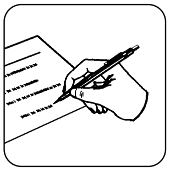
(For a discussion of LINK, see *SYSTH*, pp. 9.18-9.19, or *Success*, p. 6.27.)

➢ **"Weather by the Water"**

Have students use the Fact-Based Article Analysis (Matchullis and Mueller, 1994) approach to analyze the information provided in "How Big Lakes and Oceans Affect Climate: Weather by the Water" (BLM 8-H). Using this approach, have students summarize the key concept, draw a figurative representation, list scientific facts, write a summary, list questions, identify key words, and discuss the relevance of the information presented.

(For a BLM of the Fact-Based Article Analysis frame, refer to *SYSTH*, Attachment 11.6, or *Success*, p. 6.114.)

Suggestions for Assessment



Extended Response

Have students work in groups to complete the following:

Ocean Currents and Climate

Group members: ________________________________

____

Complete the following tasks with your group. You may use atlases, textbooks, and other references. One map and explanation sheet should be submitted per group.

1. Place the following cities on the map provided ("World Map: Ocean Currents," BLM 8-F):
   a. St. John's, NF
   b. Vancouver, BC
   c. San Francisco, CA
   d. Boston, MA
   e. Juneau, AK
   f. Washington, DC

2. On a separate sheet of paper, explain whether these cities would experience a warming or cooling effect on their climates because of the associated ocean currents. Provide reasons/supporting evidence for your responses.

Rating Scale

Criteria	**Poor**		**Good**	**Excellent**	
The group					
• locates cities on map	1	2	3	4	5
• identifies warming or cooling trends for cities	1	2	3	4	5
• provides reasons/supporting evidence for claims	1	2	3	4	5
• provides a clear and complete explaination	1	2	3	4	5

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Sections 4.11, 4.21)

Sciencepower 8 (Section 12.1)

Prescribed Learning Outcomes

Students will...

8-4-06 Describe the components of the global water cycle and explain how it works.

GLO: D3, D5, E2

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

Suggestions for Instruction

➢ **The Water Cycle**

Have students use their knowledge of the water cycle and global water systems to write a fictional account of a drop of water from 10 000 years ago to today. "The Incredible Journey" (BLM 8-I) provides a source of background information on this topic. Ensure that students include the following terms in their writing:

- *the Sun*
- *condensation*
- *evaporation*
- *precipitation*
- *runoff*
- *transpiration*
- *groundwater*
- *bodies of water*

Teacher Notes

Teachers may choose to address the concepts of the water cycle and global water systems following the learning experiences suggested for learning outcome 8-4-07.

Suggestions for Assessment

Extended Response

Provide students with the following:

The Water Cycle

Using a Word Cycle provided, show the relationships among the following terms that describe the water cycle:

- the Sun
- condensation
- evaporation
- precipitation
- runoff
- transpiration
- groundwater
- bodies of water

(For a BLM of a Word Cycle, see *SYSTH*, Attachment 10.1, or *Success*, p. 6.99.)

Scoring Rubric	
Score	**Criteria**
3	All connecting phrases succinctly and accurately explain the relationships between/among terms.
2	Most connecting phrases accurately explain the relationships between/among the terms.
1	Several connecting phrases are missing or show a lack of understanding of the relationships between/among terms.

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Sections 4.12-4.13)

Sciencepower 8 (Sections 11.3-12.2)

Prescribed Learning Outcomes

Students will...

8-4-07 Describe features of the North American drainage system.

Include: local and regional watersheds, direction of water flow, continental divide.

GLO: C6, D5

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts.
GLO: A2, C4 (ELA Grade 8, 1.2.1)

Suggestions for Instruction

Teacher Notes

Background Information

Watersheds describe the flow of water within a region toward a common destination. Small watersheds lead to larger and larger watersheds and eventually into the oceans of the world.

Canadian waters eventually flow into the Atlantic, Pacific, or Arctic Ocean. These form the basis of Canadian watersheds, with waters in the North having two major subdivisions: the Arctic and Hudson Bay drainage systems. Most of the water in Manitoba eventually ends up in Hudson Bay.

Wetlands play an important role in Canadian watersheds and the global water cycle.

➢ Where Is the Watershed?

Use explicit instruction to introduce students to the concept of *watersheds*. Have students use the map, “North America: Watersheds” (BLM 8-J) to draw and label the major North American watersheds (Atlantic, Pacific, and Arctic, Hudson Bay, and Mississippi), the Continental Divide, and the following rivers: Mackenzie, Nelson, St. Lawrence, Mississippi, Red, Assiniboine, Saskatchewan, Fraser, and Thelon.

➢ Journey to the Sea (Hudson Bay)

Provide students with a topographical/physical map of Manitoba. Have students

- describe the route a pail of water would take from their home community to its ultimate destination
- trace the route that precipitation in the form of rainfall would take through the natural water drainage system, starting from various points in Manitoba

SUGGESTIONS FOR ASSESSMENT

Restricted Response

Note: This quiz can be used as an Admit Slip or an Exit Slip. Provide students with the following:

North American Watersheds

1. The majority of Canadian waters flow into the following three large bodies of water:
   __________________, __________________,
   __________________.
2. Most of the water in Manitoba eventually ends up in ________________________, part of the ___________________ Ocean.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8: *Water Systems* (Section 4.9)

Sciencepower 8 (Section 10.1)

Prescribed Learning Outcomes

Students will...

8-4-08 Describe how erosion and deposition are influenced by the flow rate of a stream or river, and contrast the related characteristics of young and mature streams.

Examples: meanders, oxbows, alluvial deposits, sandbars, flood plains, deltas...

GLO: C8, D5, E3

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-4e ➲ Demonstrate work habits that ensure personal safety, the safety of others, and consideration for the environment. Include: keeping an uncluttered workspace; putting equipment away after use; handling glassware with care; wearing goggles when required; disposing of materials safely and responsibly. GLO: C1

8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

8-0-9c ➲ Demonstrate confidence in their ability to carry out investigations. GLO: C5

(continued)

Suggestions for Instruction

➢ How Water Affects Land

Have students read/view topographical maps, videos, CD-ROMs, Internet sources, books, magazines, or other reference materials to derive definitions, diagrams, and examples for the following terms: *meander, oxbow, alluvial deposit, sandbar, flood plain,* and *delta*. Have students record their information using the Three-Point Approach (Simons, 1991).

(For a BLM of the Three-Point Approach for Words and Concepts, see *SYSTH* Attachment 10.2, or *Success*, p. 6.101.)

➢ Stream Table Investigation

Provide students with stream tables. (Stream tables may be purchased or built using rectangular plastic containers such as plant trays, wallpaper trays, or storage boxes. Make a hole at one end of each container to drain water.) Have students

- observe the paths/features created in the stream tables by moving water
- experiment with variables such as flow rates, angles of elevation (gradients), and different materials through which the water could flow
- record their observations by indicating the variable they were testing and drawing a diagram of the results
- identify the features they have observed in the stream table (see the terms identified in the "How Water Affects Land" learning activity)

Note: In this investigation, students will readily identify deltas but may find it challenging to identify other features. After students have attempted to test each of the variables, demonstrate and discuss results.

Some possible findings:

- Large pebbles are deposited when a fast stream slows as it levels out (alluvial deposit). Fast-flowing water has more power than slow-moving water to carry heavy objects.
- A fast stream or river is deeper than a slow one and has sharper angles that have been cut into the terrain. The bottom of a slow river has a broader base than that of a fast river.
- Deltas are deposits of sand, soil, and rocks formed where a stream enters a lake or an ocean. This occurs because the speed of the water slows when it comes upon the relatively still water of the lake or ocean and therefore cannot hold as much material.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

PRESCRIBED LEARNING OUTCOMES
Students will...
8-4-08 *(continued)*

SUGGESTIONS FOR INSTRUCTION

(continued)

➢ **Comparing Young and Mature Rivers**

Have students use print and/or multimedia resources to develop posters illustrating and comparing the characteristics of young and mature rivers.

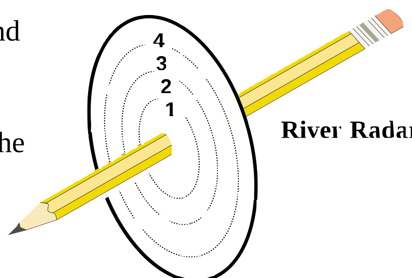
Example:

Characteristics of Young and Mature Rivers

Young Rivers	Mature Rivers
• flow fast	• move slowly
• are straight	• wind, meander
• carve out steep banks	• have gently sloping banks
• carry material of larger size	• carry material of smaller size, are full of sediment
• erode banks quickly	• erode banks slowly

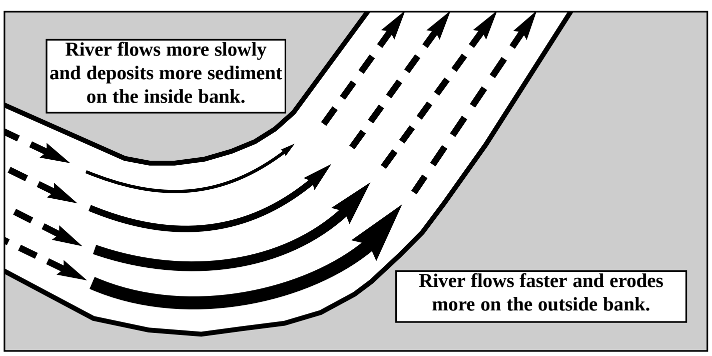
➢ **River Radar**

To illustrate how rivers flow around curves, have students follow these steps:

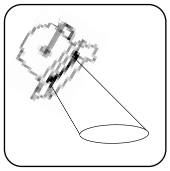


- Cut a disk out of cardboard and divide it into four numbered segments.
- Poke a hole in the middle of the disk, place a pen or pencil through the disk, and spin the disk.
- Observe which numbers appear to be moving faster than others. (The outside numbers appear to move faster.)
- Relate these observations to a meandering river and label the parts of a meander with respect to speed and eroding power.

Example:



Suggestions for Assessment



Where to Build?

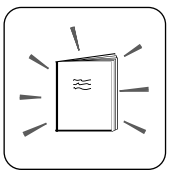
Provide students with the following:

Where to Build?

In your science notebook, explain whether it would be better to build a house on the banks of an outside curve of a river or on an inside curve of a river. Explain your reasoning.

Look for:

The water on the outside portion of a meander moves faster, causing more erosion. A house built on the outside bank may lose support as the river erodes the soil, and may therefore end up in the river. A house built on the inside bank will actually have material deposited around it, thus increasing the size of property.



As the River Runs

Have students create a comic strip, flip book, set of transparency overlays, or another similar product to show the sequence of the development of river features such as meander, oxbow, sandbar, and delta. The product should be suitable to share with students in a lower grade.

As a class, develop an assessment tool for this product, identifying what criteria will be included and whether it will include a self- or peer-assessment component.

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Sections 4.4, 4.9)

Sciencepower 8 (Section 10.1)

PRESCRIBED LEARNING OUTCOMES

Students will...

8-4-09 Describe how wave action and ice movement in large bodies of water cause erosion and deposition.

GLO: D5, E3

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

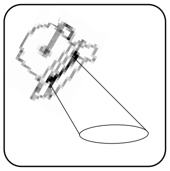
8-0-5a ➲ Make observations that are relevant to a specific question. GLO: A1, A2, C2

SUGGESTIONS FOR INSTRUCTION

➢ **Erosion and Deposition of Shorelines**

Have students use multimedia resources, field trips, or print resources to learn about erosion caused by large bodies of water. A field trip would allow students to make observations and gather information related to this learning outcome, as well as learning outcome 8-4-11. Students can also gather stories from family and friends about examples of effects of ice and wave action (e.g., a dock being broken up by the ice in spring). Have them describe, in their science notebooks, the factors that lead to the erosion and deposition of shorelines in large bodies of water.

Suggestions for Assessment



Lake Winnipeg Beaches

Have students apply their understanding of the movement of rivers, the erosion they cause, and the features they create to explain what takes place along shorelines of large bodies of water. Provide students with the following:

Lake Winnipeg Beaches

You are a researcher who has been studying the erosion of rivers for several years. You would now like to move into a new but related area of study: large bodies of water and their shorelines. Your specific area of study is Lake Winnipeg, and your focus is to explain the differences between the fine-grained shoreline at Grand Beach and the mixed pebble/sand shorelines at Winnipeg Beach and Gimli Beach.

Carry out any research you may think is necessary, consult with fellow scientists (students), and then prepare your report explaining the differences between the make-up of these beaches. Indicate what further information and/or research would be needed to confirm your theory.

Scoring Rubric

Score	Criteria
4	The explanation is plausible, uses examples and/or evidence to support theory, applies prior learning related to river deposition, and contains evidence of higher-order thinking.
3	The explanation is plausible, uses examples and/or evidence to support theory, and applies prior learning related to river deposition.
2	The explanation is plausible, uses examples and/or evidence to support theory, but contains significant errors in thinking.
1	The explanation is implausible and/or contains major errors in thinking.

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.14)

Sciencepower 8 (Section 11.1)

Prescribed Learning Outcomes

Students will...

8-4-10 Explain how tides are caused and describe their effects on shorelines.

GLO: D5, D6

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

Suggestions for Instruction

➢ All about Tides

Have students construct an Inquiry Chart (Hoffman, 1992) to investigate the causes and effects of tides. Teacher and student questions should drive the inquiry. The process of constructing Inquiry Charts (I-Charts) requires students to access prior knowledge, identify information sources, carry out research, generate summary statements for their findings, and record information.

(For further information related to I-Charts, refer to *5-8 ELA*, Strategies, p. 83. For strategies to aid students in using a variety of information sources, determining the usefulness of information, constructing meaning, recording information, and referencing and evaluating sources, refer to *5-8 ELA*, learning outcome 3.2.2–3.2.5 and 3.3.2–3.3.3.)

➢ Effects of Tides

Have students use a Word Splash (Saphier and Haley, 1993) to gather information about tides. (For a discussion of this strategy, see *Success*, p. 6.28.)

Divide students into groups of three and ask them to assign a recorder in the group. Give each group the title of the article "The Effects of Tides" and the corresponding "Word List: Tides" (BLM 8-K). Ask groups to

- make thought connections between different words on their list
- record their connections in note form or on a map
- identify connections they believe to be true and connections of which they are unsure

Review each group's thought connection notes or map, and then ask students to read the article "The Effects of Tides" (BLM 8-L). Once students have read the article, have each group meet and analyze their word connection notes or map and identify differences between their predictions and the actual information in the article.

SUGGESTIONS FOR ASSESSMENT

All about Tides

When assessing the "All about Tides" student inquiry, look for indications of the following:

All about Tides: Assessment Checklist		
Criteria The student	**Yes**	**No**
• uses pre-established criteria to evaluate information sources		
• self-questions to determine appropriateness of sources		
• discards inappropriate sources		
• differentiates between suitable and unsuitable information		
• recognizes that information serves different purposes		

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8: *Water Systems* (Section 4.15)

Sciencepower 8 (Section 11.1)

Prescribed Learning Outcomes	**Suggestions for Instruction**
Students will...	
8-4-11 Describe examples of human interventions to prevent riverbank or coastal erosion. *Examples: vegetation, reinforcement (concrete, boulders), piers, breakwaters...* GLO: B2, B5, D5 **8-0-2a** ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)	➢ **Local Survey** Have students tour their community to identify examples of methods used to prevent riverbank or coastal erosion. Students should sketch and describe each example. Discuss safety issues prior to leaving the class. This learning experience can be supplemented (or replaced) with a presentation by a guest speaker (e.g., a member of the local public works department responsible for preventing riverbank erosion). Multimedia and/or print resources can also be used to illustrate different methods of riverbank or coastal erosion.
8-4-12 Identify factors that can cause flooding either individually or in combination. *Examples: heavy snow pack, quick thaw, rain in spring, lack of vegetation to remove water through transpiration, frozen ground preventing absorption, agricultural drainage systems, dams, diversions...* GLO: C8, D5 **8-0-2a** ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2) **8-0-2b** Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2) **8-0-2c** Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2) **8-0-4c** ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2) **8-0-7g** ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)	➢ **Recipe for a Flood** 1. Using multimedia, Internet, and print resources, have students determine the factors that lead to flooding in general, and the factors that led to the Manitoba Flood of 1997 in particular. 2. Have small groups of students create a recipe/scenario for a flood disaster that contains at least three steps. Provide students with key phrases such as the following: • Start with... • Add (or Remove)... • Result: Have students present their recipes/scenarios orally or on a large recipe card. Example: Start with a wet summer where the water tables are high. Add several heavy snowfalls in winter and a quick spring thaw where the ground is still frozen and cannot absorb the extra runoff. Add extra precipitation in the form of heavy rainfall within a short period. End off with a large frozen lake that impedes the movement of the runoff. Result: Backup of extra water/runoff and subsequent higher river levels that cause flooding.

SUGGESTIONS FOR ASSESSMENT

Recipe for a Flood

When assessing students' "Recipe for a Flood," look for indications of the following:

Rating Scale					
Criteria	**Poor**		**Good**		**Excellent**
The recipe					
• includes key causes of floods	1	2	3	4	5
• presents information in a recipe format	1	2	3	4	5
• uses clear, correct language	1	2	3	4	5

SUGGESTED LEARNING RESOURCES

'Protecting Your Shorelands' Canada Fisheries and Oceans Publication (Dept. of Fisheries and Oceans Central and Arctic Region, 501 University Crescent, Wpg. MB. R3T 2N6. Phone: 983-5108)

Nelson Science & Technology 8: *Water Systems* (Sections 4.14, Design Challenge)

Sciencepower 8 (Section 11.1)

Nelson Science & Technology 8: *Water Systems* (Section 4.8)

Sciencepower 8 (Section 10.1)

PRESCRIBED LEARNING OUTCOMES	SUGGESTIONS FOR INSTRUCTION

Students will...

8-4-13 Provide examples of the way in which technology is used to contain or prevent damage due to flooding, and discuss related positive and negative impacts.

Examples: floodway, diversion, dike, levee...

GLO: A5, B1, D5

8-0-8d ➲ Describe examples of how technologies have evolved over time in response to changing needs and scientific advances. GLO: A5, B1, B2

8-0-8g ➲ Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

8-0-9e ➲ Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

8-0-9f ➲ Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

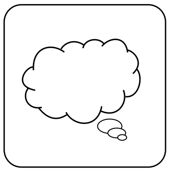
➢ **Case Study: Manitoba Flood of 1997**

As a class, identify the major barriers used to prevent damage by flood water during the Manitoba Flood of 1997 (e.g., Red River floodway, Brunkild dike, levees, sandbags). Divide the class into groups and have each group

- describe each barrier used to prevent flood-water damage
- explain how each barrier worked
- highlight technology that made each barrier possible (e.g., the development of a new sandbagging machine)
- discuss the positive and/or negative impacts of each barrier
- give an oral presentation or create a poster featuring information gathered for this case study

(**Note:** *Red River Raging: The Flood of the Century, Manitoba 1997*, a video produced by CKND Newsline and Canwest Global System, can be obtained through the Manitoba Text Book Bureau.)

SUGGESTIONS FOR ASSESSMENT



Journal Reflection

Have students reflect, in their science journals, how they were affected (if at all) by the Manitoba Flood of 1997, or by subsequent floods.

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8: *Water Systems* (Sections 4.4, 4.8)

Sciencepower 8 (Section 10.1)

Prescribed Learning Outcomes

Students will...

8-4-14 Identify sources of drinking water and describe methods for obtaining water in areas where supply is limited.

Examples: desalination, melting of ice, condensation...

GLO: B1, B2, B3, D5

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

8-0-8g ➲ Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

8-0-9e ➲ Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

(continued)

Suggestions for Instruction

➢ **Sources of Drinking Water**

Have students identify the source of their drinking water and the drinking water of neighbouring communities (e.g., specific lakes, rivers, or wells).

"Slow the Flow" available from Fort Whyte Centre (telephone 204-989-8358) contains student learning activities related to sources of drinking water across Manitoba and Canada.

Ask students to identify how/where they would obtain clean drinking water if they were

- on a canoe trip (They could obtain water directly from a lake or a swiftly running river, but might need to use water purifying tablets/filters or boil the water to ensure cleanliness.)
- on a winter camping trip (They could melt snow or ice. Explain that snow or ice should be melted to prevent hypothermia.)
- hiking in the desert (They could carry water.)

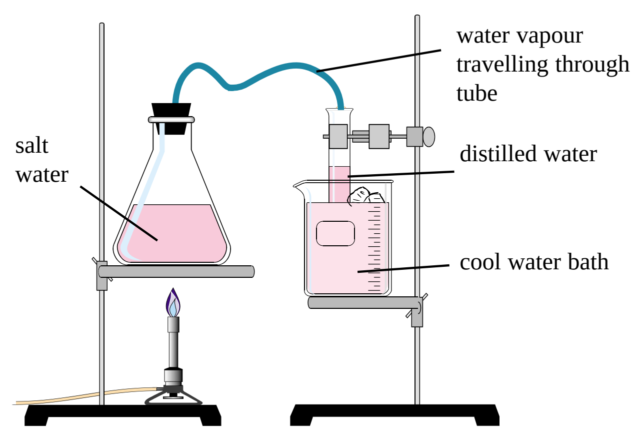
➢ **Other Methods of Obtaining Clean Drinking Water**

Part A: Distillation

Place some salty water in one pan and distilled water in another pan. Have students compare pans after evaporation has occurred and cite proof as to whether the salt was separated from the water.

> Teacher Notes
>
> **Prior Knowledge**
>
> Separating mixtures was addressed in Grade 7, Cluster 2: Particle Theory of Matter.

Demonstrate the distillation of salt water (as shown in the diagram below).



Have students explain whether there is the potential for large-scale use of distillation in the production of clean drinking water.

(continued)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Nelson Science & Technology 8: *Water Systems* (Section 4.5)

Sciencepower 8 (Section 12.3)

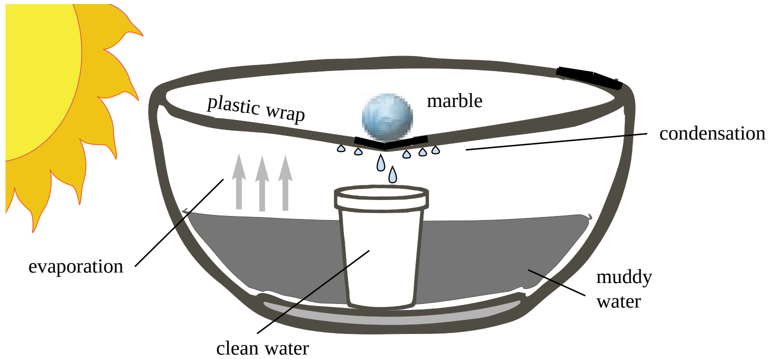
Prescribed Learning Outcomes
Students will...
8-4-14 *(continued)*

Suggestions for Instruction

(continued)

Part B: Solar Still

Demonstrate the use of a solar still to obtain clean drinking water (see diagram below). Ask students to explain the process of obtaining the drinking water. Have them explain whether there is the potential for large-scale use of this method in the production of clean drinking water.



➢ **Role of Wetlands**

Have students investigate the role of wetlands in cleaning water and in recharging groundwater supplies. Nature centres such as Oak Hammock Marsh can provide resources on this topic and serve as field trip destinations.

➢ **Areas Where Water Supply Is Limited**

Have students, working in groups, research a variety of sources to determine areas where the supply of clean drinking water is limited (e.g., in areas of California where water may be contaminated due to natural disasters) and identify ways in which those communities are attempting to solve the problem (e.g., desalinization, boiling water, rationing, buying water from another country). Ask each group to create a short newspaper article in which they detail the location experiencing a water shortage, explain the problem, and describe the community's attempts to solve it.

Note: Students should recognize that clean-looking drinking water does not automatically mean that the water is free of bacteria—it may require boiling or disinfecting.

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

Have students complete the "How I Worked in My Group" (BLM 8-M) for self-assessment purposes.

PRESCRIBED LEARNING OUTCOMES

Students will...

8-4-15 Explain how and why water may need to be treated for use by humans.

Include: filtration, settling, chlorination, fluoridation.

GLO: B1, B3, D5

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

SUGGESTIONS FOR INSTRUCTION

➢ **Drinking Water: Guest Speaker**

Invite a guest speaker to talk to the class about the source and treatment of the local water supply. Have students prepare questions prior to the visit, actively listen to the speaker during the discussion, and take notes on the information provided. Ensure that students become familiar with the terms *filtration, settling, chlorination,* and *fluoridation.*

Note: Learning activities related to learning outcomes 8-4-15 and 8-4-17 may be found at the following websites:

- Learning for a Sustainable Future <http://www.schoolnet.ca/learning/teacher/classroom/index_en.html> (see Travelling Pollutants, Pollution Close to Home, and Poisoned Water)
- Environment Canada <http://www.ec.gc.ca/water_e.html>

Information can also be obtained from Manitoba Conservation, Water Quality Management Section (telephone 1-800-282-8069), and City of Winnipeg, Water and Waste Department (telephone 204-986-4478).

Suggestions for Assessment

Drinking Water: Guest Speaker

When assessing students' active listening skills, look for indications of the following:

Assessing Active Listening

Observed Behaviours	Student Names								
• looks at speaker									
• controls personal activity level									
• encourages the speaker with non-verbal cues (nodding, smiling)									
• asks relevant questions									
• shows respect for the speaker (does not interrupt, distract others)									

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.7)

Sciencepower 8 (Section 12.3)

Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators (Teacher Reference)

Prescribed Learning Outcomes

Students will...

8-4-16 Compare the waste-water disposal system within their communities to one used elsewhere.

Include: process involved, environmental impact, cost.

GLO: B2, B5

8-0-2a ➲ Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

Suggestions for Instruction

➢ **Sewage Treatment Facility**

Have the class visit a local sewage treatment facility or examine information pamphlets on its operation. Following the visit/study, have students answer the following questions in their science notebooks:

1. How does sewage get to the treatment plant?
2. What biological components can be used to help break down sewage?
3. What are some additional treatment steps taken to clean the water?
4. What happens to the cleaned (potable) water after treatment?
5. What steps are taken to ensure that the effluent meets environmental standards before it is reintroduced into the natural water system?
6. Where is the solid waste deposited after treatment?
7. Is it used for any other purpose?
8. Is the present sewage treatment facility working at capacity?
9. Is there a need for expansion or for building another facility to keep up with population demands? If so, what would it cost to upgrade the existing facility or to build a new one?

➢ **Other Methods of Waste-Water Disposal**

Have students research other methods (e.g., septic field and sewage pump-out system, ejector system with solid waste pump-out system, outhouse with pit for sewage) used for waste-water disposal. Ask students to draw a diagram, write a brief description of a specific disposal method, and describe the associated environmental impacts.

Suggestions for Assessment

Other Methods of Waste-Water Disposal

When assessing students' work related to "Other Methods of Waste-Water Disposal," look for indications of the following:

Rating Scale			
Criteria	**Possible Points***	**Self-Assessment**	**Teacher Assessment**
Waste disposal method is clearly described.			
Diagram is labelled and effectively illustrates process.			
Environmental impacts are identified and discussed.			
A variety of resources are included.			
References are cited appropriately.			

* Relative weights should reflect the particular emphasis(es) of this assessment.

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Section 4.7)

Prescribed Learning Outcomes

Students will...

8-4-17 Identify substances that may pollute water, related environmental and societal impacts of pollution, and ways to reduce or eliminate effects of pollution.

GLO: B2, B3, B5, D5

8-0-2a Access information, using a variety of sources. *Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet…* GLO: C6 (ELA Grade 8, 3.2.2)

8-0-2b Develop and use criteria for evaluating information sources. Include: distinguish between fact and opinion. GLO: C6, C8 (ELA Grade 8, 3.2.2, 3.2.3; TFS 2.2.2)

8-0-2c Make notes in point form, summarizing major ideas and supporting details and referencing sources. GLO: C6 (ELA Grade 8, 3.3.2)

Suggestions for Instruction

➢ **Identifying Water Pollution Issues**

Have students look for newspaper and/or magazine articles related to water pollution (e.g., the potential effects of hog farming, E. coli, oil spills). Have them use an Issue-Based or a Fact-Based Article Analysis sheet (Matchullis and Mueller, 1994) to record information as they read the articles.

(For a BLM of an Issue-Based and a Fact-Based Article Analysis sheet, see *SYSTH*, Attachments 11.5 and 11.6, or *Success*, pp. 6.114-6.115.)

Teacher Notes

This learning experience would be a good introduction to Public Hearing (an instructional strategy suggested for learning outcome 8-4-18), where students choose one issue to analyze and hear presentations from all parties involved in the issue.

Suggestions for Assessment

Journal Reflection

Have students reflect, in their science journals, on the importance of the issue of water pollution to society and the environment.

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Sections 4.6, 4.17)

Sciencepower 8 (Sections 10.1, 10.3, 12.3)

Prescribed Learning Outcomes

Students will...

8-4-18 Identify environmental, social, and economic factors that should be considered in the management of water resources.

Examples: ecosystem preservation, employment, recreation, industrial growth, water quality...

GLO: B5, D5

8-0-4c ➲ Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 8, 5.2.2)

8-0-7b ➲ Critically evaluate conclusions, basing arguments on fact rather than opinion. GLO: C2, C4

8-0-7f ➲ Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts. GLO: A2, C4 (ELA Grade 8, 1.2.1)

8-0-7g ➲ Communicate methods, results, conclusions, and new knowledge in a variety of ways. *Examples: oral, written, multimedia presentations...* GLO: C6 (ELA Grade 8, 4.4.1)

8-0-7h ➲ Identify and evaluate potential applications of investigation results. GLO: C4

8-0-8g ➲ Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5

8-0-9b ➲ Express interest in a broad scope of science- and technology-related fields and issues. GLO: B4

8-0-9e ➲ Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment. GLO: B5

8-0-9f ➲ Consider both immediate and long-term effects of their actions. GLO: B5, C4, E3

Suggestions for Instruction

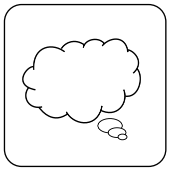
➢ **Public Hearing**

Have students prepare presentations for, and hold a public hearing on, an environmental issue that deals with the management of water resources, proceeding as follows:

1. Select an issue that affects a local or global water supply, such as:
   - locating a new landfill site on land near a creek
   - moving oil supertankers through the Arctic Ocean and the straits near Canada’s northern islands
   - developing a gold mine by Shoal Lake (Winnipeg’s water source)
   - building a river diversion for the purpose of irrigating farmland
   - selling fresh water to the United States
   - developing cottages on a lake that is used as a water supply by a population centre
   - building a new pulp and paper mill
   - diverting water from one watershed into another
2. Select five students to form a hearing panel, one of whom will serve as the chairperson. The role of the panel is to listen to all the presentations and ultimately come up with a decision following the hearings.
3. Research and create a presentation arguing either in favour of or in opposition to the selected issue, based on the following points of view:
   - government officials
   - company representatives
   - environmentalists
   - citizens who will be affected by the issue
   - other companies who might benefit if the proposal is accepted
   - local people who might benefit if the proposal is accepted
4. Students who are not on the hearing panel should role-play the presentations, addressing the hearing panel. (Each presentation should be approximately five minutes.)
5. Submit a hard copy (written or on a computer disk) to the panel/teacher upon completion of the presentation.

(For strategies and assessment suggestions to aid students in developing appropriate delivery skills for use in presentations, as well as public listening and viewing behaviours, refer to *5-8 ELA*, learning outcomes 4.4.2-4.4.3.)

SUGGESTIONS FOR ASSESSMENT



Presentation to the Hearing Panel

Provide students with the following self-assessment tool:

Self-Assessment of Presentation

Name ____

Issue ____

I represented/played the role of ______________________

1. I found it difficult to represent my character's side because ______
   ____
2. I especially represented my character well when I ______________
   ____
3. Other characters whose views were similar to those of my character were ____
   ____
4. If I were to make a second presentation to the hearing panel, I might include other points of information such as ______________
   ____
5. Topics I might have to research to obtain more pertinent information to present to the panel include ____________________
   ____
6. I could have improved my actual presentation in the following way(s) (e.g., spoken more clearly, dressed appropriately, provided visuals, looked at the panel while speaking) ____________________
   ____
7. As a student, I agreed with the conclusion of the panel. (Circle one and explain the reason for your answer.) Yes No________________
   ____
   ____

SUGGESTED LEARNING RESOURCES

Education for a Sustainable Future: A Resource for Curriculum Developers, Teachers, and Administrators. Winnipeg, MB: Manitoba Education and Training, 2000.

Nelson Science & Technology 8: *Water Systems* (Sections 4.6, 4.18, 4.21)

Sciencepower 8 (Section 12.3)

Prescribed Learning Outcomes

Students will...

8-4-19 Use the design process to develop a system to solve a water-related problem.

GLO: B2, B3, C3, D5

8-0-1c Identify practical problems to solve. *Examples: How can I make water flow uphill? Which type of bottled water should I buy?…* GLO: C3

8-0-1d ⊂ Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.8)

8-0-3d ⊂ Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3

8-0-3e ⊂ Create a written plan to solve a problem. Include: materials, safety considerations, three-dimensional sketches, steps to follow. GLO: C3, C6

8-0-4b ⊂ Construct a prototype. GLO: C3

8-0-5b ⊂ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5

8-0-6d ⊂ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4

8-0-7d ⊂ Propose and justify a solution to the initial problem. GLO: C3

8-0-7e ⊂ Identify new practical problems to solve. GLO: C3

Suggestions for Instruction

➢ **Design Process**

Have students design a system to solve a water-related problem. Examples:

- a filtration system to clean dirty water
- a way to clean an oil spill
- a way to prevent nitrates from entering streams and rivers
- a way to provide potable water on a camping trip or during an environmental emergency in an area where drinking water has been contaminated

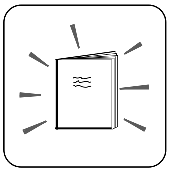
Ask students to create a written plan for the system, identify materials for a working model, and develop criteria for a successful design (e.g., removes 90% of the oil spill). When the plans are completed and the materials have been gathered, have students test the effectiveness of their designs, using evaluation criteria such as following:

- shows a reduction in pollutant
- includes detailed drawings

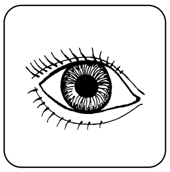
Students may use “Design Project Report” (BLM 8-O) to record their work.

Suggestions for Assessment

Refer to the following BLMs for assessment suggestions:



"Design Project Report: Assessment" (BLM 8-P)



"Constructing a Prototype: Observation Checklist" (BLM 8-N)

Suggested Learning Resources

Nelson Science & Technology 8: *Water Systems* (Design Challenge)

Sciencepower 8 (Section 12.3, Unit 4)

By Design: Technology Exploration & Integration (Design Process Reference and Tools)

Design and Technology System (Design Process Reference and Tools)

Mathematics, Science, & Technology Connections (Design Process Reference and Tools)

Notes

Grade 8

Blackline Masters

- The Compound Microscope (BLM 8-A)
- Waves (BLM 8-B)
- The Titanic (BLM 8-C)
- A Tiring Story (BLM 8-D)
- How We Worked Together (BLM 8-E)
- World Map: Ocean Currents (BLM 8-F)
- Facts about Ocean Currents (BLM 8-G)
- How Big Lakes and Oceans Affect Climate: Weather by the Water (BLM 8-H)
- The Incredible Journey (BLM 8-I)
- North America: Watersheds (BLM 8-J)
- The Effects of Tides (BLM 8-K)
- Word List: Tides (BLM 8-L)
- How I Worked in My Group (BLM 8-M)
- Constructing a Prototype: Observation Checklist (BLM 8-N)
- Design Project Report (BLM 8-O)
- Design Project Report: Assessment (BLM 8-P)
- Conducting a Fair Test: Observation Checklist (BLM 8-Q)
- Experiment Report (BLM 8-R)
- Experiment Report: Assessment (BLM 8-S)

The Compound Microscope

Purposes:

- Identify and describe the function of the parts of a compound microscope.
- Demonstrate proper care and use of the microscope (i.e., carrying the microscope, cleaning lenses, focusing carefully).
- Demonstrate the ability to prepare wet mounts, focus, calculate magnification, estimate specimen size, and sketch specimens as they appear under magnification using a compound microscope.

Procedure:

A. Handling the Microscope

1. Clean lenses as needed using lens paper only. Normal tissue is too coarse and may scratch lenses.
2. Microscopes are fragile and must be handled with care. Carry the microscope with one hand under the base and one hand grasping the arm. Make sure the electrical cord is secured to prevent accidents.
3. Put the lowest power objective lens in place and cover the microscope with the dust cover when finished.
4. Never use direct sunlight as a light source.

B. Adjusting Light

The diaphragm regulates the amount of light passing through a specimen. Too much light results in flare, causing a lack of contrast or lost detail when viewing the specimen.

C. Preparing a Wet Mount

1. Place a drop of water on the slide.
2. Place a very thinly sliced specimen in the water.
3. Hold the cover slip against the water at a 45-degree angle, and then release. This will reduce the number of air bubbles, which may obscure portions of the specimen or the entire specimen. Gently pressing on the coverslip with a pencil eraser can eliminate some air bubbles.

D. Focusing

1. Always begin with the lowest power objective lens in position. This gives the largest field of vision and the greatest depth of field. It also reduces the chance of the lens striking the slide.
2. To avoid breaking the slide during focusing, move the lowest power objective lens as close as possible to the slide while watching from the side of the microscope. Centre the specimen and focus by moving the objective lens away from the slide.
3. Turn the adjustment dials to sharpen the image.
4. Adjust the diaphragm for optimum contrast.
5. When going from a lower power objective lens to a higher power objective lens:
   - centre the specimen in the field of view
   - change to the next power objective lens
   - use the adjustment dials to sharpen the image and adjust the diaphragm for optimum contrast

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E. Determining Total Magnification

Total magnification = ocular lens power x objective lens power (e.g., 5X x 4X = 20X)

Note: the units are times (X).

1. Determine the total magnification for each combination of ocular and objective lenses found on your microscope. Complete the table below:

	Ocular Lens Power (X)	**Objective Lens Power (X)**	**Total Magnification (X)**
Low Power			
Medium Power			
High Power			

2. Prepare a wet mount slide of the following letter: e (lower case). Use an "e" from a newspaper or magazine or draw your own.
   a. In the space below, draw the letter as it appears with the unaided eye on the stage of the microscope. To the right of this diagram, draw the letter as it appears in the field of view under low power.

   b. Compare the two drawings and describe what you see. (In your description, answer the following questions: What is the consistency of the ink or pencil lead? Describe the texture of the paper. Is the position or orientation of the letter in the two drawings the same or different?)

   c. Describe the movement of the specimen in the field of view when you move the slide to the left. Describe the movement of the specimen in the field of view when you move the slide away from you.

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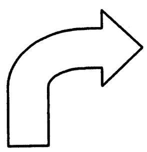
d. Make a general statement about the orientation and movement of objects viewed through a microscope.

e. What would you say to help a friend who is having trouble locating a specimen in the field of view?

f. The image below is drawn as viewed through the microscope. Draw what you would expect to see on the stage.



3. Prepare a wet mount slide of two overlapping hairs or thin threads.

   a. Locate the hairs under low power. Is it possible to have both hairs in focus?

   b. Locate the hairs under medium power. Is it possible to have both hairs in focus? Draw what you see. Indicate the total magnification.

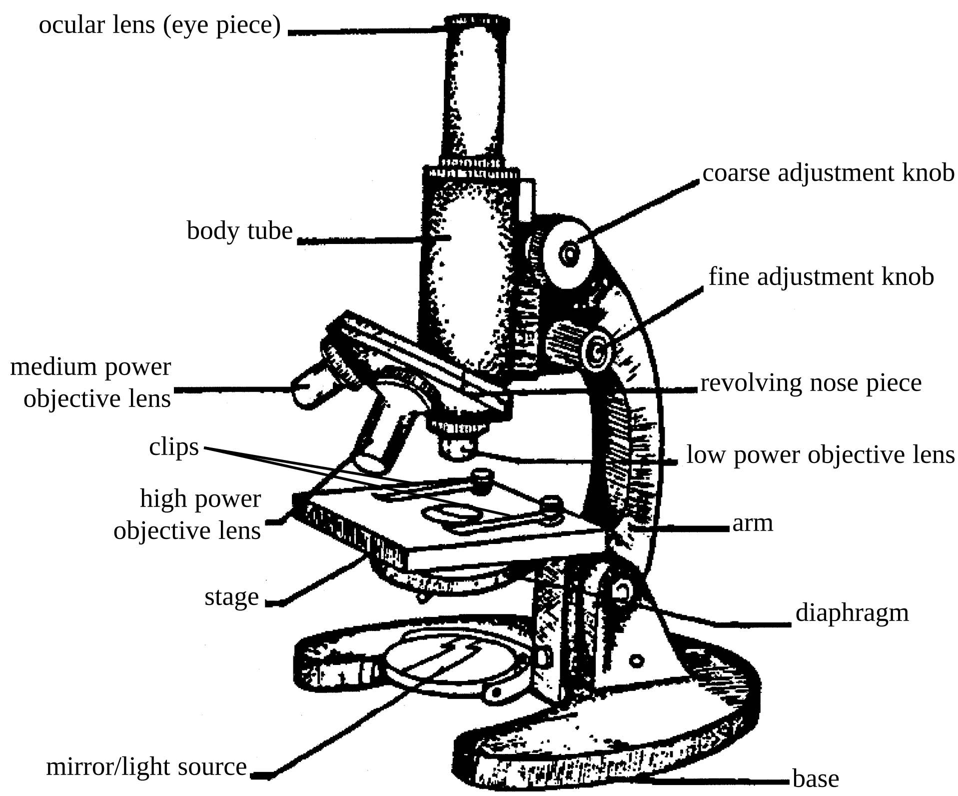
   c. Locate the hairs under high power. Is it possible to have both hairs in focus?

   d. What happens to the depth of field (i.e., the ability to focus on more than one object when the objects are at different depths on the slide) as magnification increases?

(continued)

(continued)

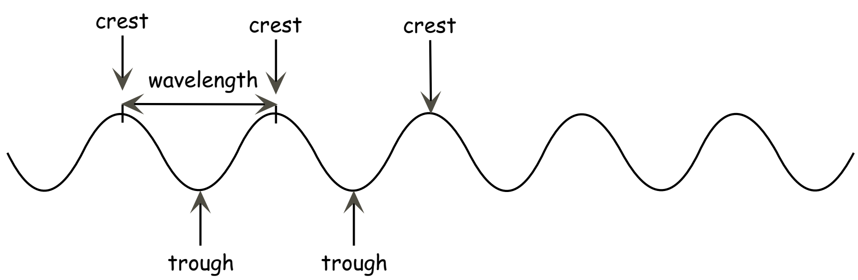
The Microscope



Waves

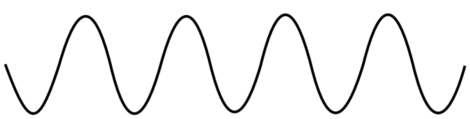
Electromagnetic radiation describes a stream of massless particles, each travelling in a wave-like pattern at the speed of light, and containing a certain amount of energy. The *electromagnetic spectrum* is the term used to describe the whole range of different types of electromagnetic radiation, each with its own wavelength, frequency, and amount of energy. Types of electromagnetic radiation include: radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays, and gamma rays.

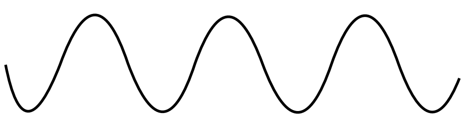
1. Observe a still surface of water that is touched by a vibrating rod. Describe the movement of the water when the rod touched the surface of the water and draw an overhead view and a side view of the water movement.
2. Electromagnetic radiation also moves in waves. To find the wavelengths of the representative diagram below, use a ruler to measure the distance from one crest to another.

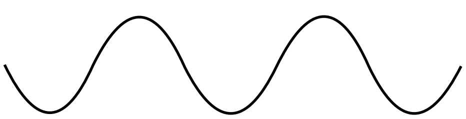


3. The number of waves within a specified distance is the frequency of a wave of electromagnetic radiation. Using a ruler, determine which of the following has the highest (most waves per cm) frequency.

Number of waves per cm

a.  ______________________

b.  ______________________

c.  ______________________

4. What is the relationship between the wavelength and the frequency of a wave of electromagnetic radiation?

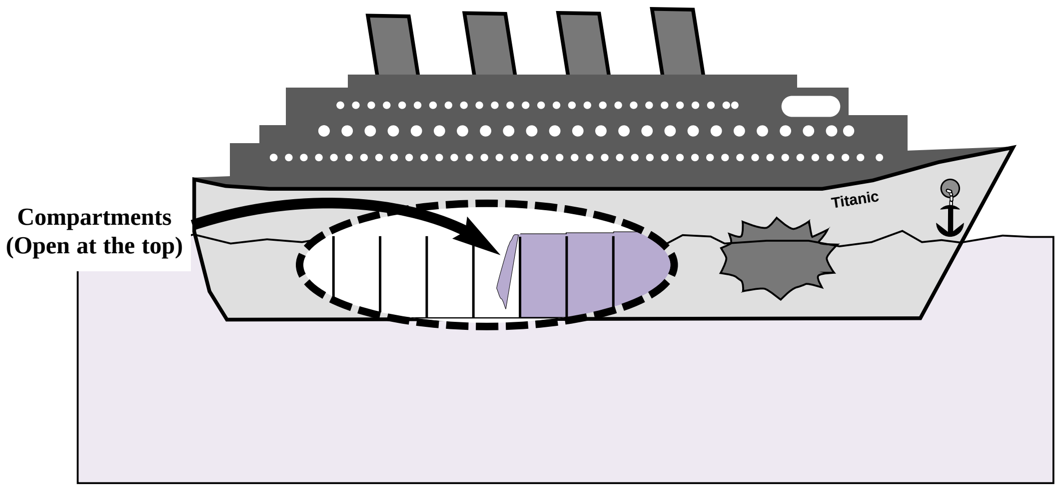
Look for:

1. Waves rippled out in circles from the point of contact. Higher waves emanated from the centre, eventually becoming lower waves and then disappearing.
2. 2 cm
3. (a) has the highest frequency.
4. The higher the frequency, the shorter the wavelength.

The Titanic

The Titanic, a passenger liner launched April 10, 1912, was considered unsinkable. Because it was believed that lifeboats would never be needed, the ship was equipped with fewer lifeboats than were necessary to hold all of the passengers on board. Designers had built in some safeguards, however. Besides having a well-built hull, the bottom portion of the ship was hollow with walled-off compartments of air so that in case the hull was damaged and water seeped in, the water would fill up only one compartment and the ship could still float.

On the night of April 14, off the coast of Newfoundland, the Titanic ran into an iceberg that ripped open the side of its hull. The compartments worked; water filled the once air-filled compartments and then did not invade the rest of the ship . . . initially, that is.



Based on your findings regarding density and buoyancy, create a newspaper article informing the public of the scientific flaws of the Titanic's specially made compartments and their inability to keep the Titanic afloat. Suggest design modifications to improve the effectiveness of the compartments.

Look for:

The compartments were initially filled with air, which made the ship's average density less than that of sea water. As sea water filled the compartments, the ship began to lose its ability to float. As the Titanic began to tip, more of the compartments filled with water, creating an average density that became greater than the buoyant force of the sea water. If the compartments had been closed off at the top, water might not have overflowed into the neighbouring compartments.

A Tiring Story

One fine spring day, Sam took his car to a local garage, had the oil in his car changed and, as part of the car maintenance program, had the air pressure in his tires checked. The mechanic said that the air pressure was good.

One chilly morning a few days later, Sam went out to his car and noticed that his back left tire looked a little flatter. On his way to work he stopped at a local self-serve gas station to put some air in his tire but realized he didn't have his tire air pressure gauge with him. Not having time to go back home to get it, Sam put a small amount of air in his tire.

Weeks passed and Sam went for a summer trip across the prairies. One day after he had been driving several hundred kilometres during a scorching heat wave, Sam experienced a blowout. Luckily it was a rear tire, no other cars were around, and he was able to keep control of his car and come to a safe stop.

Sam purchased a new tire at a nearby town. He had it installed and had all his tires checked for wear and tear and air pressure. The mechanic assured Sam that everything was up to specifications.

Months passed and Sam had no problems with his tires until one cold night in January. In fact, it was so cold that the thermometer outside his window read –40°C. Sam was called into work for an emergency and when he got to his car he noticed all four tires were low. Sam decided to call a taxi cab to avoid the chance of getting stuck with a flat tire on the road late at night.

Explain what happened to Sam's tires.

Look for:

The tires are being affected by the temperature of the air. (Cold temperatures caused the pressure in the tires to drop and subsequently reduce the volume, which gave the tire the appearance of being flat.) High temperatures and increased heat energy due to the friction of the road caused the pressure and the volume to increase until the tire burst.

How We Worked Together

Name: ________________________________

Date: ________________________________

Task: ________________________________

Group Members:

____

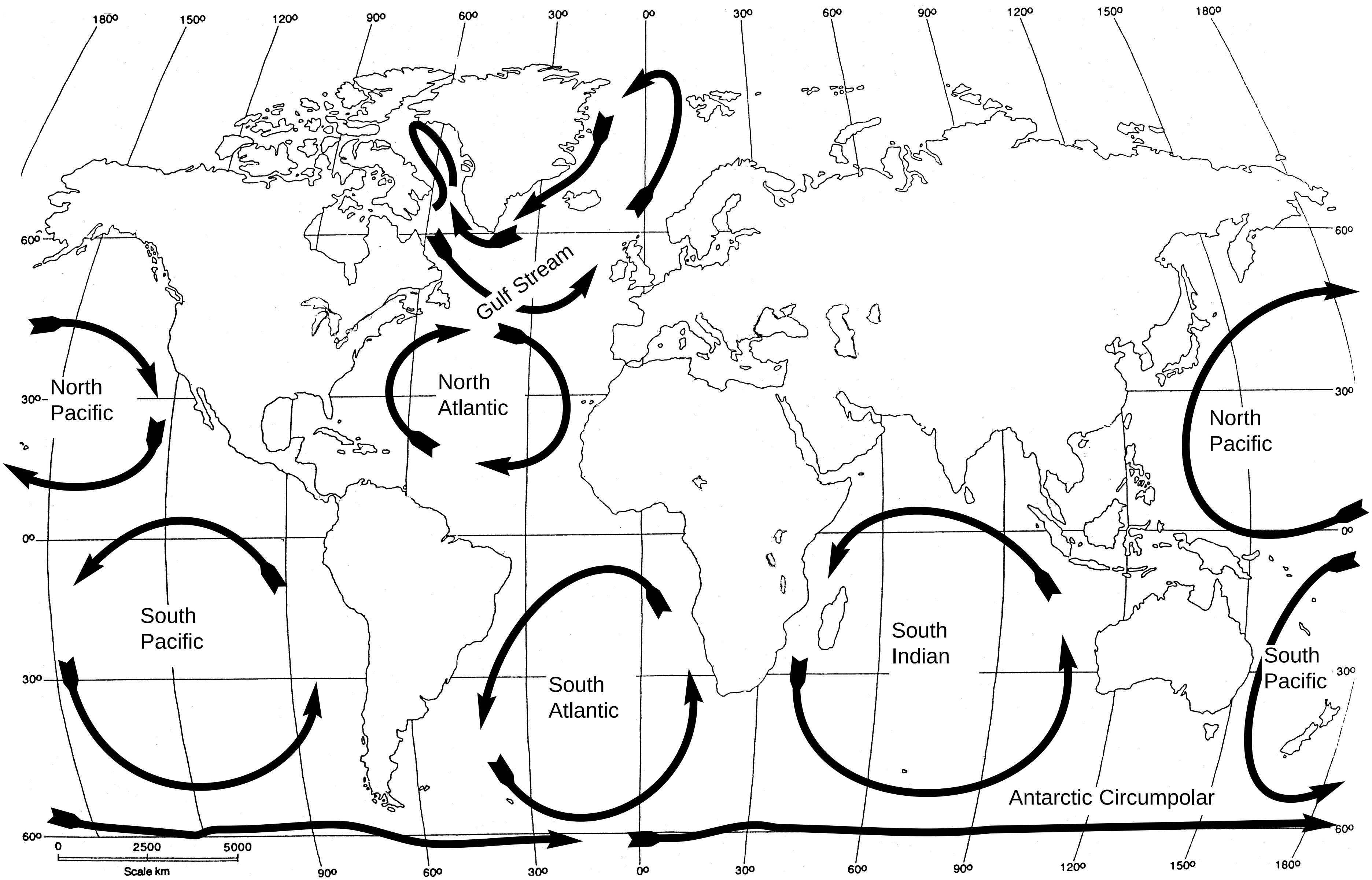
____

____

	Yes	Sometimes	No
Everyone participated.			
We listened to each other.			
We encouraged each other.			
We took turns sharing ideas.			
The group stayed together.			
We accomplished our task.			

How We Worked Together: Reproduced from *Grades 5 to 8 Mathematics: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1997. Appendix.

World Map: Ocean Currents



Facts about Ocean Currents

- Ocean waters are constantly on the move. How they move influences climate and living conditions for plants and animals, even on land.
- Currents flow in complex patterns affected by wind, the water's salinity and heat content (density), bottom topography, the position of continents, and the Earth's rotation (Coriolis effect).
- The ocean is layered. It is cold at the bottom and warmer on top.
- Warm surface currents invariably flow from the tropics to the higher latitudes, driven mainly by atmospheric winds and the Earth's rotation.
- Cold surface currents come from polar and temperate latitudes, and they tend to flow toward the equator, driven mainly by atmospheric forces.
- Our planet's rotation produces a force on all bodies of water moving relative to the Earth. That force is greatest at the poles and least at the equator. It is called the Coriolis effect, and it causes the direction of winds and ocean currents to be deflected. Water is deflected clockwise, or to the right, in the northern hemisphere, and counterclockwise, or to the left, in the southern hemisphere.
- Ocean water at the surface is warmed at the tropics and moves toward the poles where it loses heat, becomes saltier and denser, and sinks.
- The cold bottom layer of ocean water circulates through the oceans, taking up to 1,000 years to circulate completely throughout the oceans of the Earth.
- The Gulf Stream surface current is one of the strongest currents. It is warm, deep, fast, and relatively salty.
- Organisms move from one layer of the ocean to another, and plant and animal remains containing nutrients "rain" down. Upwelling stirs the oceans and brings nutrients that have settled in deep water back to the surface, providing a rich source of nutrients for marine organisms, particularly fish. Coastal upwelling occurs against the western sides of continents in the Atlantic, Indian, and Pacific Oceans. There, colder water rises to replace warm surface water blown out to sea by strong winds. Upwelling supports about half of the world's fisheries.

The Antarctic Circumpolar Current

- The Southern Ocean is the only ocean that circles the globe without being blocked by land. It contains the Antarctic Circumpolar current and is the world's largest ocean current.
- The Antarctic bottom water (cold, salty, and dense) sinks into the deep sea, spills off the continental shelf, and travels northward hugging the ocean floor beneath other water masses. This is a huge amount of water that pushes the warmer water out of the way, usually by flowing underneath it, causing new flows and currents in other directions. It travels as far as the North Atlantic and North Pacific Oceans. The bottom water flowing away from Antarctica has to be replaced by other water, so the warmer waters in the north tend to flow southward to fill the gap. Then they cool down and the cycle keeps going.
- The Antarctic Circumpolar current has a powerful influence on much of the word's climate as it redistributes heat, influencing patterns of temperature and rainfall.

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Ocean Currents: Questions

1. List the factors that affect the movement of ocean currents.
2. Indicate which of these factors predominantly affect the surface (horizontal) movement of currents. Indicate which factors affect the ocean's lower layer and result in convection currents (vertical movement) as well as horizontal movement.
3. What impact does the Coriolis effect have on the direction of wind and ocean currents?
4. Why is density important to understanding the movement of ocean currents?
5. What affects the density of ocean water?
6. Draw two labelled diagrams to contrast what takes place in coastal upwelling with what takes place with the Antarctic bottom water. The diagrams should clearly show the movement of warm and cold water.
7. Why is ocean water upwelling important to the economy?
8. Why is the movement of the Antarctic bottom water important?

Look for:

1. Wind, water's salinity and heat content (density), bottom topography, position of continents, and the Coriolis effect influence the movement of ocean currents.
2. Surface: wind, position of continents, Coriolis effect
   Lower layer: water's salinity and heat content (density), bottom topography, Coriolis effect
3. The Coriolis effect deflects wind and ocean currents to the right in the Northern hemisphere, and to the left in the southern Hemisphere.
4. Denser water sinks.
5. The temperature and salinity of the water affect the density of ocean water.
6. In coastal upwelling, cold water rises to replace the warm surface water blown out to sea by strong winds. The dense Antarctic bottom water sinks into the deep sea, spills off the continental shelf, and travels north. As a result, warm water is drawn south to replace it.
7. Upwelling brings nutrients to the surface for fish, resulting in good fishing areas.
8. The movement of the Antarctic bottom water circulates water around the world and redistributes heat, influencing temperature and rainfall.

HOW BIG LAKES AND OCEANS AFFECT CLIMATE

WEATHER BY THE WATER

Among water's amazing properties is its capacity to hold and transfer heat. This property has significant implications for arctic weather patterns, especially for those of us who live right next door to the sea or one of the many "Great Lakes" of the north.

Water absorbs and releases heat like little else can. That's why it is so commonly used as a coolant for transferring heat away from engines, whether in a 100 horsepower car or 5 megawatt electrical generator. It's the same in nature when rivers, lakes and oceans absorb the day's heat then release it through evaporation or as the air cools during the night.

Water's distinctive capacity to efficiently transfer thermal energy is due to its high "Heat Capacity", the amount of heat needed to raise the temperature of a substance by one degree Celcius. A common way of comparing the heat capacity of various substances is by recording the amount of heat, measured in Joules (J), needed to raise a fixed mass of that substance – one kilogram (kg) – by one degree Celcius.

Using this approach, the heat capacity of water comes out way ahead of several other common compounds listed in the following chart.

HEAT CAPACITIES OF SOME COMMON COMPOUNDS

Compound	Heat Capacity Joules/kg^{0}C
WATER (liquid)	4.18×10^3
Methanol	2.55×10^3
Ethanol	2.46×10^3
Hexane	2.26×10^3
Ice	2.06×10^3
Water vapour	1.87×10^3
Toluene	1.80×10^3
Sulphuric acid	1.13×10^3

Outside of the laboratory, you can observe the effects of water's high heat capacity not by comparing the temperature of different substances but by comparing the weather in different places.

If you live on a seacoast or beside a large lake like Athabasca, Great Slave, Great Bear or Baker Lake, you probably know from direct experience that large amounts of stored water can influence local weather patterns in a big way. It's because large bodies of water can act as giant heat reservoirs, wind generators, cloud factories, and snow and rain-makers.

Since water heats up more slowly than land and holds its heat longer, large water bodies generally a have moderating influence on adjacent lands, slightly delaying the arrival of green-up in the spring and postponing the arrival of frost in the fall. For example, Yellowknife, perched on the north shore of Great Slave Lake,

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averages 111 frost-free days a year, giving it a longer growing season than landlocked Regina almost 2,000 kilometres to the south.

During stable periods in mid-summer, winds on the big lakes follow a predictable daily rhythm well known to sailors and fishermen: *'In by day, out by night'*. Onshore "sea breezes" are set in motion when strong daytime heating causes warm air to rise over the land, sucking in cooler air from over the water. At night, gusty offshore "land breezes" often develop in the opposite direction as the land cools and warm air begins to rise over the water. As this air rises, it usually takes a moisture load with it, contributing to local cloud cover and, eventually, showers.

Large water bodies can effect not only the general direction of local winds but also their speed. Knowing boaters or fishermen are aware of the following tips to estimate the relative wind speeds over water.

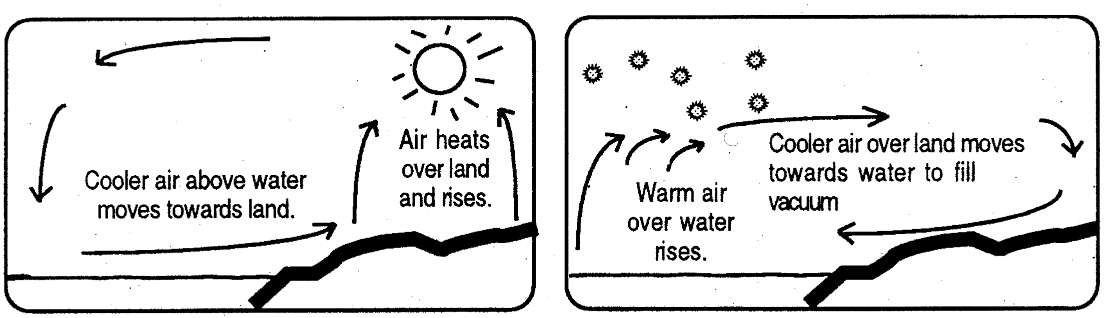
In general, winds over water are stronger than those over land because water offers less friction to moving air than the land. With a land wind of 5 to 10 knots, winds over water can be 50 to 100% stronger!

When winds are strong and the air temperature is colder than the water temperature, expect the wind over land and water to be the same. This situation is most common in the fall.

When the air is warmer than the water and the wind is moderate to strong (15 to 33 knots), expect the wind over water to be up to 30% stronger than on land.

Besides water bodies, there are many factors that could influence your local climate including the comings and goings of sea or lake ice, the presence of nearby mountains, local vegetation cover and many other factors. Is water somehow helping to bring today's weather report where you live?

LAND AND SEA BREEZES



SEA BREEZE -> "In by Day"

<- LAND BREEZE "Out by Night"

Land and sea breezes are observed when the prevailing winds are light and daytime heating is strong. This is often the case in summer when a large, stable area of high pressure can dominate the weather pattern.

(continued)

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Temperature and Precipitation Summary for Sample NWT Communities— Can You See the Influence of Large Water Bodies on Local Climate?

The six communities presented below were selected because they include pairs of climate data sets taken from approximately the same latitude but only one of which comes from beside the shore of a large water body, in this case, Great Slave Lake and Hudson Bay. Do these water bodies influence the local climate? Look for trends between the two data sets to try and explain them in terms of factors influencing the local climate (look beyond just the possible influence of adjacent water bodies). Try graphing these data to help your analysis. Compare Yellowknife with Fort Simpson, Hay River with Fort Smith, and Rankin Inlet with Baker Lake.

	Yellowknife	**Fort Simpson**	**Hay River**	**Fort Smith**	**Baker Lake**	**Rankin Inlet**
Normal Temperatures (Celsius)						
January	–27.9	–26.7	–24.5	–25.4	–32.6	–32.9
February	–24.5	–22.0	–21.2	–21.2	–32.1	–30.3
March	–18.5	–14.2	–15.8	–14.0	–28.0	–25.8
April	–6.2	–1.3	–3.5	–1.4	–17.8	–16.6
May	5.0	8.5	5.9	8.1	–6.7	–6.6
June	13.1	14.7	12.3	14.0	4.1	3.5
July	16.5	16.9	15.8	16.3	11.1	9.9
August	14.1	14.3	14.4	14.3	9.4	9.0
September	6.7	7.5	8.2	7.6	2.4	3.3
October	–1.4	–2.0	0.9	0.4	–7.4	–5.5
November	–14.8	–16.8	–12.4	–12.6	–20.6	–18.4
December	–24.1	–23.8	–20.9	–21.7	–28.3	–27.9
Normal Precipitation (mm)						
January	14.9	19.6	22.2	19.9	8.4	6.5
February	12.6	17.8	17.6	14.3	6.9	8.1
March	10.6	17.6	16.1	13.9	10.5	14.6
April	10.3	16.4	15.3	13.5	15.6	14.7
May	16.6	29.8	21.7	29.2	13.9	17.7
June	23.3	44.3	35.0	45.3	22.1	39.0
July	35.2	53.3	45.3	56.8	39.8	42.7
August	41.7	50.7	43.8	49.1	40.3	60.2
September	28.8	30.2	37.7	38.5	40.5	40.7
October	34.8	36.1	34.2	28.1	35.1	35.6
November	23.9	25.7	32.6	25.2	19.3	24.5
December	14.7	18.9	20.8	19.2	9.4	8.5

Temperature and Precipitation Summary for Sample NWT Communities: Information for all stations except Rankin Inlet taken from Environment Canada's 1961-1990 Climate Normals, also available on the Internet at: http://www.cmc.ec.gc.ca/climate/normals/eprovwmo.htm. Information for Rankin Inlet is derived from weather records for the period 1981-1990 only. Further information of this type is available by contacting Environment Canada directly at 204 983-2082.

The Incredible Journey

Background

While water does circulate from one point or state to another in the water cycle, the paths it can take are variable.

Heat energy directly influences the rate of motion of water molecules. When the motion of the molecule increases because of an increase in heat energy, water will change from solid to liquid to gas. With each change in state, physical movement from one location to another usually follows. Glaciers melt to pools which overflow to streams, where water may evaporate into the atmosphere.

Gravity further influences the ability of water to travel over, under, and above Earth's surface. Water as a solid, liquid, or gas has mass and is subject to gravitational force. Snow on mountaintops melts and descends through watersheds to the oceans of the world.

One of the most visible states in which water moves is the liquid form. Water is seen flowing in streams and rivers and tumbling in ocean waves. Water travels slowly underground, seeping and filtering through particles of soil and pores within rocks.

Although unseen, water's most dramatic movements take place during its gaseous phase. Water is constantly evaporating, changing from a liquid to a gas. As a vapor, it can travel through the atmosphere over the Earth's surface. In fact, water vapor surrounds us all the time. Where it condenses and returns to Earth depends upon loss of heat energy, gravity, and the structure of Earth's surface.

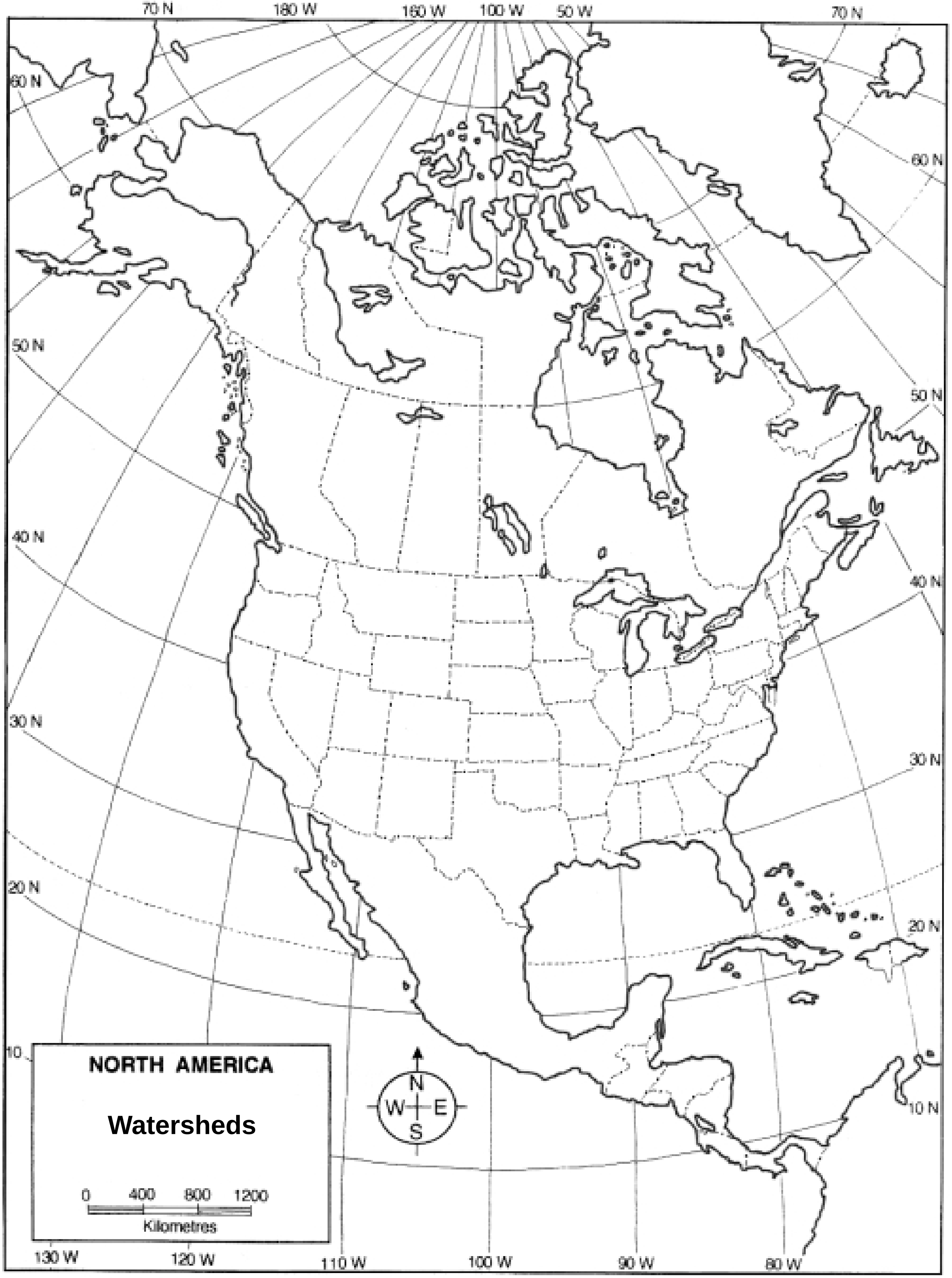
Water condensation can be seen as dew on plants or water droplets on the outside of a glass of cold water. In clouds, water molecules collect on tiny dust particles. Eventually, the water droplets become too heavy and gravity pulls the water to Earth.

Living organisms also help move water. Humans and other animals carry water within their bodies, transporting it from one location to another. Water is either directly consumed by animals or is removed from foods during digestion. Water is excreted as a liquid or leaves as a gas, usually through respiration. When water is present on the skin of an animal (for example, as perspiration), evaporation may occur.

The greatest movers of water among living organisms are plants. The roots of plants absorb water. Some of this water is used within the body of the plant, but most of it travels up through the plant to the leaf surface.

When water reaches the leaves, it is exposed to the air and the sun's energy and is easily evaporated. This process is called transpiration.

All these processes work together to move water around, through, and over Earth.


70 N
180 W
160 W
100 W
50 W
70 N
60 N
60 N
50 N
50 N
40 N
40 N
30 N
30 N
20 N
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NORTH AMERICA
Watersheds
0 400 800 1200
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E
S
130 W
120 W
110 W
100 W
90 W
80 W

The Effects of Tides

Living organisms near large bodies of water have felt the effects of the rise and fall of tidal waters for thousands of years. Saltwater organisms, such as snails and starfish, move to small tidal pools that are left behind as the water recedes from the shoreline. They hide in dark, wet places under rocks which protect them from predators and the drying Sun. Sea anemones close up to conserve water and, like other saltwater organisms, camouflage themselves from predatory birds. While low tide is a dangerous time for exposed creatures, it is also an opportunity for birds and humans to feast on mussels, crabs, and other sea creatures left stranded by the receding waters.

While organisms have long dealt with the changes that tides have caused, the shorelines themselves have been greatly affected. The ebb and flow of large masses of water have eroded rocky cliffs into pebbles, created beaches, and changed the shapes of shorelines. The rise and fall of the water in Hudson Bay may only vary approximately 6 metres, but the Bay of Fundy in Nova Scotia sees a change of approximately 16 metres. That is a large amount of water with energy to move things.

Humans also have a long history of adapting to tides. For example, they have had to time their entrances into, and departures from, harbours. In some cases, harbours are mainly sand at low tide. Knowing when a tide would be high or low was essential for safety and prosperity in the fishing industry, so people began to make observations about the relationships between tides and other phenomena.

Early seafarers noticed that the phases of the moon coincide somewhat with tidal changes. Today we know that the gravity of the moon has the greatest impact on tides. The spinning of the Earth on its axis causes the waters on the Earth to bulge out at the equator. This bulge is further affected by the gravity of the moon in that the waters on the side of the Earth closest to the moon bulge further, raising water levels and causing high tides. Subsequently the waters on the opposite side of the Earth recede from shorelines, causing low tides.

Yet another contributing factor to the production of tides is the Sun's gravity. Due to its great distance away from the Earth, the Sun does not exert as much pull on the Earth as the moon; however, when the Sun and moon are aligned and act together, they cause especially large tides. When the Sun is in a position that counteracts the pull of the moon, especially low tides result.

Word List: Tides

tidal pools

gravity

Earth's spin

eroded

beaches

recede

rocky cliffs

starfish

predator

water

Sun

ebb and flow

drying sun

shorelines

low tide

timing

enter a harbour

high tide

How I Worked in My Group

Name: ____________________________________ Date: ___________________________________

Task: ____

I took turns.	**Comments**
I participated.	
I encouraged others.	
I shared materials.	
I stayed with my group.	
I listened.	
I accomplished the task.	

How I Worked in My Group: Reproduced from *Grades 5 to 8 Mathematics: A Foundation for Implementation*. Winnipeg, MB: Manitoba Education and Training, 1997. Appendix.

Constructing a Prototype: Observation Checklist

Date: _______________________________ Problem/Challenge: ______________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Constructing a Prototype: Observation Checklist *(continued)*

Names	Has Safe Work Habits (ensures personal safety and safety of others)	Works with Group Members to Carry Out Plan	Participates in Analysis and Modification of Prototype	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
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26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Design Project Report

Name: ______________________________ Date: ______________________________

Problem/Design Challenge:

Criteria:

Brainstorming (What are all the different ways . . .):

Planning:

Steps to Follow:

Materials:

Safety Considerations:

(continued)

Design Project Report *(continued)*

Testing:

Criteria	Test Used

Test Results: Attach Data Summary

Evaluating and Improving:

- Justification of changes to original design:

- Strengths and weaknesses of final design:

- Comment/Reflection (Next time . . . , A New Problem . . . .):

(continued)

Design Project Report *(continued)*

Prototype Sketch 1 (Plan):

Prototype Sketch 2 (Final):

Design Project Report: Assessment

Prototype: ______________________________ Date: ______________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Identifying the Practical Problem and Criteria for Success • the problem is clearly stated • class and/or group criteria are identified • criteria address all or some of the following: function, aesthetics, environmental considerations, cost, efficiency			
Planning • all steps are included and clearly described in a logical sequence • all required materials/tools are identified • safety considerations are addressed • a three-dimensional sketch of the prototype is included (Sketch 1)			
Testing the Prototype • tests are described and align with criteria (e.g., each criterion has been tested) • test results are presented in an appropriate format (data sheet is attached)			
Evaluating and Improving the Design • a final sketch of the prototype is included (Sketch 2) • changes to the original plan are justified • strengths and weaknesses of the final prototype are presented • suggestions for “next time” are included and/or “new problems” are identified			
Total Points			
Comments:			

***Note:** The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Conducting a Fair Test: Observation Checklist

Date: ___________________________________ Experiment: _________________________________

A group of students can be selected as a focus for observation on a given day, and/or one or more of the observational areas can be selected as a focus. The emphasis should be on gathering cumulative information over a period of time.

Names	Has Safe Work Habits (workspace, handling equipment, goggles, disposal)	Ensures Accuracy/ Reliability (e.g., repeats measurements/ experiments)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					

(continued)

Conducting a Fair Test: Observation Checklist *(continued)*

Names	Has Safe Work Habits (workspace, handling equipment, goggles, disposal)	Ensures Accuracy/ Reliability (e.g., repeats measurements/ experiments)	Works with Group Members to Carry Out Plan	Shows Evidence of Perseverance and/or Confidence	Comments
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
26.					
27.					
28.					
29.					
30.					
31.					
32.					
33.					

Notes:

Experiment Report

Name: ______________________________ Date: ______________________________

Experiment: ____

Testable Question:

Independent Variable:

Dependent Variable:

Prediction/Hypothesis: (Identify a cause and effect relationship between independent and dependent variables.)

Planning for a Fair Test

- **Apparatus/Materials:**

- **Variables to Control:**

- **Method:** (Include steps to follow, safety considerations, and plan for disposal of wastes.)

(continued)

Experiment Report *(continued)*

Observation: (Include data tables/charts on a separate sheet, if required.)

Analysis of Data: (Identify patterns and discrepancies.)

Note: Attach graph on a separate page, if required.

(continued)

Experiment Report *(continued)*

Strengths and Weaknesses of Approach/Potential Sources of Error:

Conclusion: (Support or reject prediction/hypothesis; pose new question(s).)

Applications/Implications: (Link to daily life or area of study.)

Experiment Report: Assessment

Experiment Title: ______________________________ Date: ____________________________

Team Members: ____

Criteria	Possible Points*	Self-Assessment	Teacher Assessment
Creating a Testable Question • the question is testable and focused (includes a cause and effect relationship)			
Making a Prediction/Hypothesis • independent and dependent variables are identified • the prediction/hypothesis clearly identifies a cause and effect relationship between independent and dependent variables			
Planning for a Fair Test • required apparatus/materials are identified • major variables to be controlled are identified • steps to be followed are included and clearly described • safety considerations are addressed • a plan for disposing of wastes is included			
Conducting a Fair Test/Making and Recording Observations • evidence of repeated trials is provided • detailed data are recorded, appropriate units are used • data are recorded in a clear/well-structured/appropriate format			
Analyzing and Interpreting • graphs are included (where appropriate) • patterns/trends/discrepancies are identified • strengths and weaknesses of approach and potential sources of error are identified • changes to the original plan are identified and justified			
Drawing a Conclusion • cause and effect relationship between dependent and independent variables are explained • alternative explanations are identified • prediction/hypothesis is supported or rejected			
Making Connections • potential applications to or implications for daily life are identified and/or links to area of study are made			
Total Points			

*__Note:__ The teacher and/or the class assigns possible points to reflect the particular emphasis/es of the project.

Appendices

*APPENDIX A: GENERAL LEARNING OUTCOMES**

The purpose of Manitoba science curricula is to help students gain a measure of scientific literacy that will assist them in becoming informed, productive, and fulfilled members of society. As a result of their Early, Middle, and Senior Years science education Manitoba students will be able to:

Nature of Science and Technology

A1. recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena

A2. recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop

A3. distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values

A4. identify and appreciate contributions made by women and men from many societies and cultural backgrounds towards increasing our understanding of the world and in bringing about technological innovations

A5. recognize that science and technology interact with and advance one another

Science, Technology, Society, and the Environment (STSE)

B1. describe scientific and technological developments, past and present, and appreciate their impact on individuals, societies, and the environment, both locally and globally

B2. recognize that scientific and technological endeavours have been and continue to be influenced by human needs and the societal context of the time

B3. identify the factors that affect health and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social

B4. demonstrate a knowledge of, and personal consideration for, a range of possible science- and technology-related interests, hobbies, and careers

B5. identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally

Scientific and Technological Skills and Attitudes

C1. recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations

C2. demonstrate appropriate scientific inquiry skills when seeking answers to questions

C3. demonstrate appropriate problem-solving skills while seeking solutions to technological challenges

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*Source: The general learning outcomes are identified in Manitoba Education and Training. *Kindergarten to Grade 4 Science: Manitoba Curriculum Framework of Outcomes*. Renewing Education: New Directions series. Winnipeg, MB: Manitoba Education and Training, 1999.

C4. demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information

C5. demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind

C6. employ effective communication skills and utilize information technology to gather and share scientific and technological ideas and data

C7. work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities

C8. evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life

Essential Science Knowledge

D1. understand essential life structures and processes pertaining to a wide variety of organisms, including humans

D2. understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole

D3. understand the properties and structures of matter, as well as various common manifestations and applications of the actions and interactions of matter

D4. understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts

D5. understand the composition of the Earth’s atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them

D6. understand the composition of the universe, the interactions within it, and the impacts of humankind’s continued attempts to understand and explore it

Unifying Concepts

E1. describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world

E2. describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems

E3. recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved

E4. recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them

APPENDIX B: KINDERGARTEN TO GRADE 4 AND SENIOR 1 CLUSTER TITLES

Manitoba's *Science Frameworks (Kindergarten to Grade 4, Grades 5–8, Senior 1)* present specific learning outcomes (SLOs) that are arranged into groupings, referred to as clusters. The clusters are thematic and generally relate to the three science disciplines: life science, physical science, and Earth and space science.

The cluster titles for both Kindergarten to Grade 4 Science, and Senior 1 Science have been reproduced in the figure below.

Whereas the SLOs themselves are mandatory, the order in which they are addressed is not. Teachers are encouraged to plan their instruction based on student needs, individual contexts, learning resources, and other pertinent considerations.

Grades / Clusters	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Senior 1
Cluster 0	Overall Skills and Attitudes (to be integrated into Clusters 1 to 4)					
Cluster 1	Trees	Characteristics and Needs of Living Things	Growth and Changes in Animals	Growth and Changes in Plants	Habitats and Communities	Reproduction
Cluster 2	Colours	The Senses	Properties of Solids, Liquids, and Gases	Materials and Structures	Light	Atoms and Elements
Cluster 3	Paper	Characteristics of Objects and Materials	Position and Motion	Forces that Attract or Repel	Sound	Nature of Electricity
Cluster 4		Daily and Seasonal Changes	Air and Water in the Environment	Soils in the Environment	Rocks, Minerals, and Erosion	Exploring the Universe

Notes

APPENDIX C: PETS IN THE CLASSROOM*

When we think of classroom pets, we often imagine small mammals such as gerbils, hamsters, or guinea pigs. While these are interesting creatures to observe, hamsters and gerbils are nocturnal animals and, as such, tend to be rather sleepy during the day. In fact, one group of Grade 1 students once questioned whether or not there was a real animal in the hamster cage. The children would occasionally annoy the hamster into activity, but for the most part, he remained an unseen fixture of the classroom.

Generally speaking, most animals in the classroom are best left as visitors, rather than residents. It is expected that students will have opportunities to observe living creatures, but this can be accomplished by having animals as special visitors for a period of time. Of course, teachers should outline strict guidelines for the safety of the animals, ensuring that they undergo as little stress as possible. Teachers must also be aware of allergies the students might have, especially to fur-bearing animals.

Teachers who are planing to maintain a "classroom pet" for any period of time need to recognize that all vertebrate animals have important dietary and housing concerns that require time, expertise, and care to address.

Birds, for the most part, do not make good classroom pets. Some, like the budgie or any member of the parrot family, can be carriers of parrot fever and should not be housed in a school or classroom. Other birds, such as finches, canaries, or pin quail, are sensitive to temperature changes and require large flight pens to move around comfortably.

Reptiles and amphibians require very specific environments and carefully designed diets. Being cold-blooded, these animals will endure a slow death of starvation if their dietary needs are not met. Turtles, of course, must be avoided in classrooms, due to concerns regarding salmonella. Amphibians, such as frogs, are sensitive to temperature and humidity changes and require large environments so that they have suitable ranges for movement.

Exotic pets of all types need not be resident in schools or classrooms. Large and small snakes, tropical birds, monkeys, and reptiles are interesting creatures for students to observe. However, with the availability of media today, there is no reason for these animals to be long-term "classroom pets."

Wild animals may carry potentially dangerous pathogens, and must not be brought into classrooms unless under the care of a knowledgeable expert. Animals found by students and brought into school (such as raccoon babies, injured squirrels, small snakes, and other creatures) should be directed to a local humane shelter or wildlife rescue organization.

Small fish make good classroom pets. With proper housing, feeding schedules, and cleaning, an aquarium can house a collection of small fish, readily available from most pet stores. Teachers should avoid keeping fancy tropical fish in their classrooms. Fish can be sensitive to light and temperature changes — some schools turn down their heating over the weekends in wintertime, making heaters essential for aquaria. Feeding schedules must be maintained. While it may seem that classroom fish can make it through a holiday weekend without being fed such fasting periods put undue stress on the fish and make them far more susceptible to diseases.

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*Source: Adapted from "Keeping Animals in the Classroom: A Guide." Implementation Planning Workshop for *The Ontario Curriculum, Grades 1-8: Science and Technology.* © Queen's Printer for Ontario, 1998. Adapted with permission.

Invertebrates can make good classroom pets. These pets are relatively easy to maintain. They require minimal amounts of space and small quantities of food. Of course, teachers have to be aware of their environmental and dietary needs.

The following guide provides some general classroom care information regarding the needs of a variety of living things. This guide should be used prior to having an animal in the classroom. It is, by no means, comprehensive, but rather gives teachers some information about the dietary and environmental needs of a number of animals they may wish to have as classroom visitors.

Organism	Housing	Temperature Range	Food	Causes of Failure	Remarks
Aquatic Snails	aquaria	24 °– 29 °C	lettuce	lack of food, drastic temperature changes	include in culture with guppies
Brine Shrimp	8 litre container or aquaria	21° - 27° C	diluted yeast solution	overfeeding, lack of oxygen, overcrowding	raise in a 3-5% solution of non-iodized salt
Chameleons-Anoles	large aquarium with screened lid	27° - 32° C	live crickets, occasional mealworm	overcrowding or lack of water/food	spray droplets or water on sides of container daily
Earthworms	organic soil in wooden or plastic box	13° - 18° C	mashed potatoes, lettuce, coffee grounds	too much heat, too much or not enough moisture, overcrowding	buss bedding works well in place of soil, keep covered
Guppies	aquaria, 8 litre container	24° - 29° C	prepared fish food, brine shrimp	excessive food	change water occasionally, include numerous aquatic plants
Mealworms	8 litre container or larger, plastic shoe box	16° - 27° C	bran, dog food, occasional apple or potato slice	mould growth from too much water	cover top of bran with cotton, sprinkle water on cotton
Newts	8 litre container, terrarium	17° - 28° C	live food, daphnia, brine shrimp or liver bits	lack of food, escape easily, no dry place	move liver when feeding (looks alive), provide dry resting place
Butterflies (painted lady)	large box with sides cut out; openings covered with screen	21° - 27° C	larvae-artificial media, adult –5% sugar water	humidity not correct	add containers of moist sand to adult container
Milkweed Bug	plastic shoe boxes or similar containers	10° - 35° C	milkweed seeds, shelled unsalted sunflower seeds	excessive mould on food, too much moisture	easily raised, good example of incomplete metamorphosis

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