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Grade 7

## **Cluster 2: Particle Theory of Matter**

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### **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

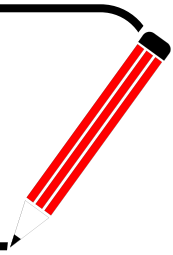
**SUGGESTIONS FOR INSTRUCTION**

**Teacher Notes**

**Prior Knowledge**

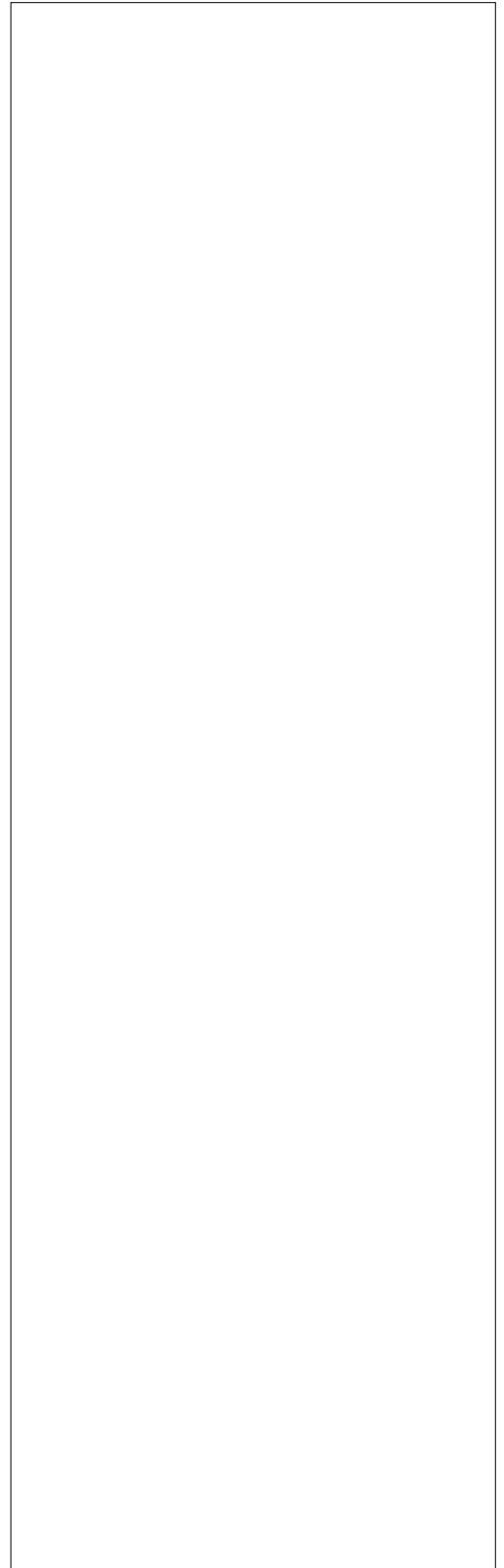
Students have had previous experiences related to this cluster in Grade 5, Cluster 2: Properties of and Changes in Substances.



- 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.



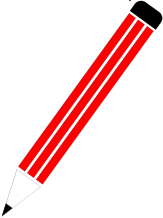
**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

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PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>7-2-02</b> Evaluate different types of thermometers using the design process.</p> <p><i>Examples: materials used, range, sensitivity, durability, scale, cost...</i></p> <p>GLO: C1, C3</p>
<p><b>7-0-3d</b> Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3</p> <p><b>7-0-3e</b> Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6</p> <p><b>7-0-4c</b>  Work cooperatively with team members to carry out a plan, and troubleshoot problems as they arise. GLO: C7 (ELA Grade 7, 5.2.1)</p> <p><b>7-0-5f</b> 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)</p> <p><b>7-0-6e</b>  Evaluate the strengths and weaknesses of a consumer product, based on predetermined criteria. GLO: C3, C4</p>

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

## SUGGESTED LEARNING RESOURCES

**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.

*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
<i>Students will...</i>
<p><b>7-2-03</b> 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</p>
<p><b>7-0-3a</b> 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)</p> <p><b>7-0-3b</b> Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2</p> <p><b>7-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2</p> <p><b>7-0-4e</b> 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</p> <p><b>7-0-5a c</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-5c</b> Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5</p> <p><b>7-0-7a</b> 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)</p> <p><b>7-0-7h</b> Identify and evaluate potential applications of investigation results. GLO: C4</p>
<i>(continued)</i>

## 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

## SUGGESTED LEARNING RESOURCES

## 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.



*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)*

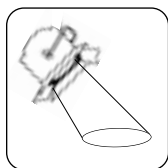
*Gases*

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**


**SUGGESTIONS FOR INSTRUCTION**

*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)

GLO: A2, C4 (ELA Grade 7, 1.2.1)

**7-0-7h** Identify and evaluate potential applications of investigation results. GLO: C4

➤ **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  $-5^{\circ}\text{C}$ . Why or why not? (It would not work at  $-5^{\circ}\text{C}$  because water freezes at  $0^{\circ}\text{C}$ , and the ice would not melt.)

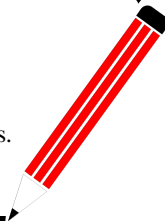
➤ **Boiling and Melting Points**

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?

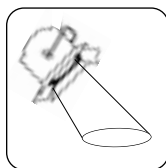
**Teacher Notes**

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

## SUGGESTED LEARNING RESOURCES

**Case Study**

Provide students with the following:

**Bars of Gold?**

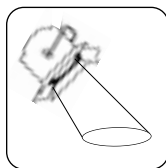
A chest is located at the bottom of the Gulf of Mexico and some metal bars are found inside. Legend has it that ships that travelled in the area carried gold bars and jewels. Often captains of the ships would substitute fake bars in the chests so that if the ships were boarded by pirates, the real gold would not be stolen as it would be hidden elsewhere on the ships.

A lab heats up the bars to  $955^{\circ}\text{C}$  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 ( $^{\circ}\text{C}$ )	Boiling Point ( $^{\circ}\text{C}$ )
Gold	$1063^{\circ}$	$2600^{\circ}$

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.

*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
<i>Students will...</i>
<p><b>7-2-05</b> Explain what scientific theories are, and provide some examples.</p> <p>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.</p> <p>GLO: A1, A2</p>
<p><b>7-0-1a</b> <b>C</b> 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)</p> <p><b>7-0-3a</b> 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)</p> <p><b>7-0-3b</b> Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2</p> <p><b>7-0-3c</b> 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)</p> <p><b>7-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2</p> <p><b>7-0-5a</b> <b>C</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-5c</b> Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5</p> <p><b>7-0-5e</b> 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)</p> <p><b>7-0-7a</b> 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)</p>
<i>(continued)</i>

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

## SUGGESTED LEARNING RESOURCES

**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.

*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
<i>Students will...</i>
7-2-05 (continued)

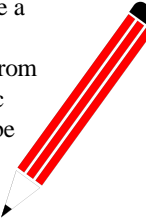
SUGGESTIONS FOR INSTRUCTION

(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

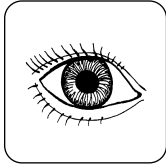
- their responses to the above questions
- the findings of their experiment testing Aristotle’s hypothesis that the mass of an object determines how fast it falls
- further research

(For a BLM of a Concept Frame, see *SYSTH*, Attachment 11.2, or *Success*, p. 6.111.)

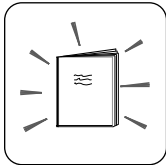
**SUGGESTIONS FOR ASSESSMENT**

**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)

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**PRESCRIBED LEARNING OUTCOMES**

**SUGGESTIONS FOR INSTRUCTION**

*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 c** 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)*

➤ **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)*

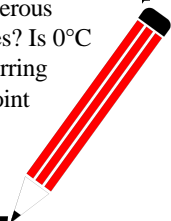


## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

**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  $0^{\circ}\text{C}$  the melting and freezing point of water? Why is melting occurring but the temperature is below  $0^{\circ}\text{C}$ ? What affects the boiling point of a substance? You may wish to guide students into further inquiries/investigations to answer these questions.



*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
<i>Students will...</i>
<p data-bbox="110 327 313 359"><b>7-2-06</b> (continued)</p> <p data-bbox="444 1856 558 1887">(continued)</p>

SUGGESTIONS FOR INSTRUCTION

(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.)

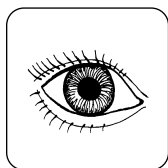
Have students analyze their graphs and answer the following questions in their science notebooks:

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.)

(continued)

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**

*Students will...*

**7-2-06** (continued)

**SUGGESTIONS FOR INSTRUCTION**

(continued)

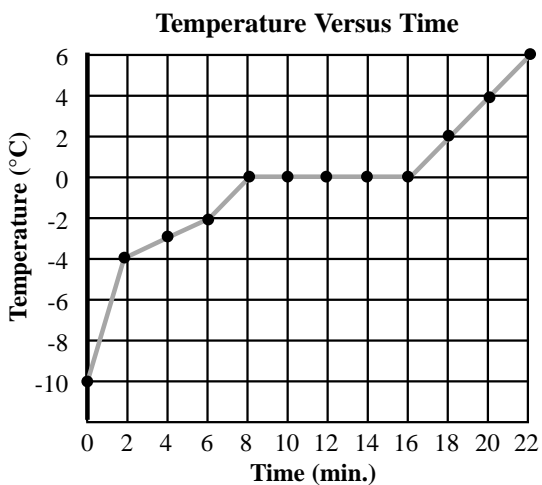
- 6. Melting points and boiling points are characteristics of pure substances. What is the boiling point of water at sea level? (100°C)
- 7. What is the melting/freezing point of water? (0°C)

➤ **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

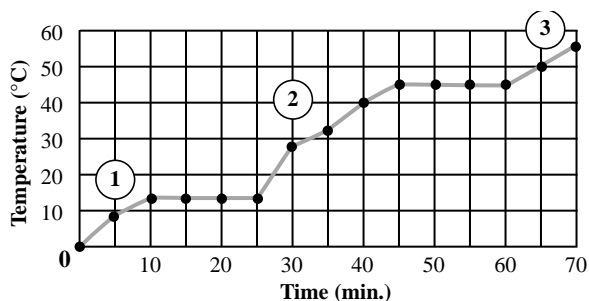
## SUGGESTED LEARNING RESOURCES

**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

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>7-2-07</b> Differentiate between the concept of temperature and the concept of heat. GLO: D3, D4, E4</p>
<p><b>7-0-3b</b> Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2</p> <p><b>7-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2</p> <p><b>7-0-4e</b> 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</p> <p><b>7-0-5a</b> <b>C</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-5c</b> Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5</p> <p><b>7-0-5e</b> 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)</p> <p><b>7-0-5f</b> 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)</p> <p><b>7-0-6a</b> Construct graphs to display data, and interpret and evaluate these and other graphs. <i>Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots...</i> GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)</p> <p><b>7-0-6b</b> Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5</p> <p><b>7-0-7a</b> 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)</p>
<i>(continued)</i>

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

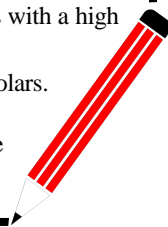
## SUGGESTED LEARNING RESOURCES

**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.



Nelson Science & Technology 7:  
(Sections 2.5-2.6)

Addison Wesley Science & Technology  
7 (Chapter 3, Sections 3.0-3.2)

**PRESCRIBED LEARNING OUTCOMES**

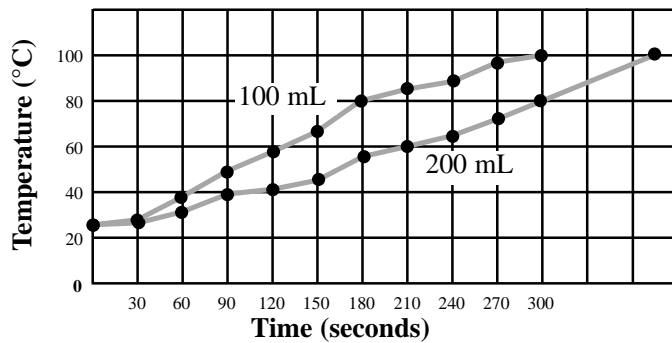
*Students will...*

**7-2-07** (continued)

**SUGGESTIONS FOR INSTRUCTION**

(continued)

**Volume Comparison: Heat Versus Temperature**





SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES

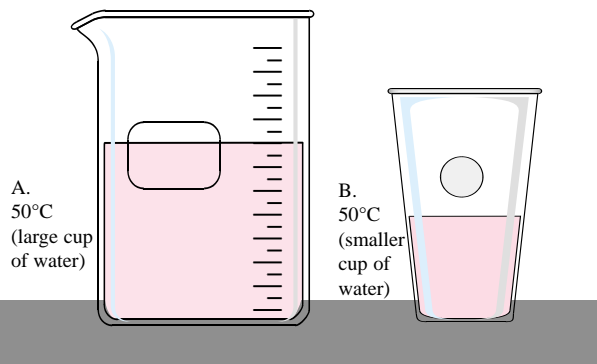


**Restricted Response**

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.

A large empty rectangular box for student response.

PRESCRIBED LEARNING OUTCOMES
<i>Students will...</i>
<p><b>7-2-08</b> Demonstrate how heat can be transmitted through solids, liquids, and gases.</p> <p>Include: conduction, convection, radiation.</p> <p>GLO: C1, D3, D4, E4</p>
<p><b>7-0-5a</b> <b>C</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-7a</b> 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)</p> <p><b>7-0-7f</b> <b>C</b> 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)</p>
<p>(continued)</p>

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

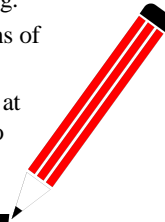
SUGGESTED LEARNING RESOURCES

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).



*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
<i>Students will...</i>
<p><b>7-2-08</b> (continued)</p>

**SUGGESTIONS FOR INSTRUCTION**

(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
<i>Students will...</i>
<p><b>7-2-09</b> 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</p>
<p><b>7-0-3a</b> 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)</p> <p><b>7-0-3b</b> Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2</p> <p><b>7-0-3c</b> 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)</p> <p><b>7-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2</p> <p><b>7-0-4e</b> 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</p> <p><b>7-0-5a c</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-5f</b> 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)</p> <p><b>7-0-6a</b> Construct graphs to display data, and interpret and evaluate these and other graphs. <i>Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots...</i> GLO: C2, C6 (ELA Grade 7, 3.3.1; Math: SP-III.2.6; TFS: 4.2.2– 4.2.6)</p> <p><b>7-0-6b</b> Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5</p> <p><b>7-0-7a</b> 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)</p>

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.

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.

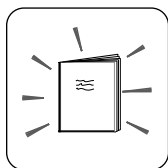
Have students

- 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

**Safety Precaution:**  
Review students’ proposed methods before testing occurs. Ensure that all safety issues have been addressed before allowing students to test their materials.

## SUGGESTIONS FOR ASSESSMENT

## SUGGESTED LEARNING RESOURCES

**Insulators and Conductors**

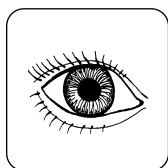
Using the Three-Point Approach (Simons, 1991), have students define good insulators and good heat conductors. Ask them to list examples and draw and label a diagram of where each might be used.

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

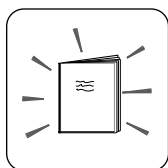
Look for:

- 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)

*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
<i>Students will...</i>
<p><b>7-2-10</b> Use the design process to construct a prototype that controls the transfer of heat energy.</p> <p><i>Examples: insulated lunch bag, solar oven, home insulation...</i></p> <p>GLO: A5, B2, C3, C4</p>
<p><b>7-0-1c</b> Identify practical problems to solve. <i>Examples: How can I keep my soup hot? Which type of sunscreen should I buy?...</i> GLO: C3</p> <p><b>7-0-1d</b> Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.7)</p> <p><b>7-0-2a</b>  Access information using a variety of sources. <i>Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...</i> GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)</p> <p><b>7-0-3d</b> Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3</p> <p><b>7-0-3e</b> Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6</p> <p><b>7-0-4b</b>  Construct a prototype. GLO: C3</p> <p><b>7-0-5b</b>  Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5</p> <p><b>7-0-6d</b>  Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4</p> <p><b>7-0-7d</b>  Propose and justify a solution to the initial problem. GLO: C3</p>


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:

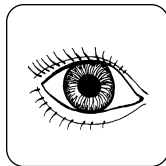
- solar water heater
- hotdog cooker
- marshmallow cooker



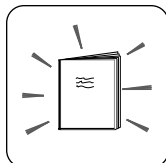
**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

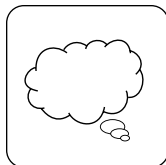
Refer to the following BLMs for assessment suggestions:



“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:

<b>Self-Assessment of the Design Process</b>	
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 _____

*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
<i>Students will...</i>
<p><b>7-2-11</b> Recognize that heat energy is the most common by-product of energy transformations, and describe some examples. <i>Examples: thermal pollution, body heat, friction...</i></p> <p>GLO: B1, D4, E4</p> <p><b>7-2-12</b> Identify different forms of energy that can be transformed into heat energy. Include: mechanical, chemical, nuclear, electrical. GLO: D4, E4</p>
<p><b>7-0-5a</b> ☐ Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-7f</b> ☐ 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)</p> <p><b>7-0-7h</b> Identify and evaluate potential applications of investigation results. GLO: C4</p> <p><b>7-0-8g</b> Discuss societal, environmental, and economic impacts of scientific and technological endeavours. Include: local and global impacts. GLO: A1, B1, B3, B5</p>
<i>(continued)</i>

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

## SUGGESTED LEARNING RESOURCES

**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

*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**

**SUGGESTIONS FOR INSTRUCTION**

*Students will...*

**7-2-11**, and **7-2-12** *(continued)*

*(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

➤ **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.

**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)

**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

Refer to the assessment strategy suggested for learning outcome 7-2-14.

*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** **C** Make observations that are relevant to a specific question. GLO: A1, A2, C2  
**7-0-7f** **C** 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:

<b>Solutions</b>	<b>Mechanical Mixtures</b>
General characteristics of solutions: <ul style="list-style-type: none"> <li>• composed of at least two parts: solute and solvent</li> <li>• do not settle out upon standing</li> <li>• uniform, appear as one state</li> <li>• evenly mixed or homogeneous</li> <li>• can be solid, liquid, or gas</li> </ul> Examples: <ul style="list-style-type: none"> <li>• salt and water</li> <li>• vinegar and water</li> <li>• drink mix and water</li> <li>• sugar and water</li> </ul>	General characteristics of mechanical mixtures: <ul style="list-style-type: none"> <li>• two or more substances mixed together</li> <li>• each component is visible</li> <li>• heterogenous</li> </ul> Examples: <ul style="list-style-type: none"> <li>• pepper and water</li> <li>• vegetable oil and water</li> <li>• soil and water</li> <li>• sand and water</li> <li>• granola cereal</li> <li>• snack mix</li> </ul>

(For a BLM of a Concept Relationship Frame, see *SYSTH*, Attachment 11.1, or *Success*, 6.104.)

SUGGESTIONS FOR ASSESSMENT

SUGGESTED LEARNING RESOURCES



**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

*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
<i>Students will...</i>
<p><b>7-2-15</b> Classify a variety of substances used in daily life as pure substances, solutions, or mechanical mixtures.</p> <p><i>Examples: distilled water, paint thinner, mouthwash, peanut butter, liquid soap, medicines, sunscreens...</i></p> <p>GLO: B1, E1</p>
<p><b>7-2-16</b> Identify solutes and solvents in common solid, liquid, and gaseous solutions.</p> <p>GLO: D3</p>
<p><b>7-0-5f</b> 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)</p>
Empty cell for additional content

SUGGESTIONS FOR INSTRUCTION

- **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.

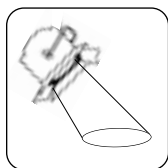
Ask students to identify each sample with a flap label that reveals the classification of the substance according to the three terms: pure substances, solutions, or mechanical mixtures. Then the class may set up a sample table for students to practise their skills by classifying each of the samples or pictures of substances, solutions, or mechanical mixtures provided by students.
  
- **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

## SUGGESTED LEARNING RESOURCES



### Classifying Substances as Pure, Mechanical Mixture, or Solution

Using a Sort and Predict Frame (Matchullis and 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 and Predict Frame, see *SYSTH*, Attachment 10.3, or *Success*, p. 6.100.)

*Nelson Science & Technology 7*  
(Section 1.11)

*Sciencepower 7* (Section 4.1)

*Addison Wesley Science & Technology 7* (Chapter 2, Sections 2.1-2.3)



### 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

*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
<i>Students will...</i>
<p><b>7-2-17</b> Describe solutions by using the particle theory of matter.</p> <p>Include: particles have an attraction for each other; the attraction between the particles of solute and solvent keeps them in solution.</p> <p>GLO: A1, D3, E1</p>
<p><b>7-0-7f c</b> Reflect on prior knowledge and experiences to construct new understanding and apply this new knowledge in other contexts.</p> <p>GLO: A2, C4 (ELA Grade 7, 1.2.1)</p>
This area is intentionally left blank for student work or additional notes

**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
<i>Students will...</i>
<p><b>7-2-18</b> Demonstrate different methods of separating the components of both solutions and mechanical mixtures.</p> <p><i>Examples: distillation, chromatography, evaporation, sieving, dissolving, filtration, decanting, magnetism, sedimentation...</i></p> <p>GLO: C1, C2</p> <p><b>7-2-19</b> Identify a separation technique used in industry, and explain why it is appropriate.</p> <p>GLO: B1, C4</p>
<p><b>7-0-1c</b> Identify practical problems to solve. <i>Examples: How can I keep my soup hot? Which type of sunscreen should I buy?... GLO: C3</i></p> <p><b>7-0-1d</b> Select and justify a method to be used in finding a solution to a practical problem. GLO: C3 (Math: SP-II.1.7)</p> <p><b>7-0-3d</b> Develop criteria to evaluate a prototype or consumer product. Include: function, aesthetics, environmental considerations, cost, efficiency. GLO: C3</p> <p><b>7-0-3e</b> Create a written plan to solve a problem. Include: materials required, three-dimensional sketches, steps to follow. GLO: C1, C3, C6</p> <p><b>7-0-4b</b> ☐ Construct a prototype. GLO: C3</p> <p><b>7-0-5b</b> ☐ Test a prototype or consumer product, using predetermined criteria. GLO: C3, C5</p> <p><b>7-0-6d</b> ☐ Identify and make improvements to a prototype, and explain the rationale for the changes. GLO: C3, C4</p> <p><b>7-0-7d</b> ☐ Propose and justify a solution to the initial problem. GLO: C3</p>

## 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

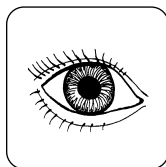
**Note:** All students should record information about each method in their science notebooks.

#### 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 of 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

## SUGGESTED LEARNING RESOURCES

**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

*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
<i>Students will...</i>
<p><b>7-2-20</b> Experiment to determine factors that affect solubility.                      Include: agitation, surface area, temperature.                      GLO: C2, D3</p>
<p><b>7-0-1a</b> <b>C</b> 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)</p> <p><b>7-0-1b</b> 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)</p> <p><b>7-0-3a</b> 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)</p> <p><b>7-0-3b</b> Identify with guidance the independent and dependent variables in an experiment. GLO: A2, C2</p> <p><b>7-0-3c</b> 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)</p> <p><b>7-0-4a</b> Carry out procedures that comprise a fair test. Include: controlling variables, repeating experiments to increase accuracy and reliability. GLO: C2</p> <p><b>7-0-5a</b> <b>C</b> Make observations that are relevant to a specific question. GLO: A1, A2, C2</p> <p><b>7-0-5c</b> Select and use tools to observe, measure, and construct. Include: microscopes, a variety of thermometers, graduated cylinders, glassware, balance. GLO: C2, C3, C5</p> <p><b>7-0-5e</b> 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)</p> <p><b>7-0-5f</b> 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)</p> <p><b>7-0-6b</b> Interpret patterns and trends in data, and infer and explain relationships. GLO: A1, A2, C2, C5</p> <p><b>7-0-6f</b> Identify how the original plan evolved and justify the changes. GLO: C2, C3 (ELA Grade 7, 3.3.4)</p> <p><b>7-0-7a</b> 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)</p>

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:

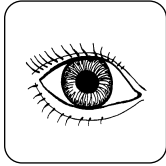
- the effect of particle size or surface area on solubility
- the effect of agitation/stirring on solubility
- the effect of temperature on solubility

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.

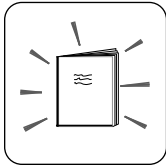
**SUGGESTIONS FOR ASSESSMENT**

**SUGGESTED LEARNING RESOURCES**

Refer to the following BLMs for assessment suggestions:



“Conducting a Fair Test: Observation Checklist”  
(BLM 7-P)



“Experiment Report: Assessment” (BLM 7-R)

*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
<i>Students will...</i>
<p><b>7-2-21</b> 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.</p> <p>Include: dilute, concentrated, grams of solute per 100 mL.</p> <p>GLO: C6, D3</p>
<p><b>7-0-7f c</b> 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)</p> <p><b>7-0-7h</b> Identify and evaluate potential applications of investigation results. GLO: C4</p>
This cell is intentionally left empty for instructional purposes

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:

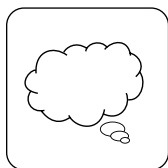
1. What would assist you in writing accurate instructions for someone else on how to make a tasty drink without continuously having to taste test and add more of an ingredient? (use of measurement tools)
2. What term might be used to describe a watery tasting drink solution: diluted or concentrated? 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**

**SUGGESTED LEARNING RESOURCES**



**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 quantitatively.

*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**

**SUGGESTIONS FOR INSTRUCTION**

*Students will...*

**7-2-22** Demonstrate the difference between saturated and unsaturated solutions.

GLO: C2, C6, D3

**7-0-7f** **C** 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** **C** 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)

➤ **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

## SUGGESTED LEARNING RESOURCES

**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

*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
<i>Students will...</i>
<p><b>7-2-23</b> Discuss the potential harmful effects of some substances on the environment, and identify methods to ensure their safe use and disposal.</p> <p><i>Examples: pollution of groundwater from improper disposal of paints and solvents; pollution of the atmosphere by car exhaust...</i></p> <p>GLO: B1, B3, B5, C1</p>
<p><b>7-0-2a</b>  Access information using a variety of sources. <i>Examples: libraries, magazines, community resource people, outdoor experiences, videos, CD-ROMs, Internet...</i> GLO: C6 (ELA Grade 7, 3.2.2; TFS 2.2.1)</p> <p><b>7-0-2b</b> Evaluate the usefulness, currency, and reliability of information, using predetermined criteria. GLO: C6, C8 (ELA Grade 7, 3.2.3; TFS 2.2.2)</p> <p><b>7-0-2c</b> Make notes using headings and subheadings or graphic organizers appropriate to a topic and reference sources. GLO: C6 (ELA Grade 7, 3.3.2)</p> <p><b>7-0-7g</b>  Communicate methods, results, conclusions, and new knowledge in a variety of ways. <i>Examples: oral, written, multimedia presentations...</i> GLO: C6 (ELA Grade 7, 4.4.1)</p>

SUGGESTIONS FOR INSTRUCTION

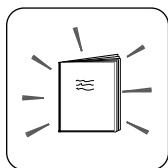
➤ **Disposing of Toxic Wastes**

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**

**SUGGESTED LEARNING RESOURCES**



**Disposing of Toxic Wastes Project**

Use the following to assess students' Toxic Waste Disposal brochures or presentations:

<b>Assessment of Toxic Waste Disposal Project</b>			
<b>Criteria</b>	<b>Possible Points</b>	<b>Self-Assessment</b>	<b>Teacher Assessment</b>
• 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			
<b>Total</b>			

*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**