SECTION 4: DOCUMENT ORGANIZATION

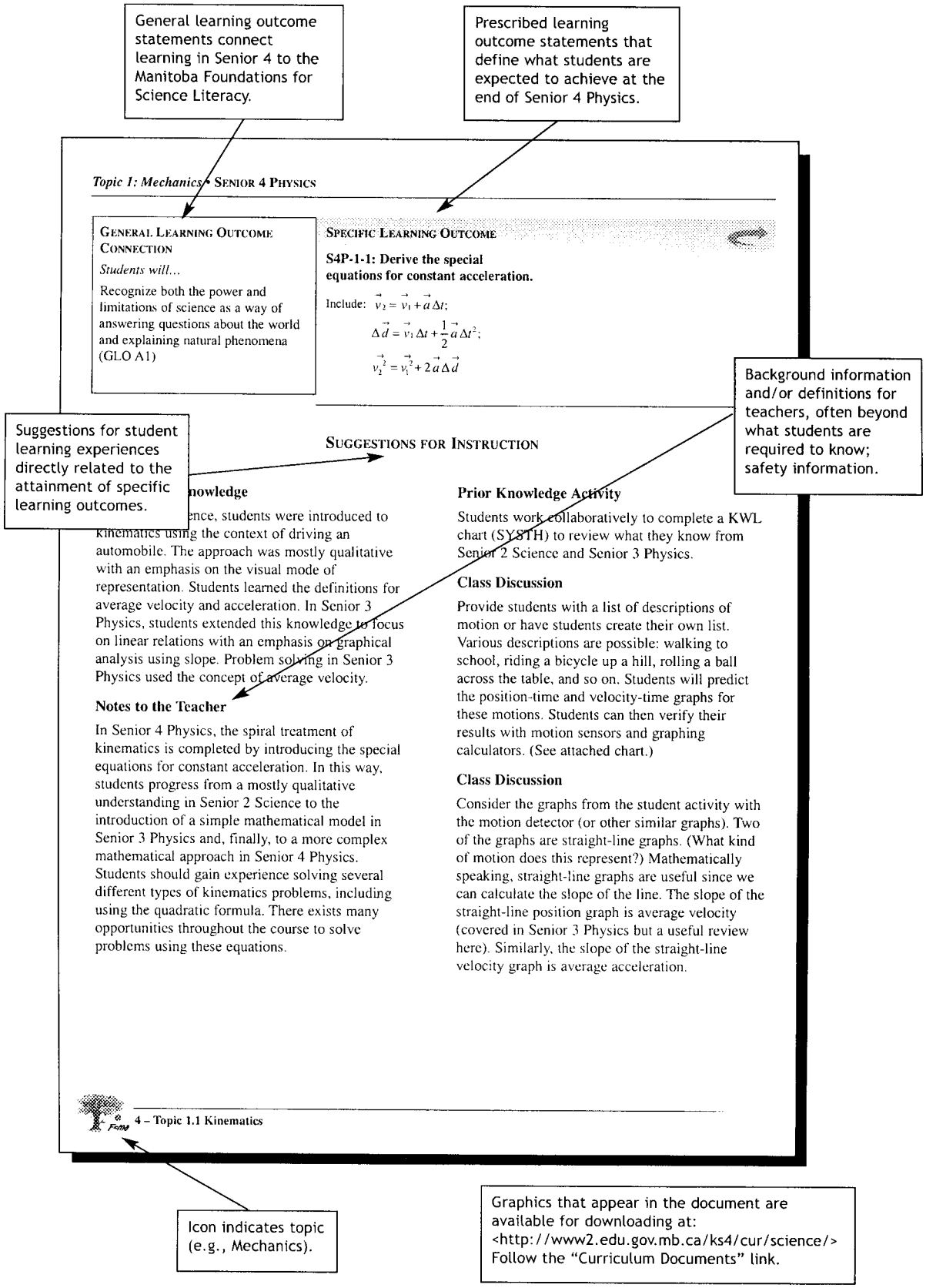
DOCUMENT ORGANIZATION

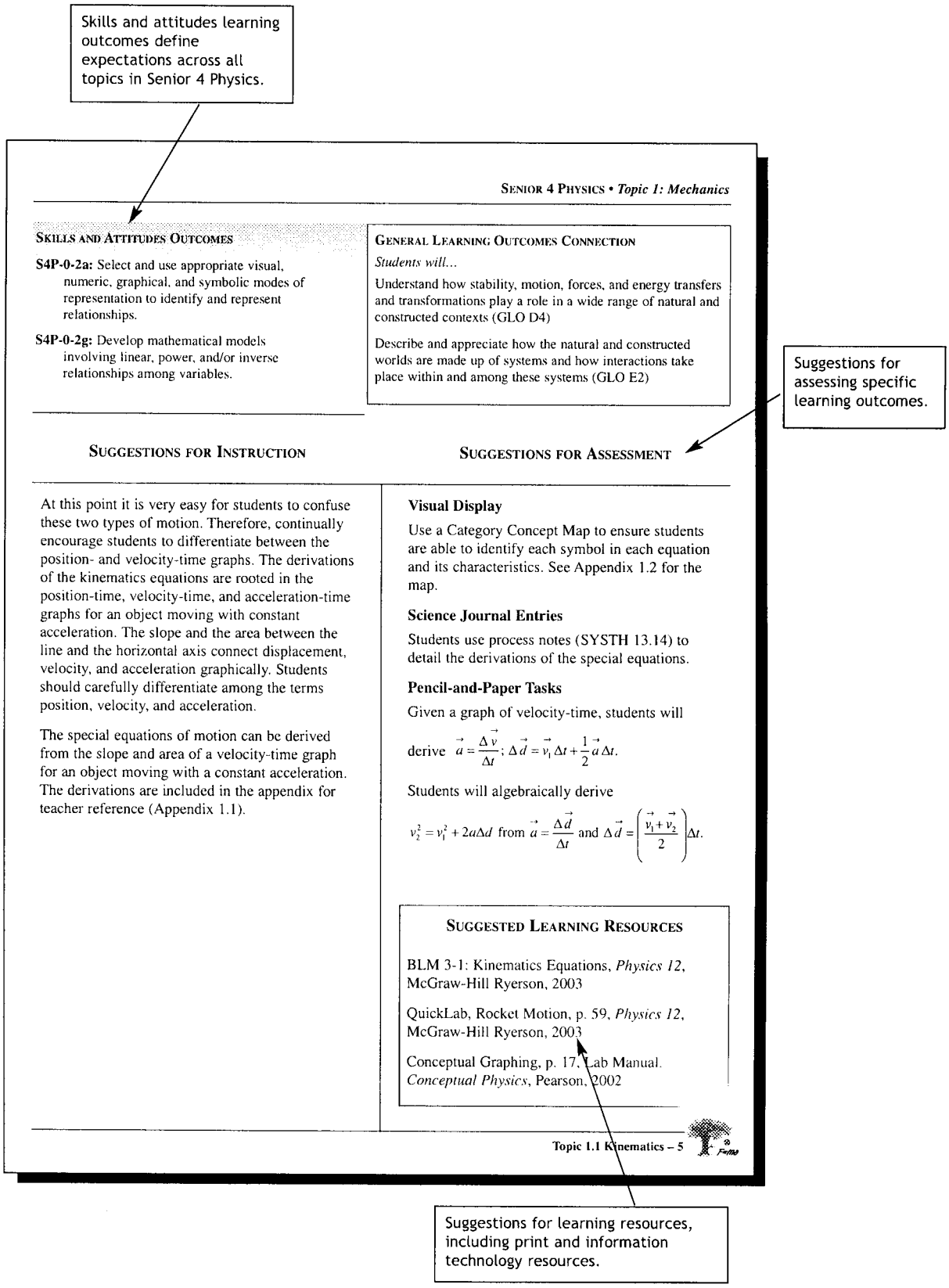
The prescribed learning outcomes and the suggestions for instruction, assessment, and learning resources contained within *Senior 4 Physics: A Foundation for Implementation* provide teacher educators with a plan for achieving the student learning outcomes. The document is organized by topics; Cluster 0: Skills and Attitudes is followed by the four "thematic" topics. In addition, the appendices are comprised of Student Learning Activities, Teacher Support Materials, and Blackline Masters. These complementary materials are designed to support, facilitate, and enhance student learning and assessment by being closely linked to the learning outcomes and the skills and attitudes.

Guide to Reading the Specific Learning Outcomes and the Document Format

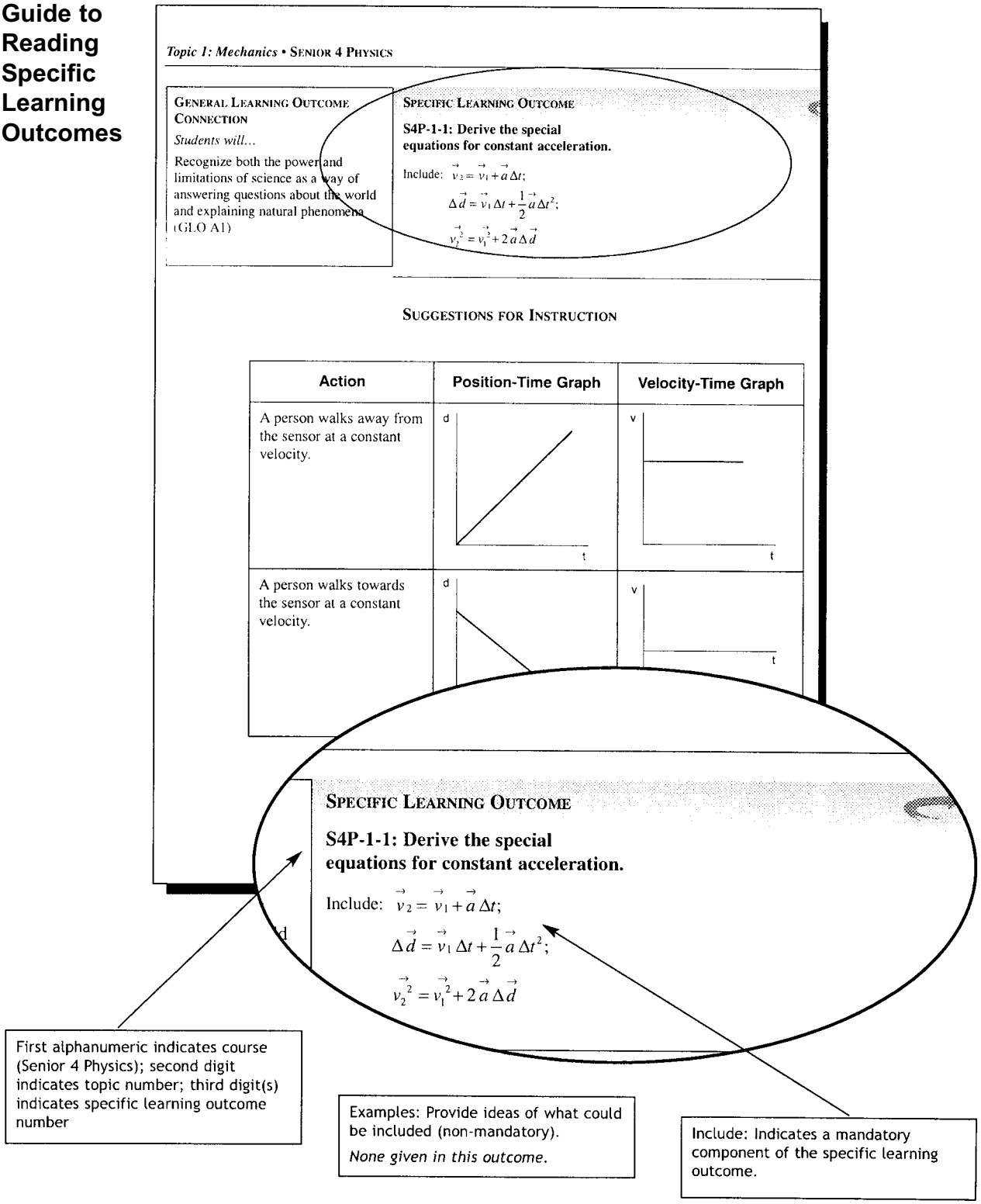
- The **Prescribed Learning Outcomes** identified in the header outline the intended learning to be achieved by the student by the end of the course. They include the specific learning outcomes related to the thematic topic in addition to the learning outcomes related to Cluster 0: Skills and Attitudes, selected to correspond to the Suggestions for Instruction.
- The **Suggestions for Instruction** directly relate to the achievement of the specific learning outcomes contained in the header at the top of each page.
- The **Suggestions for Assessment** of the specific learning outcomes offer assistance in identifying appropriate strategies.
- The **Suggested Learning Resources** are intended to guide and support instruction, the learning process, and student assessment.
- **Teacher Notes** boxes provide for handwritten planning hints, special interest material, and depth of treatment on certain issues related to the learning outcomes. These are incorporated as text boxes throughout.

The pages that follow provide detailed clarification on reading the document format.


General learning outcome statements connect learning in Senior 4 to the Manitoba Foundations for Science Literacy.
Prescribed learning outcome statements that define what students are expected to achieve at the end of Senior 4 Physics.
Topic 1: Mechanics • Senior 4 Physics
General Learning Outcome Connection
Students will...
Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena (GLO A1)
Specific Learning Outcome
S4P-1-1: Derive the special equations for constant acceleration.
Include: $\vec{v}_2 = \vec{v}_1 + \vec{a}\Delta t$;
$\Delta\vec{d} = \vec{v}_1\Delta t + \frac{1}{2}\vec{a}\Delta t^2$;
$\vec{v}_2^{\,2} = \vec{v}_1^{\,2} + 2\vec{a}\Delta\vec{d}$
Background information and/or definitions for teachers, often beyond what students are required to know; safety information.
Suggestions for student learning experiences directly related to the attainment of specific learning outcomes.
Suggestions for Instruction
nowledge
ence, students were introduced to kinematics using the context of driving an automobile. The approach was mostly qualitative with an emphasis on the visual mode of representation. Students learned the definitions for average velocity and acceleration. In Senior 3 Physics, students extended this knowledge to focus on linear relations with an emphasis on graphical analysis using slope. Problem solving in Senior 3 Physics used the concept of average velocity.
Notes to the Teacher
In Senior 4 Physics, the spiral treatment of kinematics is completed by introducing the special equations for constant acceleration. In this way, students progress from a mostly qualitative understanding in Senior 2 Science to the introduction of a simple mathematical model in Senior 3 Physics and, finally, to a more complex mathematical approach in Senior 4 Physics. Students should gain experience solving several different types of kinematics problems, including using the quadratic formula. There exists many opportunities throughout the course to solve problems using these equations.
Prior Knowledge Activity
Students work collaboratively to complete a KWL chart (SYSTH) to review what they know from Senior 2 Science and Senior 3 Physics.
Class Discussion
Provide students with a list of descriptions of motion or have students create their own list. Various descriptions are possible: walking to school, riding a bicycle up a hill, rolling a ball across the table, and so on. Students will predict the position-time and velocity-time graphs for these motions. Students can then verify their results with motion sensors and graphing calculators. (See attached chart.)
Class Discussion
Consider the graphs from the student activity with the motion detector (or other similar graphs). Two of the graphs are straight-line graphs. (What kind of motion does this represent?) Mathematically speaking, straight-line graphs are useful since we can calculate the slope of the line. The slope of the straight-line position graph is average velocity (covered in Senior 3 Physics but a useful review here). Similarly, the slope of the straight-line velocity graph is average acceleration.
4 – Topic 1.1 Kinematics
Icon indicates topic (e.g., Mechanics).
Graphics that appear in the document are available for downloading at: <http://www2.edu.gov.mb.ca/ks4/cur/science/> Follow the "Curriculum Documents" link.


Skills and attitudes learning outcomes define expectations across all topics in Senior 4 Physics.
SENIOR 4 PHYSICS • Topic 1: Mechanics
SKILLS AND ATTITUDES OUTCOMES
S4P-0-2a: Select and use appropriate visual, numeric, graphical, and symbolic modes of representation to identify and represent relationships.
S4P-0-2g: Develop mathematical models involving linear, power, and/or inverse relationships among variables.
GENERAL LEARNING OUTCOMES CONNECTION
Students will...
Understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts (GLO D4)
Describe and appreciate how the natural and constructed worlds are made up of systems and how interactions take place within and among these systems (GLO E2)
Suggestions for assessing specific learning outcomes.
SUGGESTIONS FOR INSTRUCTION
SUGGESTIONS FOR ASSESSMENT
At this point it is very easy for students to confuse these two types of motion. Therefore, continually encourage students to differentiate between the position- and velocity-time graphs. The derivations of the kinematics equations are rooted in the position-time, velocity-time, and acceleration-time graphs for an object moving with constant acceleration. The slope and the area between the line and the horizontal axis connect displacement, velocity, and acceleration graphically. Students should carefully differentiate among the terms position, velocity, and acceleration.
The special equations of motion can be derived from the slope and area of a velocity-time graph for an object moving with a constant acceleration. The derivations are included in the appendix for teacher reference (Appendix 1.1).
Visual Display
Use a Category Concept Map to ensure students are able to identify each symbol in each equation and its characteristics. See Appendix 1.2 for the map.
Science Journal Entries
Students use process notes (SYSTH 13.14) to detail the derivations of the special equations.
Pencil-and-Paper Tasks
Given a graph of velocity-time, students will
derive $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$; $\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} \Delta t$.
Students will algebraically derive
$v_2^2 = v_1^2 + 2a\Delta d$ from $\vec{a} = \frac{\Delta \vec{d}}{\Delta t}$ and $\Delta \vec{d} = \left(\frac{\vec{v}_1 + \vec{v}_2}{2} \right) \Delta t$.
SUGGESTED LEARNING RESOURCES
BLM 3-1: Kinematics Equations, *Physics 12*, McGraw-Hill Ryerson, 2003
QuickLab, Rocket Motion, p. 59, *Physics 12*, McGraw-Hill Ryerson, 2003
Conceptual Graphing, p. 17, Lab Manual. *Conceptual Physics*, Pearson, 2002
Topic 1.1 Kinematics – 5
Suggestions for learning resources, including print and information technology resources.

Guide to Reading Specific Learning Outcomes



Skills and Attitudes Outcomes Overview

Cluster 0 in Senior 4 Physics comprises four categories of specific learning outcomes that describe the skills and attitudes involved in scientific inquiry and the decision-making process for STSE issues. In Grades 5 to Senior 2, students develop scientific inquiry through the development of an hypothesis/prediction, the identification and treatment of variables, and the formation of conclusions. Students begin to make decisions based on scientific facts and refine their decision-making skills as they progress through the grades, gradually becoming more independent. Students also acquire key attitudes, an initial awareness of the nature of science, and other skills related to research, communication, the use of information technology, and co-operative learning.

In Senior 4 Physics, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the thematic topics 1 to 4 throughout the school year. To assist in planning and to facilitate curricular integration, many specific learning outcomes within the Skills and Attitudes cluster can link to specific learning outcomes in other subject areas, specifically English Language Arts (ELA) and mathematics (Math).

Nature of Science

S4P-0-1a Explain the roles of theory, evidence, and models in the development of scientific knowledge.

S4P-0-1b Describe the importance of peer review in the evaluation and acceptance of scientific theories, evidence, and knowledge claims.

S4P-0-1c Relate the historical development of scientific ideas and technology to the form and function of scientific knowledge today.

S4P-0-1d Describe how scientific knowledge changes as new evidence emerges and/or new ideas and interpretations are advanced.

S4P-0-1e Differentiate between how scientific theories explain natural phenomena and how scientific laws identify regularities and patterns in nature.

Inquiry Skills

S4P-0-2a Select and use appropriate visual, numeric, graphical, and symbolic modes of representation to identify and represent relationships.

S4P-0-2b Propose problems, state hypotheses, and plan, implement, adapt, or extend procedures to carry out an investigation where required.

S4P-0-2c Formulate operational definitions of major variables or concepts.

S4P-0-2d Estimate and measure accurately using SI units.

S4P-0-2e Evaluate the relevance, reliability, and adequacy of data and data-collection methods.

Include: discrepancies in data and sources of error

S4P-0-2f Record, organize, and display data using an appropriate format.

Include: labelled diagrams, tables, graphs

S4P-0-2g Develop a mathematical models involving linear, power, and/or inverse relationships among variables.

S4P-0-2h Analyze problems using vectors.

Include: Adding and subtracting vectors in straight lines, at right angles, and at non-orthogonal angles

S4P-0-2i Select and integrate information obtained from a variety of sources.

Include: print, electronic, specialists, or other resource people

Science, Technology, Society, and the Environment (STSE)

S4P-0-3a Analyze, from a variety of perspectives, the risks and benefits to society and the environment when applying scientific knowledge or introducing technology.

S4P-0-3b Describe examples of how technology has evolved in response to scientific advances, and how scientific knowledge has evolved as the result of new innovations in technology.

S4P-0-3c Identify social issues related to science and technology, taking into account human and environmental needs and ethical considerations.

S4P-0-3d Use the decision-making process to address an STSE issue.

S4P-0-3e Identify a problem, initiate research, and design a technological or other solution to address the problem.

Attitudes

S4P-0-4a Demonstrate work habits that ensure personal safety, the safety of others, and consideration of the environment.

S4P-0-4b Work co-operatively with a group to identify prior knowledge, initiate and exchange ideas, propose problems and their solution, and carry out investigations.

S4P-0-4c Demonstrate confidence in their ability to carry out investigations in science and to address STSE issues.

S4P-0-4d Develop a sense of personal and shared responsibility for the impact of humans on the environment, and demonstrate concern for social and environmental consequences of proposed actions.

S4P-0-4e Demonstrate a continuing and more informed interest in science and science-related issues.

S4P-0-4f Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.

Specific Learning Outcomes Overview

The Specific Learning Outcomes (SLOs) identified here constitute the intended learning to be achieved by the student by the end of a complete instructional and assessment sequence for Senior 4 Physics. These statements clearly define what students of Senior 4 Physics are expected to achieve and/or are able to perform at the end of the course. When combined with the Skills and Attitudes SLOs that appear previously, these student-specific learning outcomes constitute the bases upon which assessment and instructional design have their source.

Topic One: Mechanics

Topic 1.1: Kinematics

S4P-1-1 Derive the special equations for constant acceleration.

Include: $\vec{a} = \frac{\Delta \vec{v}}{\Delta t}$; $\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} \Delta t^2$; $v_2^2 = v_1^2 + 2a\Delta d$

S4P-1-2 Solve problems for objects moving in a straight line with a constant acceleration.

Include: $\vec{v}_2 = \vec{v}_1 + \vec{a} \Delta t$; $\Delta \vec{d} = \vec{v}_1 \Delta t + \frac{1}{2} \vec{a} \Delta t^2$; $v_2^2 = v_1^2 + 2a\Delta d$; $\Delta \vec{d} = \left(\frac{\vec{v}_1 + \vec{v}_2}{2} \right) \Delta t$

S4P-1-3 Solve relative motion problems for constant velocities using vectors.

Topic 1.2: Dynamics

S4P-1-4 Solve vector problems for objects in equilibrium.

S4P-1-5 Calculate the forces acting on an object resting on an inclined plane.

Include: normal force, friction, components of the gravitational force (mg)

S4P-1-6 Calculate the components of $\vec{F}_{\text{gravity}}$ exerted on an object resting on an inclined plane.

S4P-1-7 Solve problems with $\vec{F}_{\text{friction}}$ for objects on a horizontal surface and on an inclined plane.

Include: coefficient of friction

S4P-1-8 Solve problems using $\vec{F}_{\text{net}} = m\vec{a}$ where $\vec{F}_{\text{net}} = \vec{F}_{\text{applied}} + \vec{F}_{\text{friction}}$ and using kinematics equations from above.

Include: $\vec{F}_{\text{applied}}$ at an angle to horizontal motion; combined mass systems; $\vec{F}_{\text{applied}}$ on an inclined plane; forces acting at various angles on a body

S4P-1-9 Perform an experiment to investigate forces acting on an object.

Topic 1.3: Momentum

S4P-1-10 Derive the impulse-momentum equation from Newton's second law.

S4P-1-11 Determine impulse from the area under a force-time graph.

Include: constant positive and negative force, uniformly changing force

S4P-1-12 Experiment to illustrate the Law of Conservation of Momentum in one and two dimensions.

S4P-1-13 Solve problems using the impulse-momentum equation and the Law of Conservation of Momentum.

S4P-1-14 Relate the impulse-momentum equation to real-life situations.

Examples: hitting a ball, catching a ball

Topic 1.4: Projectile Motion

S4P-1-15 Solve simple free-fall problems using the special equations for constant acceleration.

Include: horizontal and vertical components of motion of the curved path of a projectile (without air resistance).

S4P-1-16 Draw free-body diagrams for a projectile at various points along its path (with or without air resistance).

S4P-1-17 Calculate the horizontal and vertical components with respect to velocity and position of a projectile at various points along its path.

S4P-1-18 Solve problems for projectiles launched horizontally and at various angles to the horizontal to calculate maximum height, range, and overall time of flight of the projectile.

Topic 1.5: Circular Motion

S4P-1-19 Explain qualitatively why an object moving at constant speed in a circle is accelerating toward the centre of the circle.

S4P-1-20 Discuss the centrifugal effects with respect to Newton's laws.

S4P-1-21 Draw free-body diagrams of an object moving in uniform circular motion.

S4P-1-22 Experiment to determine the mathematical relationship between period and frequency and one or more of the following: centripetal force, mass, and radius.

S4P-1-23 Derive an equation for the constant speed and acceleration of an object moving in a circle $\left(\vec{v} = \frac{2\pi r}{T},\ a = \frac{v^2}{R} \right)$.

S4P-1-24 Solve problems for an object moving with a constant speed in a circle using $a = \frac{v^2}{R}$, $\vec{v} = \frac{2\pi r}{T}$, and $\vec{F}_{\text{net}} = m\vec{a}$.

Topic 1.6: Work and Energy

S4P-1-25 Define work as the product of displacement and the component of force parallel to the displacement when the force is constant.

S4P-1-26 Determine work from the area under the force-position graph for any force.

Include: positive or negative force, uniformly changing force

S4P-1-27 Describe work as a transfer of energy.

Include: positive and negative work, kinetic energy, conservation of energy

S4P-1-28 Give examples of various forms of energy and describe qualitatively the means by which they can perform work.

S4P-1-29 Derive the equation for kinetic energy using $W = \vec{F}\ \Delta\vec{d}\cos\theta$ and kinematics equations.

S4P-1-30 Derive the equation for gravitational potential energy near the surface of the Earth ($E_p = mgh$).

S4P-1-31 Experiment to determine Hooke's Law $\left(\vec{F} = -k\vec{x}\right)$.

S4P-1-32 Derive an equation for the potential energy of a spring, using Hooke's law and a force-displacement graph.

S4P-1-33 Solve problems related to the conservation of energy.

Include: gravitational and spring potential, and kinetic energy

Topic 2: Fields

Topic 2.1: Exploration of Space

S4P-2-1 Identify and analyze issues pertaining to space exploration.

Examples: scale of the universe, technological advancement, promotion of global co-operation, social and economic benefits, allocation of resources shifted away from other pursuits, possibility of disaster

S4P-2-2 Describe planetary motion using Kepler's three laws.

Examples: relate Kepler's Third Law to objects other than planets, such as comets, satellites, and spacecraft

S4P-2-3 Outline Newton's Law of Universal Gravitation and solve problems using $F_g = \frac{Gm_1m_2}{r^2}$.

S4P-2-4 State the gravitational potential energy as the area under the force-separation curve and solve problems using $E_g = \frac{-Gm_1m_2}{r}$.

S4P-2-5 Solve problems for the escape velocity of a spacecraft.

Include: Law of Conservation of Energy, binding energy

Topic 2.2: Low Earth Orbit

S4P-2-6 Compare the Law of Universal Gravitation with the weight (mg) of an object at various distances from the surface of the Earth and describe the gravitational field as $g = \frac{Gm_{\text{Earth}}}{r^2}$.

S4P-2-7 Outline Newton's thought experiment regarding how an artificial satellite can be made to orbit the Earth.

S4P-2-8 Use the Law of Universal Gravitation and circular motion to calculate the characteristics of the motion of a satellite.

Include: orbital period, speed, altitude above a planetary surface, mass of the central body, and the location of geosynchronous satellites

S4P-2-9 Define microgravity as an environment in which the apparent weight of a system is smaller than its actual weight.

S4P-2-10 Describe conditions under which microgravity can be produced.

Examples: jumping off a diving board, roller-coaster, free fall, parabolic flight, orbiting spacecraft

S4P-2-11 Outline the factors involved in the re-entry of an object into Earth's atmosphere.

Include: friction and g-forces

S4P-2-12 Describe qualitatively some of the technological challenges to exploring deep space.

Examples: communication, flyby and the "slingshot" effect, Hohmann Transfer orbits (least-energy orbits)

Topic 2.3: Electric and Magnetic Fields

S4P-2-13 Compare and contrast the inverse square nature of gravitational and electric fields.

S4P-2-14 State Coulomb's Law and solve problems for more than one electric force acting on a charge.

Include: one and two dimensions

S4P-2-15 Illustrate, using diagrams, how the charge distribution on two oppositely charged parallel plates results in a uniform field.

S4P-2-16 Derive an equation for the electric potential energy between two oppositely charged parallel plates ($E_e = qE\Delta d$).

S4P-2-17 Describe electric potential as the electric potential energy per unit charge.

S4P-2-18 Identify the unit of electric potential as the volt.

S4P-2-19 Define electric potential difference (voltage) and express the electric field between two oppositely charged parallel plates in terms of voltage and the separation between the plates $\left(\varepsilon = \frac{\Delta V}{d}\right)$.

S4P-2-20 Solve problems for charges moving between or through parallel plates.

S4P-2-21 Use hand rules to describe the directional relationships between electric and magnetic fields and moving charges.

S4P-2-22 Describe qualitatively various technologies that use electric and magnetic fields.

Examples: electromagnetic devices (such as a solenoid, motor, bell, or relay), cathode ray tube, mass spectrometer, antenna

Topic 3: Electricity

Topic 3.1: Electric Circuits

S4P-3-1 Describe the origin of conventional current and relate its direction to the electron flow in a conductor.

S4P-3-2 Describe the historical development of Ohm's Law.

Include: contributions of Gray, Ohm, Joule, and Kirchoff

S4P-3-3 Investigate the relationships among resistance and resistivity, length, cross-section, and temperature.

Include: $R = \frac{\rho L}{A}$

S4P-3-4 Demonstrate the ability to construct circuits from schematic diagrams for series, parallel, and combined networks.

Include: correct placement of ammeters and voltmeters

S4P-3-5 Calculate the total resistance for resistors in series and resistors in parallel.

S4P-3-6 Calculate the resistance, current, voltage, and power for series, parallel, and combined networks.

Include: $P = IV$, $P = I^2R$, and $P = \frac{V^2}{R}$

Topic 3.2: Electromagnetic Induction

S4P-3-7 Define magnetic flux $(\Phi = B_{\perp}A)$.

S4P-3-8 Demonstrate how a change in magnetic flux induces voltage.

S4P-3-9 Calculate the magnitude of the induced voltage in coils using $V = \frac{N\Delta\Phi}{\Delta t}$.

S4P-3-10 Outline Lenz's Law and apply to related problems.

S4P-3-11 Describe the operation of an AC generator.

S4P-3-12 Graph voltage versus angle for the AC cycle.

S4P-3-13 Describe the operation of transformers.

S4P-3-14 Solve problems using the transformer ratio of $\frac{V_p}{V_s} = \frac{N_p}{N_s}$.

S4P-3-15 Describe the generation, transmission, and distribution of electricity in Manitoba.

Include: step-up and step-down transformers, power transfer, High Voltage Direct Current

Topic 4: Medical Physics

Topic 4.1: Medical Physics

S4P-4-1 Describe the nuclear model of the atom.

Include: proton, neutron, nucleus, nuclear forces, stability, isotope, mass number, electron, ion

S4P-4-2 Define radioactivity as a nuclear change that releases energy.

Include: Becquerel units, radioactive decay, half life

S4P-4-3 Perform decay calculations using integer numbers of half life.

S4P-4-4 Describe the following types of radiation: alpha, beta, and electromagnetic radiation.

Include: particle radiation, wave radiation, electromagnetic spectrum, linear energy transfer

S4P-4-5 Compare and contrast sources and characteristics of ionizing radiation and non-ionizing radiation.

Include: NORM (Naturally Occurring Radioactive Materials), radon, background radiation, incandescent light bulb, hot objects

S4P-4-6 Describe various applications of non-ionizing radiation.

Examples: communications, microwave oven, laser, tanning bed

S4P-4-7 Describe various applications of ionizing radiation.

Examples: food irradiation, sterilization, smoke alarm

S4P-4-8 Describe the effects of non-ionizing and ionizing radiation on the human body.

Include: equivalency of sievert (Sv) and rem units, solar erythema (sunburn)

S4P-4-9 Research, identify, and examine the application of radiation to diagnostic imaging and treatment techniques.

Examples: nuclear medicine imaging techniques such as MRI, ultrasound, endoscopy, X-ray, CT scanning, PET, heavy isotopes such as Ba; nuclear medicine therapies such as brachitherapy, external beam, gamma knife