SECTION 4

DOCUMENT ORGANIZATION

The prescribed learning outcomes and the suggestions for instruction, assessment, and learning resources contained within *Senior 3 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 comprise 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 hand-written 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.

Document Format

General learning outcome statements connect learning in Physics 30S to the Manitoba Foundations for Science Literacy.

Prescribed learning outcome statements that define what students are expected to achieve at the end of Physics 30S.

Topic 3: Mechanics • SENIOR 3 PHYSICS

GENERAL LEARNING OUTCOME CONNECTION

Students will...

Demonstrate appropriate scientific inquiry skills when seeking answers to questions (GLO C2)

SPECIFIC LEARNING OUTCOMES

S3P-3-09: Perform an experiment to demonstrate Newton's Second Law ($\overline{F}_{net} = m\overline{a}$).

S3P-3-10: Define the unit of force as the newton.

S3P-3-11: Define $\overline{F}_{net}$ as the vector sum of all forces acting on a body.

Include: force of friction, normal force, gravitational force, applied forces

Background information and/or definitions for teachers, often beyond what students are required to know; safety information.

SUGGESTIONS FOR INSTRUCTION

Entry-Level Knowledge

In Senior 2 Science, students investigated Newton's Second Law qualitatively in terms of the proportional relationships between force and acceleration and force and mass. In addition, students of Senior 2 Science were introduced to Newton's First and Third Laws.

Newton's Three Laws:

Newton's First Law: If no external or unbalanced force acts on an object, its state of rest or its constant speed are maintained.

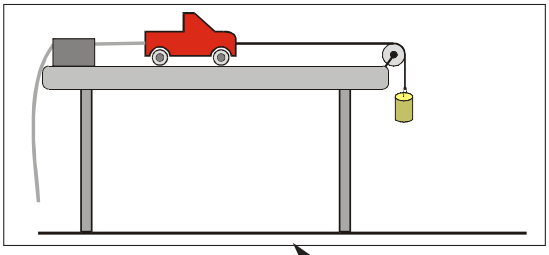
Newton's Second Law: $F_{net} = ma$.

Newton's Third Law: For every action force, there exists a reaction force that is equal in magnitude but opposite in direction.

Notes to the Teacher

Typically, an experiment to demonstrate Newton's Second Law involves a set-up in which a known net force acts on a known mass. The acceleration may be measured with a motion probe, tickertape timer device, or video analysis. The forces may be measured with a force probe, spring scale, or a known gravitational force (weight). One possible set-up is shown below.

A lab cart (m_1) on a horizontal surface is being pulled by a string that is connected to a falling mass through a pulley. If we increase the mass (force of gravity increases), we can measure acceleration and graph it. The force-versus-acceleration graph is a straight line and the slope is the ratio of force to acceleration. Ask students: Under what conditions will this ratio be large or small? It is large for objects that



Suggestions for student learning experiences directly related to the attainment of specific learning outcomes.

Topic 3.2 – 30

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 Physics 30S.

SKILLS AND ATTITUDES OUTCOMES

S3P-0-2h: Analyze problems, using vectors.
Include: adding and subtracting vectors in straight lines and at right angles, vector components

S3P-0-2b: Propose problems, state hypotheses, and plan, implement, adapt, or extend procedures to carry out an investigation where required.

SS3P-0-4b: Work cooperatively with a group to identify prior knowledge, initiate and exchange ideas, propose problems and their solutions, and carry out investigations.

S3P-0-4c: Demonstrate confidence in carrying out scientific investigations and in addressing STSE issues.

GENERAL LEARNING OUTCOME 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)

Suggestions for assessing specific learning outcomes.

SUGGESTIONS FOR INSTRUCTION

are difficult to accelerate, and small for objects that are easy to accelerate. This resistance to acceleration is called the inertial mass of the object.

The relationship between F_{net} and acceleration can also be demonstrated in a lab, using dynamic carts on an inclined plane. As the angle of the incline increases, the force acting on the cart also increases according to $\sin\theta$.

$F = ma$ defines force. The SI units for force can be derived from this equation. Therefore, a unit of force is a $kg \cdot m/s^2$, and is given the name newton (N).

Note: The F in $F = ma$ is the net force acting on the mass and should always be written as:

$F_{net} = ma$, where F_{net} = sum of the applied forces.

OR

$\sum \vec{F} = ma$, where $\sum \vec{F}$ = sum of the applied forces.

SUGGESTIONS FOR ASSESSMENT

Students submit a lab report that states the relationship among force, mass, and acceleration, and some systemic errors (specific to this lab) that could be redesigned to improve future trials.

SUGGESTED LEARNING RESOURCES

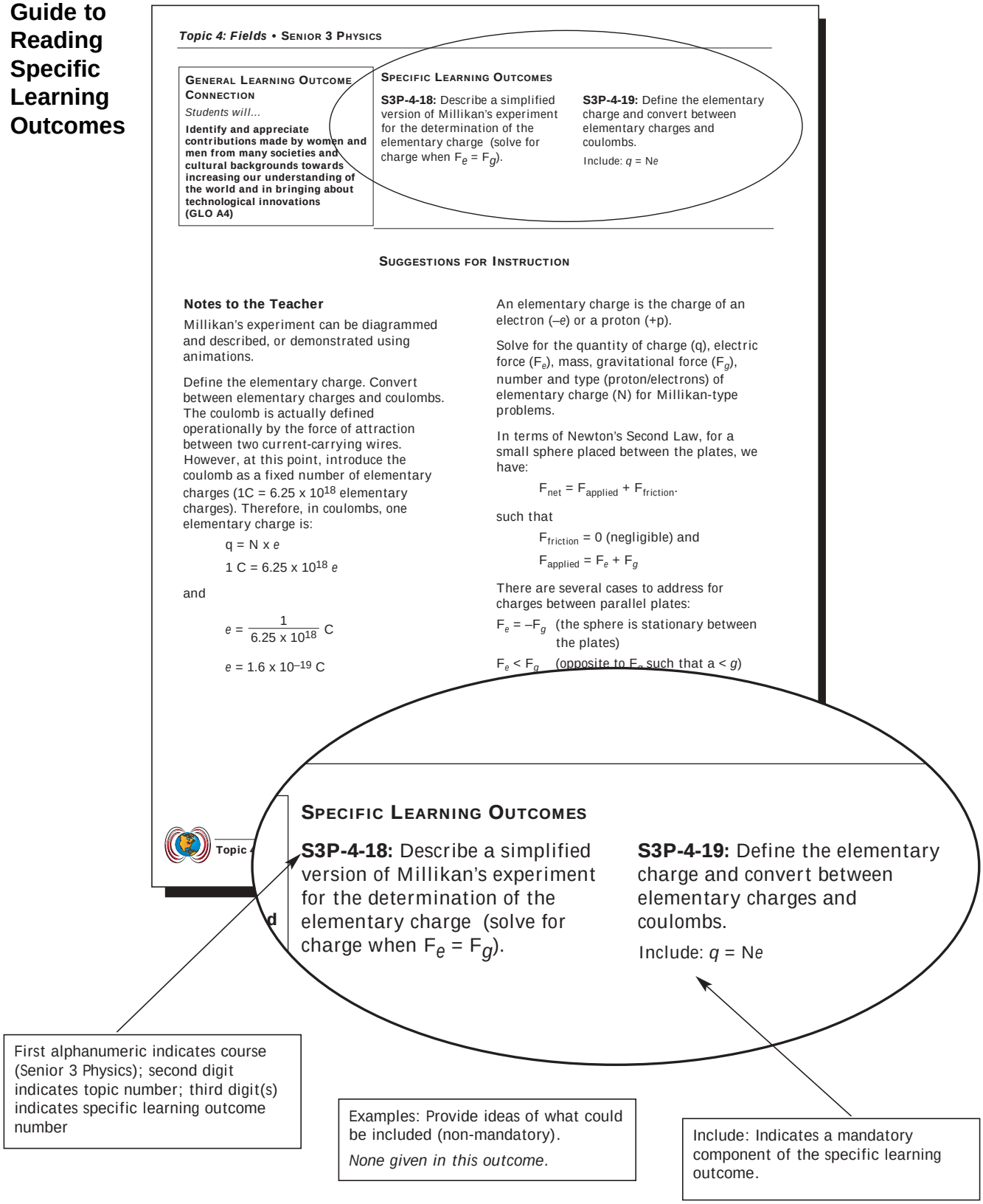
Appendix 3.15: Journal Entry: Dynamics and Diagrams

Appendix 3.16: Free-Body Diagrams: Linear Motion

Appendix 3.17: Free-Body Diagrams 2: Linear Motion

Suggestions for learning resources, including print and information technology resources.

Guide to Reading Specific Learning Outcomes



Skills and Attitudes Outcomes Overview

Cluster 0 in Physics 30S 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 cooperative learning.

In Senior 3 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. For example, students could use the decision-making process as they examine an STSE issue related to sound in Topic 1. 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

S3P-0-1a Explain the roles of theory, evidence, and models in the development of scientific knowledge.

S3P-0-1b Describe the importance of peer review in the evaluation and acceptance of scientific theories, evidence, and knowledge claims.

S3P-0-1c Relate the historical development of scientific ideas and technology to the form and function of scientific knowledge today.

S3P-0-1d Describe how scientific knowledge changes as new evidence emerges and/or new ideas and interpretations are advanced.

S3P-0-1e Differentiate between how scientific theories explain natural phenomena and how scientific laws identify regularities and patterns in nature.

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* Cluster 0: Overall Skills and Attitudes—specific learning outcomes for this grade/course are presented as a chart (separate attachment). The purpose of this chart is to provide a full course overview of skills and attitudes that need to be achieved.

Inquiry Skills

S3P-0-2a Select and use appropriate visual, numeric, graphical, and symbolic modes of representation to identify and represent relationships.

S3P-0-2b Propose problems, state hypotheses, and plan, implement, adapt, or extend procedures to carry out an investigation where required.

S3P-0-2c Formulate operational definitions of major variables or concepts.

S3P-0-2d Estimate and measure accurately, using Système International (SI) units.

S3P-0-2e Evaluate the relevance, reliability, and adequacy of data and data-collection methods.

Include: discrepancies in data and sources of error

S3P-0-2f Record, organize, and display data, using an appropriate format.

Include: labelled diagrams, tables, graphs.

S3P-0-2g Interpret patterns and trends in data, and infer or calculate linear relationships among variables.

S3P-0-2h Analyze problems, using vectors.

Include: adding and subtracting vectors in straight lines and at right angles, vector components

S3P-0-2i Select and integrate information obtained from a variety of sources.

Include: print, electronic, and/or specialist sources, resource people.

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

S3P-0-3a Analyze, from a variety of perspectives, the risks and benefits to society and the environment when applying scientific knowledge or introducing technology.

S3P-0-3b Describe examples of how technology has evolved in response to scientific advances, and how scientific knowledge has evolved as a result of new innovations in technology.

S3P-0-3c Identify social issues related to science and technology, taking into account human and environmental needs and ethical considerations.

S3P-0-3d Use the decision-making process to address an STSE issue.

S3P-0-3e Identify a problem, initiate research, and design a technological or other solution to address the problem.

Attitudes

S3P-0-4a Demonstrate work habits that ensure personal safety, the safety of others, and consideration of the environment.

S3P-0-4b Work cooperatively with a group to identify prior knowledge, initiate and exchange ideas, propose problems and their solutions, and carry out investigations.

S3P-0-4c Demonstrate confidence in carrying out scientific investigations and in addressing STSE issues.

S3P-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.

S3P-0-4e Demonstrate a continuing and more informed interest in science and science-related issues.

S3P-0-4f Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.

NOTES