Science 10

CURRICULUM GUIDE

NOVA SCOTIA

Atlantic Canada Science Curriculum: Science 10

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Foreword

The pan-Canadian *Common Framework of Science Learning Outcomes K to 12* (1997) provides the basis for the curriculum described in *Foundation for the Atlantic Canada Science Curriculum* (1998). The Council of Atlantic Ministers of Education and Training (formerly the Atlantic Provinces Education Foundation) has developed new science curriculum guidelines for grades primary–10.

Science 10 includes the following units: Weather Dynamics, Chemical Reactions, Motion, and Sustainability of Ecosystems.

This guide is intended to provide teachers with the outcomes framework for the course. It also includes some suggestions to assist teachers in designing learning experiences and assessment tasks.

Contents

Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* (Nova Scotia Department of Education and Culture 1998) and related curriculum guides was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12* (Council of Ministers of Education 1997).

Aim

The aim of science education in the Atlantic provinces is to develop scientific literacy.

Scientific literacy is an evolving combination of the science-related attitudes, skills, and knowledge that students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

Program Design and Components

Learning and Teaching Science

What students learn is fundamentally connected to how they learn it. The aim of scientific literacy for all has created a need for new forms of classroom organization, communication, and instructional strategies. The teacher is a facilitator of learning whose major tasks include

- creating a classroom environment to support the learning and teaching of science
- designing effective learning experiences that help students achieve designated outcomes
- stimulating and managing classroom discourse in support of student learning
- learning about and then using students' motivations, interests, abilities, and learning styles to improve learning and teaching
- assessing student learning, the scientific tasks and activities involved, and the learning environment to make ongoing instructional decisions
- selecting teaching strategies from a wide repertoire

Effective science learning and teaching take place in a variety of situations. Instructional settings and strategies should create an environment that reflects a constructive, active view of the learning process. Learning occurs through actively constructing one's own meaning and assimilating new information to develop a new understanding.

The development of scientific literacy in students is a function of the kinds of tasks in which they engage, the discourse in which they participate, and the settings in which these activities occur. Students' disposition toward science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to these facets of curriculum.

Learning experiences in science education should vary and should include opportunities for group and individual work, discussion among students as well as between teacher and students, and hands-on, minds-on activities that allow students to construct and evaluate explanations for the phenomena under investigation. Such investigations and the evaluation of the evidence accumulated provide opportunities for students to develop their understanding of the nature of science and the nature and status of scientific knowledge.

Writing in Science

Learning experiences should provide opportunities for students to use writing and other forms of representation as ways of learning. Students at all grade levels should be encouraged to use writing to speculate, theorize, summarize, discover connections, describe processes, express understandings, raise questions, and make sense of new information using their own language as a step to the language of science. Science logs are useful for such expressive and reflective writing. Purposeful note making is an intrinsic part of learning in science, helping students to better record, organize, and understand information from a variety of sources. The process of creating word webs, maps, charts, tables, graphs, drawings, and diagrams to represent data and results helps students learn and also provides them with useful study tools.

Learning experiences in science should also provide abundant opportunities for students to communicate their findings and understandings to others, both formally and informally, using a variety of forms for a range of purposes and audiences. Such experiences should encourage students to use effective ways of recording and conveying information and ideas and to use the vocabulary of science in expressing their understandings. Through opportunities to talk and write about the concepts they need to learn, students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they must develop and apply in reading, viewing, interpreting, and using a range of science texts for various purposes. It will be equally important for students to have demonstrations of the strategies they have to develop and apply in selecting, constructing, and using various forms for communicating in science.

The Three Processes of Scientific Literacy

An individual can be considered scientifically literate when he or she is familiar with, and able to engage in, three processes: inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanations for phenomena. While there is general agreement that there is no such thing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analyzing data, and interpreting data are fundamental to engaging in science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important in their own right, and they also provide a relevant context for engaging in scientific inquiry and problem solving.

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit them to address their students' various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biasses in their teaching, they must also actively address cultural and gender stereotyping (e.g., about who is interested in and who can succeed in science and mathematics). Research supports the position that when science curriculum is made personally meaningful and socially and culturally relevant, it is more engaging for groups traditionally under-represented in science and, indeed, for all students.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates.

Teachers should provide materials and strategies that accommodate student diversity and should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provides access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

The terms **assessment** and **evaluation** are often used interchangeably, but they refer to quite different processes. Science curriculum documents developed in the Atlantic region use these terms as described below.

Assessment is the systematic process of gathering information on student learning.

Evaluation is the process of analyzing, reflecting upon, and summarizing assessment information and making judgments or decisions based upon the information gathered.

The assessment process provides the data, and the evaluation process brings meaning to the data. Together, these processes improve teaching and learning. If we are to encourage enjoyment in learning for students now and throughout their lives, we must develop strategies to involve students in assessment and evaluation at all levels. When students are aware of the outcomes for which they are responsible and of the criteria by which their work will be assessed or evaluated, they can make informed decisions about the most effective ways to demonstrate their learning.

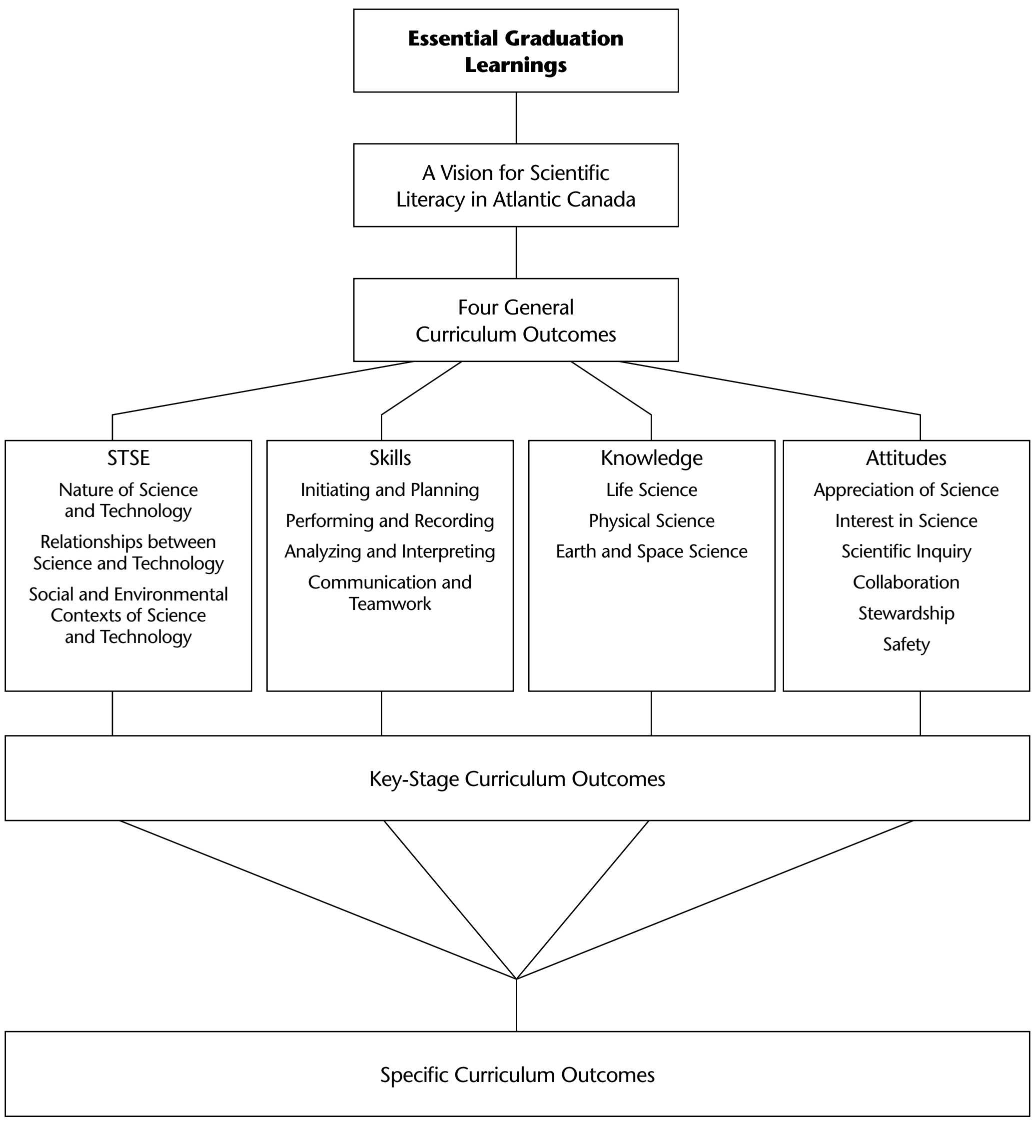
The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When assessing student progress, it is helpful to know some activities, skills, and actions associated with each process of science learning. Student learning may be described in terms of ability to perform these tasks.

Curriculum Outcomes Framework

Overview

The science curriculum is based on an outcomes framework that includes statements of essential graduation learnings, general curriculum outcomes, key-stage curriculum outcomes, and specific curriculum outcomes. The general, key-stage, and specific curriculum outcomes reflect the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*.

Outcomes Framework



Essential Graduation Learnings

Essential graduation learnings are statements describing the knowledge, skills, and attitudes expected of all students who graduate from high school. Achievement of the essential graduation learnings will prepare students to continue to learn throughout their lives. These learnings describe expectations not in terms of individual school subjects but in terms of knowledge, skills, and attitudes developed throughout the curriculum. They confirm that students need to make connections and develop abilities across subject boundaries and be ready to meet the shifting and ongoing opportunities, responsibilities, and demands of life after graduation. Provinces may add additional essential graduation learnings as appropriate. The essential graduation learnings are described below.

Aesthetic Expression

Graduates will be able to respond with critical awareness to various forms of the arts and be able to express themselves through the arts.

Citizenship

Graduates will be able to assess social, cultural, economic, and environmental interdependence in a local and global context.

Communication

Graduates will be able to use the listening, viewing, speaking, reading, and writing modes of language(s) as well as mathematical and scientific concepts and symbols to think, learn, and communicate effectively.

Personal Development

Graduates will be able to continue to learn and to pursue an active, healthy lifestyle.

Problem Solving

Graduates will be able to use the strategies and processes needed to solve a wide variety of problems, including those requiring language, mathematical, and scientific concepts.

Technological Competence

Graduates will be able to use a variety of technologies, demonstrate an understanding of technological applications, and apply appropriate technologies for solving problems.

General Curriculum Outcomes

The general curriculum outcomes form the basis of the outcomes framework. They also identify the key components of scientific literacy. Four general curriculum outcomes have been identified to delineate the four critical aspects of students' scientific literacy. They reflect the wholeness and interconnectedness of learning and should be considered interrelated and mutually supportive.

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

Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.

Skills

Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.

Knowledge

Students will construct knowledge and understandings of concepts in life science, physical science, and Earth and space science, and they will apply these understandings to interpret, integrate, and extend their knowledge.

Attitudes

Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework of Science Learning Outcomes K to 12.*

Note: Teachers should consult *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Specific Curriculum Outcomes

This curriculum guide outlines specific curriculum outcomes for Science 10 and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes.

Specific curriculum outcome statements describe what students are expected to know and be able to do at each grade level. They are intended to help teachers design learning experiences and assessment tasks. Specific curriculum outcomes represent a framework for helping students achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in four units. Each unit is of equal value. Each unit is organized by topic. Science 10 units and topics follow.

Earth and Space Science: Weather Dynamics (25%)

- Weather: Observations and Measurements
- Water's Role in Our World
- Energy Transfer
- Weather Forecasting

Physical Science: Chemical Reactions (25%)

- Investigating Chemical Reactions
- Formula Writing
- Chemical Reactions
- STSE Connections

Physical Science: Motion (25%)

- Motion: Position, Distance, Displacement
- Graphs of Speed and Velocity
- Motion: Graphs and Formulas
- Research in Science and Technology

Life Science: Sustainability of Ecosystems (25%)

- Sustainability
- Sustainability of an Ecosystem
- STSE and Sustainable Development

The following pages outline specific curriculum outcomes for Science 10 grouped by units and topics.

Earth and Space Science: Weather Dynamics (25%)

Students will be expected to

WEATHER: OBSERVATIONS AND MEASUREMENTS

- use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks (213-3, 213-6, 213-7)
- identify questions and analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies (214-10, 331-5, 212-1)

WATER'S ROLE IN OUR WORLD

- use scientific theory, identify questions about, illustrate, and explain heat energy transfers that occur in the water cycle (331-1, 214-3)
- describe how the atmosphere and hydrosphere act as heat sinks in the water cycle (331-3)

ENERGY TRANSFER

- use weather data to describe and explain heat transfers in the hydrosphere and atmosphere, showing how these affect air and water currents (331-2)
- illustrate and display how science attempts to explain seasonal changes and variations in weather patterns for a given location (215-5)

WEATHER FORECASTING

- describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves (117-10, 115-6)
- identify and report the impact of accurate weather forecasting from the personal to the global point of view (118-2, 117-6, 114-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Physical Science: Chemical Reactions (25%)

Students will be expected to

INVESTIGATING CHEMICAL REACTIONS

- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)
- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)
- describe how neutralization involves tempering the effects of an acid with a base or vice versa (321-2)

FORMULA WRITING

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts based on their characteristics, name, and formula (319-2)

CHEMICAL REACTIONS

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)
- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

STSE CONNECTIONS

- investigate and collaborate to describe science and technology relationships and their functions (116-3, 117-7, 215-6, 116-5)

Physical Science: Motion (25%)

Students will be expected to

MOTION: POSITION, DISTANCE, DISPLACEMENT

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

GRAPHS OF SPEED AND VELOCITY

- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)

MOTION: GRAPHS AND FORMULAS

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

RESEARCH IN SCIENCE AND TECHNOLOGY

- identify and imagine questions that could be investigated using relevant research in science and technology (114-6, 117-8)
- describe examples of Canadian contributions to science and technology in the area of motion (117-10)

Life Science: Sustainability of Ecosystems (25%)

Students will be expected to

SUSTAINABILITY

- question and analyze how a paradigm shift in sustainability can change society's views (114-1)

SUSTAINABILITY OF AN ECOSYSTEM

- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity (318-2, 318-5)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)

STSE AND SUSTAINABLE DEVELOPMENT

- describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)
- identify, investigate, and defend a course of action on a multi-perspective social issue (118-9, 215-4, 118-5)
- identify and describe peer review, Canadian research, and global projects where science and technology affect sustainable development (114-5, 116-1, 117-3, 118-1)

Attitudes Outcomes

It is expected that the Atlantic Canada science program will foster certain attitudes in students throughout their school years. The STSE, skills, and knowledge outcomes contribute to the development of attitudes; and opportunities for fostering these attitudes are highlighted in the Elaborations—Strategies for Learning and Teaching section of each unit.

Attitudes refer to generalized aspects of behaviour that teachers model for students by example and by selective approval. Attitudes are not acquired in the same way as skills and knowledge. The development of positive attitudes plays an important role in students' growth by interacting with their intellectual development and by creating readiness for responsible application of what students learn.

Since attitudes are not acquired in the same way as skills and knowledge, outcome statements for attitudes are written as key-stage curriculum outcomes for the end of grades 3, 6, 9, and 12. These outcome statements are meant to guide teachers in creating a learning environment that fosters positive attitudes.

The following pages present the attitude outcomes from the pan-Canadian *Common Framework of Science Learning Outcomes K to 12* for the end of grade 12.

Key-Stage Curriculum Outcomes: Attitudes

By the end of grade 12, students will be expected to

Appreciation of Science	Interest in Science	Scientific Inquiry
436 value the role and contribution of science and technology in our understanding of phenomena that are directly observable and those that are not **437** appreciate that the applications of science and technology can raise ethical dilemmas **438** value the contributions to scientific and technological development made by women and men from many societies and cultural backgrounds **Evident when students, for example,** • consider the social and cultural contexts in which a theory developed • use a multi-perspective approach, considering scientific, technological, economic, cultural, political, and environmental factors when formulating conclusions, solving problems, or making decisions on STSE issues • recognize the usefulness of being skilled in mathematics and problem solving • recognize how scientific problem solving and the development of new technologies are related • recognize the contribution of science and technology to the progress of civilizations • carefully research and openly discuss ethical dilemmas associated with the applications of science and technology • show support for the development of information technologies and science as they relate to human needs • recognize that western approaches to science are not the only ways of viewing the universe • consider the research of both men and women	**439** show a continuing and more informed curiosity and interest in science and science-related issues **440** acquire, with interest and confidence, additional science knowledge and skills, using a variety of resources and methods, including formal research **441** consider further studies and careers in science- and technology-related fields **Evident when students, for example,** • conduct research to answer their own questions • recognize that part-time jobs require science- and technology-related knowledge and skills • maintain interest in or pursue further studies in science • recognize the importance of making connections between various science disciplines • explore and use a variety of methods and resources to increase their own knowledge and skills • are interested in science and technology topics not directly related to their formal studies • explore where further science- and technology-related studies can be pursued • are critical and constructive when considering new theories and techniques • use scientific vocabulary and principles in everyday discussions • readily investigate STSE issues	**442** confidently evaluate evidence and consider alternative perspectives, ideas, and explanations **443** use factual information and rational explanations when analyzing and evaluating **444** value the processes for drawing conclusions **Evident when students, for example,** • insist on evidence before accepting a new idea or explanation • ask questions and conduct research to confirm and extend their understanding • criticize arguments based on the faulty, incomplete, or misleading use of numbers • recognize the importance of reviewing the basic assumptions from which a line of inquiry has arisen • expend the effort and time needed to make valid inferences • critically evaluate inferences and conclusions, cognizant of the many variables involved in experimentation • critically assess their opinion of the value of science and its applications • criticize arguments in which evidence, explanations, or positions do not reflect the diversity of perspectives that exist • insist that the critical assumptions behind any line of reasoning be made explicit so that the validity of the position taken can be judged • seek new models, explanations, and theories when confronted with discrepant events or evidence

Key-Stage Curriculum Outcomes: Attitudes

By the end of grade 12, students will be expected to

Collaboration	Stewardship	Safety
445 work collaboratively in planning and carrying out investigations, as well as in generating and evaluating ideas **Evident when students, for example,** • willingly work with any classmate or group of individuals regardless of their age, gender, or physical and cultural characteristics • assume a variety of roles within a group, as required • accept responsibility for any task that helps the group complete an activity • give the same attention and energy to the group's product as they would to a personal assignment • are attentive when others speak • are capable of suspending personal views when evaluating suggestions made by a group • seek the points of view of others, consider diverse perspectives, and accept constructive criticism when sharing their ideas or points of view • evaluate the ideas of others objectively • criticize the ideas of their peers without criticizing the persons • encourage the use of procedures that enable everyone, regardless of gender or cultural background, to participate in decision making • contribute to peaceful conflict resolution • encourage the use of a variety of communication strategies during group work • share the responsibility for errors made or difficulties encountered by the group	**446** have a sense of personal and shared responsibility for maintaining a sustainable environment **447** project the personal, social, and environmental consequences of proposed action **448** want to take action for maintaining a sustainable environment **Evident when students, for example,** • willingly evaluate the impact of their own choices or the choices scientists make when they carry out an investigation • assume part of the collective responsibility for the impact of humans on the environment • participate in civic activities related to the preservation and judicious use of the environment and its resources • encourage their peers or members of their community to participate in a project related to sustainability • consider all perspectives when addressing issues, weighing scientific, technological, and ecological factors • participate in social and political systems that influence environmental policy in their community • examine/recognize both the positive and negative effects on human beings and society of environmental changes caused by nature and by humans • willingly promote actions that are not injurious to the environment • make personal decisions based on a feeling of responsibility toward less-privileged parts of the global community and toward future generations • are critical-minded regarding the short- and long-term consequences of sustainability	**449** show concern for safety and accept the need for rules and regulations **450** be aware of the direct and indirect consequences of their actions **Evident when students, for example,** • read the label on materials before using them, interpret the WHMIS symbols, and consult a reference document if safety symbols are not understood • criticize a procedure, a design, or material that is not safe or that could have a negative impact on the environment • consider safety a positive limiting factor in scientific and technological endeavours • carefully manipulate materials, cognizant of the risks and potential consequences of their actions • write into a laboratory procedure safety and waste-disposal concerns • evaluate the long-term impact of safety and waste disposal on the environment and the quality of life of living organisms • use safety and waste disposal as criteria for evaluating an experiment • assume responsibility for the safety of all those who share a common working environment by cleaning up after an activity and disposing of materials in a safe place • seek assistance immediately for any first aid concerns such as cuts, burns, or unusual reactions • keep the work station uncluttered, with only appropriate lab materials present

Curriculum Guide Organization

Specific curriculum outcomes are organized into units for each grade level. Each unit is organized by topic. Suggestions for learning, teaching, assessment, and resources are provided to support student achievement of the outcomes.

The order in which the units of a grade appear in the guide is meant to suggest a sequence. In some cases, the rationale for the recommended sequence is related to the conceptual flow across the year. That is, one unit might introduce a concept that is then extended in a subsequent unit. Likewise, one unit might focus on a skill or context that will be built upon later in the year.

Some units or certain aspects of units may also be combined or integrated. This is one way of assisting students as they attempt to make connections across topics in science or between science and the real world. In some cases, a unit can require an extended time frame to collect data on weather patterns, plant growth, etc. These cases may warrant starting the activity early and overlapping it with the existing unit. In all cases, the intent is to provide opportunities for students to deal with science concepts and scientific issues in personally meaningful and socially and culturally relevant contexts.

Unit Organization

Each unit begins with a two-page synopsis. On the first page, introductory paragraphs provide a unit overview. These are followed by a section that specifies the focus (inquiry, problem solving, decision making) and possible contexts for the unit. Finally, a curriculum-links paragraph specifies how this unit relates to science concepts and skills addressed in other grades so teachers can see how the unit fits with the students' progress through the complete science program.

The second page of the two-page overview provides a table of the outcomes from the *Common Framework of Science Learning Outcomes K to 12* that the unit will address. The numbering system used is the one in the pan-Canadian document, as follows:

- 100s—Science, Technology, Society, and the Environment (STSE) outcomes
- 200s—Skills outcomes
- 300s—Knowledge outcomes
- 400s—Attitude outcomes (see pages 13–15) of this guide

These code numbers appear in parentheses after each specific curriculum outcome (SCO).

Science 10 Units

Earth and Space Science: Weather Dynamics (25%)

Physical Science: Chemical Reactions (25%)

Physical Science: Motion (25%)

Life Science: Sustainability of Ecosystems (25%)

Earth and Space Science: Weather Dynamics (25%)

Introduction

Global climate and local weather patterns are affected by many factors and have many consequences. This unit asks students to consider questions such as, What decisions do we face due to weather conditions? How are our lives affected by changing weather conditions (short term) and changing climate (long term)? What causes these weather patterns?

In Atlantic Canada weather patterns change frequently. Each season provides interesting weather conditions that influence how we dress, how we feel physically and psychologically, and how we interact socially. The direction from which air masses move, and the atmospheric pressures and temperatures in those air masses contribute to changes that can be quite significant in any given season. Rapid temperature rises in spring can cause significant snow melt, clear and dry weather in summer raises the risk of grassland or forest fires, autumn sees the arrival of storms from the Caribbean, and winter snowfall and temperature variations depend upon the north/south drift of the atmospheric jet stream. These changes influence Atlantic Canadians in a variety of ways.

Focus and Context

In addition to considering questions that you and your students generate, various learning and assessment activities will meet specific curriculum outcomes. Although this unit focuses on problem solving, there are opportunities for observation and inquiry as well as decision making and design technology. Sections in the unit present the key relationships of heat energy and its transfer, and observing weather data and the impact of weather forecasting.

Science Curriculum Links

Weather Dynamics connects with other clusters across many grade levels such as Daily and Seasonal Change (Science 1); Air and Water in the Environment (Science 2); Weather (Science 5), which includes the water cycle, changes in air caused by heating, and patterns of change in local conditions. Heat (Science 7) includes temperature and its measurement, methods of heat travel, the particle model of matter, and qualitative treatment of heat capacity. Water Systems on Earth (Science 8) links ocean currents to regional climates and the influence of polar ice caps. This unit will support Biology 11: Interaction of Living Things; Chemistry 12: Thermochemistry; Physics 11: Force, Motion, Work, Energy, Momentum, and Waves; and Geology 12.

Curriculum Outcomes

The following outcomes have been developed from *Common Framework of Science Learning Outcomes K to12*, pan-Canadian outcomes. See Appendix H for the original outcomes from which these were derived.

STSE	Skills	Knowledge
Students will be expected to **117-10, 115-6** describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves **118-2, 117-6, 114-6** identify and report the impact of accurate weather forecasting from the personal to the global point of view **118-7, 214-11, 116-1** analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting	Students will be expected to **213-3, 213-6, 213-7** use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks **214-10, 331-5, 212-1** identify questions and analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies **215-5** illustrate and display how science attempts to explain seasonal changes and variations in weather patterns for a given location	Students will be expected to **331-1, 214-3** use scientific theory, identify questions about, illustrate, and explain heat energy transfers that occur in the water cycle **331-3** describe how the atmosphere and hydrosphere act as heat sinks in the water cycle **331-2** use weather data to describe and explain heat transfers in the hydrosphere and atmosphere, showing how these affect air and water currents

WEATHER: OBSERVATIONS AND MEASUREMENTS

Students will be expected to

- use weather instruments effectively and accurately for collecting local weather data and collect and integrate weather data from regional and national weather observational networks (213-3, 213-6, 213-7)
- identify questions and analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies (214-10, 331-5, 212-1)

Tasks for Instruction and/or Assessment

Paper and Pencil

- In groups, collect the following weather data (for a given location and at specific times) over a five-day period: air temperature, air pressure, relative humidity, cloud cover, wind velocity. Organize these data in a chart.

  Place these data on a single set of graph axes in order to make comparisons over the time period. Compare the record of your group with that presented by local newspaper, radio, or television reports. Assess the process to organize data collection, graphical presentation, and the way in which the comparison was made. (214-10, 331-5, 212-1)

Presentation

- Present the comparison of data from the previous exercise. Illustrate the developing patterns through the five-day period. (214-10, 331-5, 212-1)
- Produce a weather chart that includes the following: weather feature (wind velocity), measuring instrument (anemometer), recorded data (50 km/h from west), and date. (213-3, 213-6, 213-7)

Elaborations—Strategies for Learning and Teaching

Note: An option to teaching this unit would be to have one class per week on weather throughout the semester. If the classes are scheduled in such a way that one class is taught twice a day in a week, one of these classes could be on weather. Students and teachers could collect data for a time and then use the information for various outcomes.

To frame their thinking about this unit, students might work in groups to develop concept maps about weather and climate. The teacher can activate prior knowledge about weather using a variety of graphic organizers.

Students will collect weather data throughout this unit and will make interpretations or predictions later.

Students research and prepare a proposal for the construction of a weather station that will provide basic meteorological data. Consider the following variables: air temperature, humidity, barometric pressure, wind speed and direction, and level of precipitation. If feasible at the school, students should become confident in using available equipment to measure and record data.

Research the components required to describe weather conditions and illustrate these on regional maps.

From changes in observed weather patterns and recorded data, students should generate questions they wish to answer about changes in weather or the techniques used to acquire data.

The description of weather changes at the school station can be compared to, and become part of, a larger picture produced from other sources to show a weather pattern.

Resources/Notes

List any resources/notes that may be helpful in addressing the outcomes for this section.

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 1: Weather Maps and Forecasts
- Activity 2: Building a Home Weather Station
- Activity 6: Weather Hazards

Activities from *Nova Scotia Science 10*
- Find Out Activity 1-1B: Temperature in the Atmosphere, p. 12
- Find Out Activity 1-1C: Effects of Atmospheric Pressure, p. 18
- Find Out Activity 1-2C: The Nova Scotia Wind Atlas, p. 37
- Launch Activity 2: Measuring Fog, p. 43
- Think About It Activity 2-1A: Analyzing a Weather Report, p. 45
- Think About It Activity 2-1B: Using the Humidex Scale, p. 51
- Conduct an Investigation 2-1C: Using a Barometer, p. 57
- Conduct an Investigation 2-1D: Measuring Relative Humidity, p. 58
- Conduct an Investigation 2-1E: Determining Wind Speed, p. 59
- Think About It Activity 2-2A: Forecasting by Observing Cloud Types and Motion, p. 62
- Think About It Activity 2-2B: Interpreting Weather Maps, p. 64
- Think About It Activity 2-2C: Surface Weather Station Model, p. 64
- Conduct an Investigation 2-2E: Using Weather Maps for Short-range Forecasting, p. 68

WATER'S ROLE IN OUR WORLD

Students will be expected to

- using scientific theory, identify questions about, illustrate, and explain heat energy transfers that occur in the water cycle (331-1, 214-3)
- describe how the atmosphere and hydrosphere act as heat sinks in the water cycle (331-3)

Tasks for Instruction and/or Assessment

Performance

- Design experiments that explore heat energy transfers that occur in water. (331-1, 214-3)

Journal

- Enter two concepts that you have learned about energy exchanges that take place. Make reference to the sources of the energy and the role water molecules play in the energy transfer. Reflect on how the oceans influence our weather. What is the next question about weather you would like answered? (331-3)

Paper and Pencil

- Using the information you collected (from a video or other source) about cloud formation and how lakes and oceans are sources of water vapour, identify the important factors in cloud formation. (331-3)
- Describe an investigation that tests the assumptions made in the video about each of these factors. (331-3)
- Prepare a list, with opportunities, of various careers that are related to weather and water. (331-1, 214-3)

Presentation

- With your group members, prepare a chart or concept map that shows the points of energy transfer in the water cycle. Design questions to help other students indicate the direction of energy flow and the forms it takes. (331-3)

Elaborations—Strategies for Learning and Teaching

Students' questions about energy and the water cycle should generate investigations. Discussion in small groups could be summarized with graphical methods such as concept maps. Questions might include the following:

- How does the water cycle influence the seasonal high/low temperatures for inland and coastal communities?
- Explain why the arrival of a snowstorm is normally linked to a rise in air temperature.
- How and why do clouds form? Explain the process of precipitation.
- What mutual interactions occur between the atmosphere and large bodies of water such as the ocean or lakes?

Students should explore how scientific knowledge evolves with new evidence about changes in ocean temperature and weather patterns. Groups of students could research, and present for discussion, possible explanations for new developments in meteorology and understanding of weather phenomena. Students might choose to identify and explain examples of new knowledge in areas such as changing fish stocks in given locations, the timing and routes of wildlife migrations, possible cash crops grown in microclimates, patterns of coastal erosion, transport in "iceberg alley," and airborne pollution and its effects. Relate these examples to various careers and opportunities that are possible.

The hydrosphere is a massive heat sink, and the energy stored in the ocean influences many systems. There are examples of this in our region. A study of ocean layers close to coastal regions and the edges of continental shelves will also help interpret flow patterns that influence weather patterns and regional climates, such as gyres.

Once students are comfortable with the concept of heat sink, challenge them to relate this property to their knowledge about the structure of matter and kinetic theory. Have them suggest why the water cycle occurs and how energy exchanges on a molecular scale are able to produce such large-scale effects.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*

- Activity 8: How Hot Does it Get?
- Activity 9: How Do Molecules Behave?

Activities from *Nova Scotia Science 10*

- Launch Activity 1: Modelling Air Movement in the Atmosphere, p. 9
- Conduct an Investigation 1-1D: Albedo and Surfaces, p. 22
- Think About It Activity 1-1E: The Role and Transfer of Energy in the Water Cycle, p. 23

Videos

The following videos can be ordered from the Nova Scotia Department of Education Learning Resources and Technology Services website, http://lrt.EDnet.ns.ca (See Appendix B):

- *The Hydrologic Cycle: Water in Motion*, 21 min. (23099)
- *Water Cycle: Oceanography*, 50 min. (23119)

ENERGY TRANSFER

Students will be expected to

- use weather data to describe and explain heat transfers in the hydrosphere and atmosphere, showing how these affect air and water currents (331-2)
- illustrate and display how science attempts to explain seasonal changes and variations in weather patterns for a given location (215-5)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Write a poem, prose, or song to describe how atmospheric temperature and pressure differences cause the trade winds. (215-5)
- Choose your own style of presentation to write a brief description of seasonal change and relate it to the sun's energy. (215-5)
- Develop an hypothesis about energy, weather, and the future based on balanced information and test it against new information and personal experience. (215-5)

Presentation

- State a hypothesis about weather patterns in Atlantic Canada. Make a three-minute oral presentation about a significant weather event, giving where, what, when, and its importance to people. Show how it relates to your hypothesis. (331-2)
- Using a flashlight (sun) and globe or ball (Earth), describe and illustrate the relationship between light source position and density of radiation incident to the surface of the globe at various locations. Consider the following:
  - daily changes with globe axis fixed
  - seasonal changes with change in globe axis (215-5)
- Use models (print, three-dimensional) or drama to illustrate how a high-pressure region moving across Atlantic Canada affects atmospheric flow laterally and vertically. Show where significant energy transfers are taking place. (215-5)
- Using weather data, show how this impacts on the environment, resources, and economy for various areas in the world. (331-2)

Portfolio

- Design and produce an entry for your portfolio. This entry is to comprise text and visual images. It can be in paper or electronic form. The entry is to illustrate and explain the link between ocean currents, atmospheric jet streams, and coastal weather patterns. (215-5)

Elaborations—Strategies for Learning and Teaching

Obtain data from a source such as Environment Canada about temperatures and flow directions for air and water for a weather system moving across a large body of water. For this example, consider energy exchanges within the hydrosphere and atmosphere. Students are better able to appreciate the various exchanges that take place in more complex weather systems. Have students describe and explain how global air currents (such as trade winds, westerlies) and water currents cause these heat transfers.

Students should search for (from various sources—anecdotal, print, and electronic) and make brief presentations on, specific examples of notable weather events. It is important that students are able to relate these historical accounts with the concept of energy exchanges within the systems. Intense weather events can have societal impacts. Students might explore possible relationships between habitation patterns in the region and weather patterns or between trends in sectors of the economy of our region and weather events. The interconnectedness of present world economic, environmental, political, and social issues is a powerful aspect of perspectives and philosophies for students to discuss.

Latitude of a location and incline of Earth's axis (in terms of incident solar radiation) play a major role in seasonal change. Students might better appreciate these effects if they design a three-dimensional model to illustrate them (flashlight and globe). Challenge some groups to use the model to describe seasonal changes not only for the Atlantic region but for considerably different locations such as Ireland, Cuba, Hawaii, Tasmania, and New Zealand.

These differences should contribute to students' explanations how variations in pressure and temperature will contribute to the movement of air both regionally and globally. Have students use diagrams to explain the cause and consequences of sea breezes, land breezes, and the relative motion of air currents and the rotation of Earth (Coriolis effect). With this, have students look at the planet's finite system.

Resources/Notes

Activities

Activity from *Science 10: A Teaching Resource*
- Activity 7: Web Quest: Weather Technology

Activities from *Nova Scotia Science 10*
- Launch Activity 1: Modelling Air Movement in the Atmosphere, p. 9
- Find Out Activity 1-1B: Temperature in the Atmosphere, p. 12
- Conduct an Investigation 1-1D: Albedo and Surfaces, p. 22
- Find Out Activity 1-2A: Angle of Sunlight, p. 27
- Find Out Activity 1-2B: Modelling the Coriolis Effect, p. 31

Videos

The following videos can be ordered from the Nova Scotia Department of Education Learning Resources and Technology Services website, http://lrt.EDnet.ns.ca (See Appendix B):
- *Blowing Hot and Cold*, 25 min. (22829)
- *Atmosphere Below*, 28 min. (23105)
- *Weather and Climate*, 15 min. (21332)

117-10 115-6 118-2 117-6 114-6 118-7 214-11 116-1
WEATHER FORECASTING

WEATHER FORECASTING

Students will be expected to

- describe examples of Canadian contributions to weather forecasting and satellite imaging, showing how scientific knowledge evolves (117-10, 115-6)
- identify and report the impact of accurate weather forecasting from the personal to the global point of view (118-2, 117-6, 114-6)
- analyze and report on the risks, benefits, and limitations of society's responses to weather forecasting (118-7, 214-11, 116-1)

Tasks for Instruction and/or Assessment

Informal/Formal Observation

- During a discussion intended to distinguish weather from climate, identify students who can clearly express their ideas and make the distinction. (118-2, 117-6, 114-6)

Performance

- Show a group of younger students how to research information about a severe weather event, identifying the physical data and reports that indicate the social impact of the event. (118-7, 214-11, 116-1)

Journal

- Reflect on the following questions about you and weather:
  - What have I learned about forecasting weather in Atlantic Canada?
  - Which types of weather do I most enjoy, and why do I prefer them?
  - If or when I move away from here, how will climate conditions influence my choice of where to live and work?
  - How does weather affect a society? (118-2, 117-6, 114-6)

Paper and Pencil

- The teacher will provide a sequence of weather satellite images for our region. Study the images and describe the weather conditions at the indicated locations. Complete one of the following, giving reasons for your conclusions:
  - as a farmer or fisher or forester, suggest some positive and negative consequences of these images
  - as a sports or tourist director, suggest some positive and negative consequences of these images
  - write a brief autobiography of a nitrogen molecule as it is taken from one indicated point to another
  - write a brief autobiography of a jellyfish at a given location resulting from the weather shown in these images (117-10, 115-6)

- Prepare a brief article or flyer that explains the advantages of weather satellite technology compared to methods used in the mid-twentieth century. (117-10, 115-6)
- Look at weather satellite images for various regions. Discuss the society that lives there and the impact that weather, science, and technology may have on the development of the society. (117-10, 115-6)

Interview

- Give an example of Canada's contribution to meteorology and how it benefits society. Give an example that illustrates the limitations of predicting weather conditions. (118-7, 214-11, 116-1)
- Look at various careers and how weather has an impact on them. (118-7, 214-11, 116-1)

Presentation

- In groups, give a four-minute presentation about a technology that has improved the accuracy of weather forecasting. (118-7, 214-11, 116-1)

Portfolio

- Choose a piece of work from this unit in which you think you have captured the social, environmental, and economic impact of weather conditions. Attach a statement explaining reasons for your selection. (118-2, 117-6, 114-6)

Elaborations—Strategies for Learning and Teaching

It is important that all students examine and explain satellite imaging and the importance of timely and accurate information. Students can identify and compare the basic weather patterns found at low latitudes (no fronts), middle latitudes (low pressures, high pressures, and fronts), and high latitudes. Students can look at the weather and the role of science and technology in the development of societies and the impact of these technologies on the environment. Connections can then be made to the environment, societies, and cultures. Students can identify how imaging technology has improved decision making about projects in which weather systems can have significant economic impact.

Have students individually, or as groups, research a technology that has improved the collection or analysis of data related to weather forecasting. Examples might include Doppler radar, infrared and visible imaging from satellites, fog detectors, precipitation detectors, remote sensing, and transmission data stations.

Our country has regions that experience some extreme variation in weather conditions. Students can find examples of Canadian contributions to meteorology associated with regions such as the Rocky Mountains, Arctic, Prairies, and Atlantic Canada.

In Atlantic Canada, forecasting weather conditions accurately may be a challenge. Despite the facilities to accumulate and analyze ever-increasing amounts of data, we live at a "junction" of flowing systems. Through interviews, print, or electronic sources, students should discover and appreciate the limits to accuracy caused by our location on the North American continent. This research might also introduce some discussion of climate, the evidence of its change, and the effects that climate change could have on society.

Students should reflect on the way in which they are personally influenced by, and respond to, various weather conditions. Although changing climate conditions are less obvious, high school students should take the opportunity to consider evidence of change and consider its consequences for us individually and on our society in Atlantic Canada.

Have groups of students choose a severe weather event and analyze its effects on an individual and for the entire community. This could be presented as a written account, a visual-image essay, or perhaps as a news report.

Ask student groups to select a particular career or occupation and a community in which to live (other than their own). For a prospective immigrant to this community in Canada, have students prepare a report or video on how the annual weather cycle affects this occupation.

Challenge students to offer examples of what society considers "severe" weather systems that occur in each of our four seasons. Groups could develop concept maps about the social impact and consequences of severe storms. What policies has a community developed to minimize the consequences? How, and on what basis, does society make these decisions? What emergency measures could each family prepare for?

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*

- Activity 3: The Weather
- Activity 4: Past, Present, and Future
- Activity 5: Weather Predictions
- Activity 10: Scrapbook Weather

Activities from *Nova Scotia Science 10*

- Think About It Activity 2-2D: Canadian Contributions to Meteorology, p. 67
- Think About It Activity 2-3A: Be Prepared!, p. 76
- Think About It Activity 2-3B: Should We Attempt to Control the Weather?, p. 78

Videos

The following videos can be ordered from the Nova Scotia Department of Education Learning Resources and Technology Services website, http://lrt.EDnet.ns.ca (See Appendix B):

- *Air: Climate,* 20 min. (23340)
- *Maple Tree: Climate*, 24 min. (23077)
- *Hurricane: Earth's Greatest Storm,* 20 min. (22251)
- *Cyclone!*, 60 min. (21636)
- *Thunderstorms,* 20 min. (23098)

Physical Science: Chemical Reactions (25%)

Introduction

After students have developed an understanding of atomic structure and the periodic table in Science 9, the study of chemical reactions provides them with an opportunity to apply their understanding of atomic structure to how chemicals react. By naming and writing common ionic and molecular compounds and by balancing a variety of equation types, students begin to make connections to a variety of chemical examples in everyday life.

Focus and Context

This unit should have a principal focus of observation and inquiry. There are opportunities for decision making as well as design technology in the experiment research components of this unit. Atlantic Canada offers a possible context for this unit because it is particularly affected by acid precipitation and other forms of air pollution due to prevailing winds in North America. These winds carry large amounts of air pollutants from the more populated and industrialized regions of the United States and Canada. The problem is further complicated by our own industrial plants and power-generation plants. In addition, much of our region has thin soils and granite bedrock, which makes the region highly sensitive to acid damage. In this context, students will consider how chemical reactions are associated with technologically produced problems such as acid rain and look at some steps that can be taken to counter the effects of acid rain.

Science Curriculum Links

The study of chemical reactions in Science 10 connects readily with topics covered as early as Science 1, where students are introduced to materials and their senses, as well as in Science 2, where students are introduced to the idea of liquids and solids. These early considerations of states of matter are given more attention and detail in Science 5 as properties and changes in materials are studied. In Science 7, students cover in some detail the concept of mixtures and solutions. There are strong links between the topics of atomic structure in Science 9 and the chemistry studied in Science 10. For those who pursue Chemistry 11 and Chemistry 12, the materials covered previously are a solid foundation to build on as students undertake a more detailed look at traditional chemistry topics such as acids and bases; solutions and stoichiometry; and electrochemistry.

Curriculum Outcomes

The following outcomes have been developed from *Common Framework of Science Learning Outcomes K to12*, pan-Canadian outcomes. See Appendix H for the original outcomes from which these were derived.

STSE	Skills	Knowledge
Students will be expected to **116-3, 117-7, 215-6, 116-5** investigate and collaborate to describe science and technology relationships and their functions **213-9, 117-5** investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials	Students will be expected to **212-8, 213-5** perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties **212-3, 213-2, 321-3, 214-5** design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions	Students will be expected to **321-2** describe how neutralization involves tempering the effects of an acid with a base or vice versa **319-1, 114-8** name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system **319-2** classify simple acids, bases, and salts based on their characteristics, name, and formula **321-1** represent chemical reactions and the conservation of mass using balanced symbolic equations

INVESTIGATING CHEMICAL REACTIONS

Students will be expected to

- investigate chemical reactions while applying WHMIS standards, using proper techniques for handling and disposing of materials (213-9, 117-5)
- perform experiments, using appropriate instruments and procedures, to identify substances as acids, bases, or salts, based on their characteristic properties (212-8, 213-5)
- describe how neutralization involves tempering the effects of an acid with a base or vice versa (321-2)

Tasks for Instruction and/or Assessment

Performance

- Research, list, and present the various forms of fuels used for domestic heating in your home community. (213-9, 117-5)
- Test substances to classify them as acid, base, or salt. Record your results in a chart. Indicate the instruments and techniques used to achieve this. (212-8, 213-5)
- Perform chemical reactions labs. Record information in a chart, including reactants, products, names, types of equations, and balanced equations. (213-9, 117-5, 321-2)
- Do precipitation tests. Write names, reactants, products (if they occur), and balanced equations. (213-9, 117-5, 321-2)

Journal

- Write your own definitions of acids and bases based on your experiments and exercises. (212-8, 213-5, 321-2)
- Chart and compare chemicals, their uses, their changes, and their effects. (213-9, 117-5)

Paper and Pencil

- Make a list of household chemicals. In a group, divide up this list and check the WHMIS data sheets to see how they should be handled and stored. Record your findings in a group table and post it on the wall. (213-9, 117-5)

Elaborations—Strategies for Learning and Teaching

This unit requires practice, experiences, activities, investigations, and experiments in the chemistry laboratory. Chemistry laboratory time should be available to all Science 10 classes. Students should observe and describe several examples of chemical reactions. Examples could include combustion of candle wax leading to carbon dioxide and water, and combustion of sulphur (in a fume hood) leading to sulphur dioxide followed by its reaction with water forming sulphurous acid (acid rain). These activities should lead to a discussion of acid rain and its consequences.

Safe practices and proper use of equipment are very important in the laboratory. For all activities in this unit, be sure that students recognize WHMIS standards.

It is possible to do experiments in a variety of ways—a standard, a micro, and a probe are all possible. Students should have a variety of experiences. All students do not need to use the identical equipment for a particular experiment. They could determine the presence of an acid, base, salt, carbon dioxide, and water by performing tests with pH paper, limewater, cobalt chloride paper, and a conductivity apparatus. If electronic equipment such as graphing calculators, pH sensors, CO_2 sensors, and so on are available, their use should be encouraged at this point. Students could test common substances to see if they are acidic, basic, or neutral.

A detailed study of acids, bases, and salts is not expected at this point. Students should have a basic understanding of simple diagnostic tests associated with acids, bases, salts, and the major products of combustion. Acids, for example, have a sour taste (if edible), turn blue litmus red, react with active metals, conduct electricity, and neutralize bases. By contrast, bases are bitter, feel slippery, turn red litmus blue, and neutralize acids. Salts conduct electricity but do not change the colour of litmus paper.

Students should illustrate the neutralizing properties of calcium oxide (lime) by reacting it first with water (thus making the base calcium hydroxide) and subsequently with dilute sulphuric acid. This would simulate neutralizing a lake that has been affected by acid precipitation. Alternatively, other combinations of acids and bases can be used.

Students can make connections among the matter, energy, and human awareness of chemicals in their environment.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 17: Evidence of Chemical Reactions
- Activity 19: Reaction Investigation
- Activity 26: Acids and Bases
- Activity 27: Household Chemicals

Activities from *Nova Scotia Science 10*
- Launch Activity 3: A Carbon Dioxide Generator, p. 99
- Conduct an Investigation 3-1C: Properties of Ionic and Molecular Compounds, pp. 106–107
- Conduct an Investigation 3-3B: Mass Before and After, p. 135
- Launch Activity 4: Foiled Again!, p. 141
- Conduct an Investigation 4-1C: Different Types of Chemical Reactions, pp. 152–154
- Find Out Activity 4-2A: Acidic, Basic, or Neutral?, p. 161
- Think About It Activity 4-2B: Fighting Back!, p. 167
- Conduct an Investigation 4-2C: Properties of Acids and Bases, pp. 170–171
- Conduct an Investigation 4-2D: Neutralization Reactions and Salts, p. 172
- Find Out Activity 4-3A: Faster or Slower?, p. 175
- Conduct an Investigation 4-3B: Changing the Rate of a Chemical Reaction, p. 18

FORMULA WRITING

Students will be expected to

- name and write formulas for common ionic compounds and molecular compounds and describe the usefulness of the IUPAC nomenclature system (319-1, 114-8)
- classify simple acids, bases, and salts based on their characteristics, name, and formula (319-2)

Tasks for Instruction and/or Assessment

Performance

- Make a display of several examples of inorganic and organic compounds (along with their names and formulas), and identify which you think are inorganic, and those you think are not organic. Explain the basis for your decision. (319-2)

Journal

- Research the introduction of the IUPAC naming system as well as the American Chemical Society (ACS) naming system, and determine their roles in naming compounds. Debate the need for a standard system for naming compounds. (319-1, 114-8)
- Design a flowchart to be used for naming compounds. (319-1, 114-8)
- Keep a record of the chemicals you use during a typical day. Compare your list to your classmates' findings. Identify these chemicals, give a basic use, a common name (if possible), and who uses it for what. (319-2)

Paper and Pencil/Performance

- Stations can be set up in the lab to test students on formula writing. Stations could include compound formulas to name, names to write formulas for, and three-dimensional models to name. (319-1, 114-8)

Paper and Pencil

- Design and fill-in nomenclature charts that include chemical names, chemical formulas, and common names (if possible). Include ionic and covalent molecules. (319-1, 114-8)
- Classify acids, bases, and salts. Give the name or formula for each. (319-2)

Presentation/Performance

- Work in groups to design a game for naming ionic or covalent compounds. Test your games on other groups in the class. (319-1, 114-8)

Elaborations—Strategies for Learning and Teaching

Formula writing is important for chemistry courses that follow. Involve students in finding a variety of ways to learn about nomenclature.

Use molecular models to demonstrate correct naming and writing of molecular formulas for a variety of molecular compounds such as methane, water, hydrogen peroxide, and sucrose. These are examples that students are aware of. More can be added. Use the systematic approach of using the prefixes (mono, di, tri, etc.) for binary compounds such as sulphur dioxide and sulphur trioxide. Through using International Union of Pure and Applied Chemistry (IUPAC) nomenclature, students should start to appreciate the usefulness of a common naming system.

Having the properties of various substances connect with the students' lives and with future careers will give meaning to the formula writing. CO_2 and CO, for example, do different things. Have the students decide what substances molecular compounds consist of (non-metals) and what substances ionic compounds consist of (metals and non-metals). Also note that formulas for acids usually start with hydrogen.

Teachers should use examples of nitrates and phosphates that will relate to the sustainability unit. There are many helpful graphic organizers and chemistry games to complement formula writing. Students should name and write formulas for some common ionic compounds (both binary and complex), using the periodic table, a list of ions, and appropriate nomenclature for metal and non-metal ions. Students should always use a Periodic Table.

Have students practice naming and writing ionic formulas such as CaO [calcium oxide], $Ca(OH)_2$ [calcium hydroxide], $CaCO_3$ [calcium carbonate], and $CaSO_4$ [calcium sulphate] associated with acid rain, along with others such as NaCl [sodium chloride], and NaOH [sodium hydroxide]. The use of Roman numerals should also be covered for compounds such as FeO [iron(II) oxide] and Fe_2O_3 [iron(III) oxide]. An activity using aids such as ion tiles would be very helpful at this point.

Students should be able to classify, name, and write the formulas of some common acids (e.g., HCl (aq) [hydrochloric acid], H_2SO_4 (aq) [sulphuric acid], HNO_3 (aq) [nitric acid]), bases (e.g., NaOH, $Ca(OH)_2$), and salts (e.g., NaCl, CaO, $CaCO_3$). As an extension, some students might be introduced to the rules for writing and naming common acids.

Students should be made aware that all organic compounds contain carbon and hydrogen along with other possible elements such as oxygen, but that some compounds containing carbon (e.g., $CaCO_3$, CO_2) are classed inorganic. Emphasize the point that organic (carbon) compounds are far more numerous in our world than inorganic compounds.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 12: Chemical Names and Formulas
- Activity 13: Building Compounds
- Activity 14: It's in the Cards
- Activity 15: Product Labels
- Activity 16: Chemical Cubes

Activities from *Nova Scotia Science 10*
- Think About It Activity 3-1B: Patterns in Ion Formation, p. 105
- Think About It Activity 3-2A: What's in a Name?, p. 110
- Think About It Activity 3-2B: The Structure and Formulas of Ionic Compounds, p. 112
- Find Out Activity 3-2C: The Ionic Card Game, p. 120
- Think About It Activity 3-2D: Chemical Formulas of Molecular Compounds, p. 121
- Think About It Activity 3-2E: Decisions, Decisions, p. 124
- Think About It Activity 3-2F: Why IUPAC?, p. 125
- Find Out Activity 4-2A: Acidic, Basic, or Neutral?, p. 161
- Conduct an Investigation 4-2C: Properties of Acids and Bases, pp. 170–171
- Conduct an Investigation 4-2D: Neutralization Reactions and Salts, p. 172

Note: Students are able to write formulas and explain how these work without the detailed energy level information. Studies show that this can be left for a more in-depth treatment after basic formula writing. Energy levels and extensive bond formation happens in Chemistry 11.

321-1 212-3 213-2 321-3 214-5 321-1 212-3 213-2 321-3 214-5

CHEMICAL REACTIONS

CHEMICAL REACTIONS

Students will be expected to

- represent chemical reactions and the conservation of mass using balanced symbolic equations (321-1)
- design and carry out experiments, controlling variables and interpreting patterns, to illustrate how factors can affect chemical reactions (212-3, 213-2, 321-3, 214-5)

Tasks for Instruction and/or Assessment

Performance

- Make and use three-dimensional models for presentations and balancing chemical equations. (321-1)
- Perform experiments that demonstrate the law of conservation of mass. Report your findings. (212-3, 213-2, 321-3, 214-5)
- Given a reaction between two compounds involving a heat evolution or absorption and a colour change, describe and perform an experiment. Decide which two compounds give heat and which give colour changes. Describe what effect surface area would have on the reaction. Record and submit a write-up that focuses on the results of your experiment. (212-3, 213-2, 321-3, 214-5)
- Perform a practical experiment in the laboratory. Submit your write-up at the end of the class using charts for your data and conclusions. (212-3, 213-2, 321-3, 214-5)
- Write chemical reactions for all your experiments. Include words and symbols. (321-1)

Paper and Pencil

- Write a balanced equation and indicate the reaction type (combustion, combination, decomposition, single replacement, or double replacement) for each of the following:

  $H_2O\ (l) \rightarrow H_2\ (g) + O_2\ (g)$

  $Cl_2\ (g) + LiI\ (aq) \rightarrow LiCl\ (aq) + I_2\ (s)$

  $KOH\ (aq) + H_3PO_4\ (aq) \rightarrow K_3PO_4\ (aq) + H_2O\ (l)$

  octane (in gasoline) (gas) + oxygen (gas) → carbon dioxide (gas) + water (vapour)

  solid sodium + chlorine (gas) → solid sodium chloride (321-1)

- Recognize and balance equations for photosynthesis, water cycle, nitrogen cycle, and neutralization of acids and bases. (321-1)

Elaborations—Strategies for Learning and Teaching

Science 10 students require time in the chemistry laboratory to do this unit.

Students should write and balance reactions that illustrate a variety of reaction types including combustion, combination, decomposition, single replacement, and double replacement.

Students should balance different types of chemical reactions and confirm the conservation of atoms using molecular models and the particle theory. They should be introduced to identifying reactants and the products of a reaction. Here are some suggestions:

$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$
carbon + oxygen → carbon dioxide

$CO_2\ (g) + H_2O\ (l) \rightarrow H_2CO_3\ (aq)$
carbon dioxide + water → carbonic acid

$CH_4\ (g) + 2O_2\ (g) \rightarrow CO_2\ (g) + H_2O\ (l)$
methane + oxygen → carbon dioxide + water

$S_8\ (s) + 8O_2\ (g) \rightarrow 8SO_2\ (g)$
sulphur + oxygen → sulphur dioxide

$SO_2\ (g) + H_2O\ (l) \rightarrow H_2SO_3\ (aq)$
sulphur dioxide + water → sulphurous acid

The use of three-dimensional models allows students to better visualize how natural systems operate and scientific concepts are applied. A full knowledge of accurate molecular structures is not required in Science 10. Molecular models should be used so that the students see the use of the law of conservation of mass and energy.

Students might be able to predict products for simple chemical reactions by the time they have finished this section. Depending on experiences, they might see the patterns that happen in chemical reactions. Students can investigate, through experimentation and equation writing, the reactants and products of a reaction and write formulas, names of substances, and identify the type of equation. Different students comprehend formula writing and balancing equations at different times. A variety of approaches helps students be successful.

Students should look at basic equations that are used in everyday life and in various jobs. These connections will give perspectives that are meaningful.

Students should study factors that affect reaction rates, such as heating, surface area, and concentration. Doing experiments such as observing the reactions of calcium carbonate (marble) and dilute sulphuric or nitric acids must be part of the students' experiences. This reaction is intended to simulate destruction caused by acid rain, that may be a context of the unit. This will serve as an illustration of the concept of controlling variables and designing an experimental procedure. It is expected in Science 10 that factors affecting reaction rates be studied in a qualitative manner (slow, medium, fast).

For enrichment, teachers could cover some simple theoretical discussion of reaction rates using particle theory.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*

- Activity 18: Cabbage Juice Chemistry
- Activity 20: Dissolve This
- Activity 21: Types of Chemical Reactions
- Activity 22: Balancing Chemical Equations
- Activity 23: Observing Chemical Reactions
- Activity 24: Rates of Chemical Reactions
- Activity 25: Double Displacement Reactions
- Activity 28: Changing the Rate of a Chemical Reaction

Activities from *Nova Scotia Science 10*

- Find Out Activity 3-3A: Paper Clip Reactions, p. 131
- Conduct an Investigation 3-3B: Mass Before and After, p. 135
- Think About It Activity 4-1A: Representing Chemical Reactions, p. 143
- Think About It Activity 4-1B: Metal Reactivity: It's All Relative, p. 148
- Conduct an Investigation 4-2C: Properties of Acids and Bases, pp. 170–171
- Find Out Activity 4-3A: Faster or Slower?, p. 175
- Conduct an Investigation 4-3B: Changing the Rate of a Chemical Reaction, p. 180

Equipment/Materials

- molecular model kits
- various chemistry reaction games

STSE CONNECTIONS

Students will be expected to

- investigate and collaborate to describe science and technology relationships and their functions (116-3, 117-7, 215-6, 116-5)

Tasks for Instruction and/or Assessment

Informal/Formal Observation/Presentation

- Present your research on acid precipitation to the whole class. (116-3, 117-7, 215-6, 116-5)

Journal/Portfolio

- Report in journals about the research projects, or write a summary of the work to include in a portfolio. (116-3, 117-7, 215-6, 116-5)

Paper and Pencil/Presentation

- Present your project using various forms such as a web page design, an information flyer or a brochure, a newspaper advertisement, or a radio spot. (116-3, 117-7, 215-6, 116-5)
- List and describe the careers that are connected to chemicals, the environment, and social problems. (116-3, 117-7, 215-6, 116-5)

Note: Many activities can be arranged using co-operative groups. These can be assessed not only for the product (scientific content or skill) but also the process (participation by students in given roles).

Elaborations—Strategies for Learning and Teaching

This chemical reactions unit can focus on many areas. Teachers could have the students work in groups on a variety of areas. Here, we describe an acid rain activity. There are other activities that the teacher may choose. Collecting and interpreting of data over time is an important concept. Have student teams research the sources (e.g., automobile emissions and coal burning emissions) and degree of acid precipitation in their local area by collecting various water samples and testing for pH over an extended period of time. Data from this testing should be assembled in appropriate formats to display trends and variations in pH for various locations. Students should work co-operatively to develop and carry out a plan that includes compiling and organizing their data to infer patterns or trends in the data.

Have students research and describe the relationship between domestic and industrial technologies and the formation of acid rain. Students should compile and organize data on acid precipitation in order to interpret patterns and trends in these data. They should infer or calculate linear and non-linear relationships among variables such as pH, time, and location. Students should propose alternative solutions to the problem of acid precipitation, assess each solution, and select one as the basis for a plan of action, defending the decision. Students should identify and describe science-and technology-based careers related to airborne pollution. They should find and compare examples of the presence of airborne pollution being used by society to influence decisions concerning science and technology.

Students should research other areas that are associated with acid precipitation. They should write a balanced (i.e., presenting all sides) report on the subject, based on information gathered, which includes reference to causes, possible remedies, and the career potential for people working in this field. Students should defend their positions with relevant arguments from different perspectives and include examples of how society supports and influences science and technology. They should also identify examples of technologies developed based on scientific understanding.

Students might identify and describe careers related to their topic. By integrating careers into this unit, the topic becomes relevant to the students' lives.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 11: Consumers and Chemicals
- Activity 29: Careers in Chemistry
- Activity 30: Chemicals and Our Environment

Activities from *Nova Scotia Science 10*
- Find Out Activity 3-1A: Can You Judge a Product by Its Label?, p. 101
- Think About It Activity 4-2B: Fighting Back!, p. 167
- Conduct an Investigation 4-3B: Changing the Rate of a Chemical Reaction, p. 180

Physical Science: Motion (25%)

Introduction

The concept of motion allows students to investigate and develop their interest in the sports that are part of their daily lives. Students not only will have opportunities to investigate the principles of kinematics but will also be encouraged to apply them in areas of individual interest. Whether they choose Olympic sports events or personal leisure activities such as snowmobiling or biking, students will develop their understanding of the concepts of displacement, velocity, and acceleration.

Focus and Context

The unit on motion has two principle focuses—inquiry and problem solving. Students will be able to examine questions by inquiring into the relationships between and among observable variables that affect motion. By understanding these relationships, students can begin to address the problems associated with design investigations.

By applying mathematical and conceptual models to qualitative and quantitative data collected, we can represent motion graphically. This provides a visual representation of aspects of velocity and acceleration. Mathematics and graphical analysis allow us to see basic similarities in the motion of all objects.

In addition, the unit provides opportunities to explore decision making as the students investigate the developments in design technology.

Science Curriculum Links

Prior to Science 10, the study of motion has received little depth of treatment. Indirect connections are found with Forces and Simple Machines in Science 5 and Flight in Science 6. Those students who pursue studies in Physics 11 and Physics 12 will develop further connections in force, motion, work, energy, and momentum. The study of motion will also develop a strong link to mathematics in grades 9 and 10, where data management includes the collection, display, and analysis of data.

Curriculum Outcomes

The following outcomes have been developed from *Common Framework of Science Learning Outcomes K to12*, pan-Canadian outcomes. See Appendix H for the original outcomes from which these were derived.

STSE	Skills	Knowledge
Students will be expected to **114-3, 115-4, 118-3** describe and evaluate the design and functions of motion technology **114-6, 117-8** identify and imagine questions that could be investigated using relevant research in science and technology **117-10** describe examples of Canadian contributions to science and technology in the area of motion	Students will be expected to **212-9, 213-3** use instruments and terminologies effectively and accurately for collecting data in various experiments	Students will be expected to **325-1, 212-7, 325-2** using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) **325-3, 212-2** distinguish among constant, average, and instantaneous speed and velocity of an object

MOTION: POSITION, DISTANCE, DISPLACEMENT

Students will be expected to

- use instruments and terminologies effectively and accurately for collecting data in various experiments (212-9, 213-3)

Tasks for Instruction and/or Assessment

Performance

- Construct a data table of collected values. Plot data points on a distance/time graph and join them by a line representing the motion. (212-9, 213-3)

Journal

- Comment on this statement: "Calculations recorded in a data chart should recognize the precision of the measurements." (212-9, 213-3)

Paper and Pencil

- How can you determine the distance travelled from a line graph? What is meant by "path taken"? (212-9, 213-3)
- Draw and interpret a velocity graph. Specifically, give examples to show what the slope, area, and reading the graph mean. Do all of them give relevant information? (212-9, 213-3)

Presentation

- Represent the linear motion of two moving people or objects. Include how the data will be collected, organized, and put in a format that will allow for analysis. (212-9, 213-3)

Elaborations—Strategies for Learning and Teaching

This unit has direct appeal to all students who wish to drive any vehicle and who are interested in transportation. Various skill sets are used throughout this unit. Students can get a feel for motion in one dimension by getting up to move. The first activity teachers should ask students to do is to come up with an explanation that describes the relationship between constant speed and distance when the time interval is kept the same. Students have some understanding of distance, speed, and time. After making an explanation, they should perform an activity and observe the results. They should discuss how the faster you go, the farther you travel, when the time interval is constant.

Teachers can then ask the question, What would we need to measure to determine how fast we are going? Galileo was the first scientist to realize that to measure motion, you have to think in terms of time rates of change. Students should discuss what devices can be used to measure distance, time, and speed.

When they can explain how the faster they move, the further they go in equal time intervals, students should then work in small groups to determine how far a constant-motion vehicle travels during a specific time interval. Various instruments can be used such as remote control cars, cars with a battery, and so on. Ticker-tape timers may be used to collect data of the constant-motion vehicle moving in a straight line. Students should keep their ticker tapes for a future extension activity.

The quantities of distance and time will be used later to determine speed. Teachers may incorporate the use of skills sets in the activity so that proper techniques are used to collect information. Skills such as measuring, estimating, and calculating percentage error are all necessary to use while doing this activity. So are a knowledge of precision and accuracy.

Teachers should now have students complete an activity. This time students will use a stopwatch and mark where they were at five-second intervals. They will then plot the distance-versus-time graphs to represent the motion that they created, using the same scale on both axes. This activity should bring students to the realization that slope of a distance/time graph shows us information about the speed of an object.

Teachers should ask, How would you describe what distance is? and encourage the answer, Distance is a measure of how far you have gone. Teachers should then ask students to discuss what would happen to distance if instead of just moving forward you moved backwards as well. Students should come up with the idea that distance will always be getting larger as time goes on because it depends on the path taken. Accompany this discussion with examples.

Teachers should then introduce the idea that distance might not be the best information to record about motion because it does not show anything about direction. Direction is an important part of motion. Teachers should introduce the concept of position and that to be fully described it requires an origin, magnitude, units, and direction. This is the opportunity for teachers to introduce the concept of vector and scalar quantities, which can be done using a number line. Be sure that positions are written consistently with a number, a unit, and a sign.

Teachers can then pose the question, How do we know when there has been motion? Discussion should lead to the idea that to move we would have to be in different places at different times. The concept of displacement should be introduced as the change of position an object undergoes (and as an indicator that motion has occurred). Number-line examples should be helpful in reinforcing the concepts of position, distance, and displacement. The definitions of these quantities are key concepts in this unit.

Students should then plot position-versus-time graphs from number-line diagrams and see how the graphs relate to the motion. They should not draw displacement-versus-time graphs. Teachers should then introduce how to analyze the graphs (which now show more detail) to tell us more about the object's motion. Three ways of getting information from a graph are to read off the axes, find the slope, and find the area. It is important that students gain extensive experience with collecting data and with plotting and interpreting graphs.

Students who have access to a GPS unit might use it to track their position on a field trip, and then show data such as their time of travel, distance, and displacement.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 31: Position and Displacement
- Activity 35: Uniform Motion
- Activity 36: Moving
- Activity 37: Ticker-tape Experiment: How Far Did the Car Go?
- Activity 38: Matching Data, Graphs, and Words
- Activity 40: Toying with Motion

Activities from *Nova Scotia Science 10*
- Launch Activity 5: Where Are We Going?, p. 201
- Find Out Activity 5-1A: Determining Position, p. 204
- Conduct an Investigation 5-1E: Ticker-tape Time Trials, pp. 216-217
- Find Out Activity 5-2A: Distance, Time, and Speed, p. 223
- Conduct an Investigation 5-2B: Slow Motion and Fast Motion Ticker-tape Trials, pp. 224–225
- Launch Activity 6: How Can Velocity Change?, p. 237
- Find Out Activity 6-1A: Accelerated Motion, p. 241
- Conduct an Investigation 6-1B: The Direction of Acceleration, p. 245

Note: Students should identify and explain sources of error and degree of uncertainty. It is important to discuss accuracy of measurement and techniques that minimize errors. The differences between accuracy and precision (of data) should be developed. Significant digits are not science outcomes. They are relevant to scientific measurement and calculation. Time should be spent on experiments, experiences, and graphing. Students should not be assessed on significant digits in Science 10.

Equipment/Materials

- tickertape timers
- stop watch
- toy cars (remote/battery)

325-1 212-7 325-2
GRAPHS OF SPEED AND VELOCITY

GRAPHS OF SPEED AND VELOCITY

Students will be expected to

- using linear experimentation with appropriate technologies, analyze graphically and quantitatively the relationship among distance, time, and speed (scalar quantities) and the relationship among position, displacement, time, and velocity (vector quantities) (325-1, 212-7, 325-2)

Tasks for Instruction and/or Assessment

Performance

- Measure and record time and position using the proper measuring instrument or device. Measurements should reflect the precision of the measuring instrument. Plot a position/time graph and use it to find the velocity. (325-1, 212-7, 325-2)

Presentation

- Illustrate graphically the motion sequence for an object. Include at rest (no motion), motion toward, and motion away from the original starting point. (325-1, 212-7, 325-2)

Elaborations—Strategies for Learning and Teaching

Discuss the slope of the graph (which relates to the rate of change) with reference to everyday life (such as ramps, stairs, and hills) so that students use their prior knowledge.

Teachers should ask students to bring out their graphs from Activity 32: Ticker-tape Experiment: How Far Did the Car Go? In discussion, students should recognize and state that as the person walks faster the slope increases. Students should acknowledge that the slope of a distance-versus-time graph gives the speed of the object. Determining the units of the slope might help some students understand this. Students should develop the operational definition of speed as a distance over a time. Teachers should take the time to establish that speed is a rate. The concept of rate is used in other Science 10 units.

Teachers should discuss how straight-line distance/time graphs are an indication of constant speed.

Students can then be asked whether or not the slope of a position-versus-time graph can tell us more information. By examining the graphs produced earlier from the number lines, students should acknowledge that the slope of a position/time graph can tell us the rate of change of position (which includes direction). This is known as velocity (or change in position over time). Students should have many opportunities to calculate the slope of both distance/time graphs and position/time graphs as well as reading off the axes. The position/time graphs should show a variety of starting points and directions of motion but only depict linear motion at this time.

Students should investigate speed and velocity. Teachers may introduce the idea that absolute constant speed is actually a very difficult movement to maintain even for small time intervals. Teachers can initiate a discussion about motion using an example of driving a car from the student's home to school. Students should be able to demonstrate that resulting distance/time graphs would not be straight lines.

Discuss what type of motion can be determined if the graph is not perfectly linear. Teachers should introduce the term **average speed** and indicate how we can use it to describe more complex motions. Ask students to show that it is possible for two people to cover the same distance in the same time when one goes at a constant speed and the other uses another motion. To do this, line two students up at a starting point and have an ending point 10 m away. Allow one student to go, walking at a constant speed. Then, a few seconds later, have the second student go with the instruction to catch up and arrive at the ending point at the same time as the student walking at a constant speed. The motions are different, but the two students cover the same total distance in the same amount of time.

Ask the students, What happens if our time interval of observing the motion is very small (much like a police officer with a radar gun)? Discussion should lead to a realization that you can determine your speed at an instant, or instantaneous speed. To determine this from a position/time graph, you find the slope of the tangent to the line or curve at the time in question. Actual calculations using tangent are not necessary.

Teachers should reinforce the idea that since there are only three ways to analyze a graph: read it, find the slope, find the area. On a distance/time graph, the slope will always give you a speed. If the slope is of a perfectly straight line, it will represent a constant speed (that the person travelled equal distances during equal time intervals—constant motion over time). If it is of the line connecting any two points on the graph it will be called the average speed (motion over a period of time). If it is the slope of the tangent to the curve (the slope at an instant) it will be called instantaneous speed (motion at an instant).

Have students identify instruments used to measure instantaneous speed, such as radar guns, speedometers, and photogates. Discuss their limitations and degree of precision. Other devices used to measure motion also have limitations. It is important to discuss the limitations and degree of precision in both ticker-tape times and motion sensors. Teachers should be aware that these measuring devices will not produce negative position/time graphs. Teachers should give students exposure to negative position/time graphs, using number-line problems.

Students should then be able to relate the information found on distance/time graphs to what the three slopes of a position/time graph represent.

Students should be given an opportunity to use motion sensors to analyze real-life motions. The purpose of this activity should be to reinforce what constant motion looks like on a position/time graph, but also to expose the students to what a new type of motion, acceleration (rate of change of velocity), looks like on a position/time graph.

Teachers must take care when using distance/time graphs as they should not be shown to be going back towards the origin. Position/time graphs are a better choice when graphing because direction of motion can be represented.

Resources/Notes

Activity

Activities from *Science 10: A Teaching Resource*
- Activity 32: Talking about Speed
- Activity 33: Describing Graphs
- Activity 34: Reading Position/Time Graphs
- Activity 39: Motion Sensors
- Activity 41: Interpreting and Doing Problems, Part 1

Activities from *Nova Scotia Science 10*
- Find Out Activity 5-1B: Determining Distance, Displacement, and Time Interval, p. 210
- Think About It Activity 5-1C: Graphing Motion Data, p. 213
- Think About It Activity 5-1D: Analyzing Position-Time Graphs, p. 215
- Find Out Activity 5-2A: Distance, Time, and Speed, p. 223
- Conduct an Investigation 5-2B: Slow Motion and Fast Motion Ticker-tapeTrials, pp. 224–225
- Find Out Activity 5-3A: Slope, Average Velocity, and the Position-Time Graph, p. 230
- Conduct an Investigation 5-3B: Walking and Velocity, pp. 232–233

Appendix C: Cards, Data Tables, and Graphs

Note: It is important to reiterate that position/time graphs can give more information than distance/time graphs and should be used whenever possible. Care should be taken to ensure that the students recognize that there are three ways to analyze a graph: read it, find the area, find the slope. The slope of a position-time graph will always give a velocity. Ensure that students recognize the scalar-vector difference.

Review with students both uniform and non-uniform motion, using a graphical analysis. Show how the slope of a displacement/time graph, at any time, represents the instantaneous velocity. Calculate the instantaneous velocity value for at least two time points, one on each graph.

Curriculum Link

- Physics 11: Acceleration
  Draw tangents (representing instantaneous velocity) to each slope at one-second time intervals, for each graph (up to where maximum velocity is reached).

Extension

- Acceleration can be introduced as the rate of change of velocity per unit time. Students might be able to translate this qualitatively by examining the slope of each tangent and its relative change at each time interval. (This is done in Physics 11).

Video

- *Motion*, 20 min. (23111)

MOTION: GRAPHS AND FORMULAS

Students will be expected to

- distinguish among constant, average, and instantaneous speed and velocity of an object (325-3, 212-2)
- describe and evaluate the design and functions of motion technology (114-3, 115-4, 118-3)

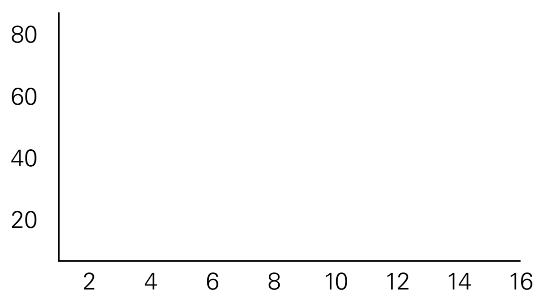
Tasks for Instruction and/or Assessment

Performance

- Measure and record time and position using the proper measuring instrument or device. Measurements should reflect the precision of the measuring instrument. Plot a position/time graph and use it to find velocity. (325-3, 212-2)

Paper and Pencil

- Calculate the velocity at t = 2, 6, 10, 12, 14 s. Describe the motion. (325-3, 212-2)



- During summer vacation, I travelled 2200 km [W] in 12 hours to get to my friend's house. On this trip, I travelled by car, plane, and train.
  a. Write the givens from this question.
  b. What type of motion is this (constant or average speed, constant or average velocity)?
  c. Show the unit analysis for Part b.
- It took you a total of 15 seconds to run 150 m [E].
  a. What was your average velocity in m/s ?
  b. What would your average velocity be in km/h?
- A soccer ball is kicked horizontally. What is its average speed if it travelled 21 m after 4 s? (325-3, 212-2)

Presentation

- In a group, suggest ways to improve the method by which data are collected and recorded. Use various formats (video, role-playing, demonstration) for presenting. (114-3, 115-4, 118-3)
- Present a method of representing the one-dimensional accelerated motion of moving people or objects. Include how the data will be collected, organized, and put in a format that will allow for analysis. Suggest different kinds of qualitative analysis. (325-3, 212-2)

Portfolio

- Enter an operational definition for displacement, velocity, and acceleration. Provide examples of acceleration in daily life. Leave space so that it can be updated as your study of acceleration continues. (325-3, 212-2)

Elaborations—Strategies for Learning and Teaching

Ask students to tell you how far someone has travelled if they were going 100 km/h for two hours. Students will probably be able to do this calculation. However, they may have difficulty explaining or showing how they got the answer—they may lack the vocabulary and problem-solving skills we wish them to develop. At this point, students will probably recognize that to do an experiment and then collect and display the information is a time-consuming task, and that it does yield information. In physics, one of the ways we interpret information is through the use of formulas.

Teachers should make the connection that formulas come from the definitions of physical quantities or from graphs that are generated from observations during experimentation. Knowing what the motion formulas are will enable students to solve problems without requiring a graph.

It is important in this unit to develop a consistent problem-solving technique that involves the demonstration of the information that is known or given, the formula that could be used to solve the problem, conversions that may be necessary, the rearrangement of the basic formulas if required, the work done, the solution with proper signs and units, and a picture that represents the problem. Motion maps should be introduced at this time as a way to represent motion in a diagram.

Teachers should introduce word problems and help the students recognize the relevant information by identifying key words or units of measure. It is important that teachers use proper terminology consistently in this section.

Revisit vector and scalar quantities and note their similarities and differences in these constant motion formulas:

- Distance equals speed multiplied by time.
- Displacement equals velocity multiplied by time.
- Average speed is distance travelled divided by time.
- Average velocity is change in position divided by time.
  OR
- Average velocity is displacement divided by time.

Teachers should be very clear in their questions about whether they are describing constant motion or average motion and whether they are using scalars or vectors.

Teachers could use sporting examples in this unit. Information could be obtained from running events (perhaps from the school's own track team) or other sporting events (car races, horse races, marathons, etc.). Students should discuss whether or not the motion during the race would have been constant. Teachers can introduce the information that is often collected for a race (the total distance and total time) and ask students to determine the speed of the runner. Since the motion was not constant, students should recognize that the answer cannot be described as a constant speed or velocity but rather as an average speed or velocity.

Illustrate how these velocity/time values are used as data to construct a velocity/time graph for each motion. Draw in a line to represent a constant slope. Compare the slope of the velocity/time graph to its corresponding displacement/time graph and draw generalizations for each type of motion. Develop the concept that the slope of a velocity/time graph represents the acceleration and that it can be represented mathematically as average acceleration = change in velocity/change of time. The analysis of velocity/time graphs with negative slopes should also be analyzed.

Students should describe the historic development of a motion technology.

Evaluate the design of a motion technology and the way it functions with relation to safety, construction, cost, availability, and impact on everyday life and the environment. Students should evaluate the role of continued testing in the development and improvement of a motion technology. This will allow connections among careers, environment, and societies. Various scenarios can be done.

Resources/Notes

Notes

Students will have explored graphics beginning in grade primary. This unit provides a conceptual framework for motion. While students at this grade level can find the slope of a velocity/time graph to get acceleration, they are not required to fully understand the underlying mathematical principles.

For distance equals speed multiplied by time, many texts and activities use different representations.

Students should calculate the area under a velocity/time graph and relate it to an object's displacement. Students should be given data for two of three variables in the change in velocity/corresponding change in time and then they should calculate the third. Students should determine the acceleration of an object from a velocity/time graph. Acceleration is limited to basic calculations only.

Introduce acceleration word problems to students. It is important at this stage simply to use acceleration as a change in velocity over a change in time and ensure that all questions use velocity, not speed.

Acceleration is a change in velocity over a change in time.

Acceleration should be discussed as the time rate of change of velocity.

Students do not have to be able to rearrange the acceleration formula, as this will be covered in Physics 11. This may be done as an extension with those students who are capable.

Sample Problems

- A motorcycle accelerates uniformly from +12 m/s to +30 m/s in 10 seconds. What is its acceleration? Draw a graph.
- A car accelerates uniformly from rest to +50 m/s in 5 seconds. What is its acceleration?
- While driving along at +60 km/h, a person sees the stoplight ahead change to red. The driver applies the brakes and comes to a stop in 10 seconds. What was the acceleration?

Activities

Activity from *Science 10: A Teaching Resource*
- Activity 42: Interpreting and Doing Problems, Part 2

Activities from *Nova Scotia Science 10*
- Find Out Activity 5-3A: Slope, Average Velocity, and the Position-Time Graph, p. 230
- Conduct an Investigation 5-3B: Walking and Velocity, pp. 232–233

Print Resources

Nova Scotia Science 10:
- Science Watch: Speed Guns, p. 226
- Science Watch: Human Acceleration, p. 246

RESEARCH IN SCIENCE AND TECHNOLOGY

Students will be expected to

- identify and imagine questions that could be investigated using relevant research in science and technology (114-6, 117-8)
- describe examples of Canadian contributions to science and technology in the area of motion (117-10)

Tasks for Instruction and/or Assessment

Journal

- Using a Venn diagram (or concept map), present various science disciplines and interdisciplinary studies for a particular interest in motion. (114-6, 117-8)
- Pick a career you are interested in and connect it to motion. (117-10)

Presentation

- In a research group, develop and present a Venn diagram (or concept map) that links the study of motion to science and technology. (114-6, 117-8)
- Present various careers and their relationship to motion. (114-6, 117-8)

Portfolio

- Research and write a report on a specific Canadian contribution to science and technology in the area of motion, including such details as design contributions, recent developments, and global impact (e.g., Bombardier, SPAR Aerospace, Rupert W. Turnbull). (117-10)

Elaborations—Strategies for Learning and Teaching

Students can develop a Venn diagram or concept map to detail each of the following:

- relationship of a particular interest to specific science disciplines and interdisciplinary studies (For example, the motion of running can be related to studies in kinematics, aerodynamics, biology, and mathematics.)
- identification of possible areas of future study related to science and technology (For example, factors that affect the motion of a runner can be related to sports training, computer technology, mechanical engineering, and aerodynamics.)

Teachers might have to show students the format expected for the Venn diagram or concept map and explain the detail or reference expected.

Students can present examples of Canadian contributions in a specific area of interest. They might research a specific company (e.g., Bombardier designs in snowmobiles, trains, and airplanes) or a topic (e.g., Canadian contributions in the area of track surface or bicycle design). The report should include such details as design contributions, recent developments, and global impact. Example: Review the studies done for Lance Armstrong in preparing for the Tour de France.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 43: Investigating Canadian Contributions to Motion
- Activity 44: Buy Canadian!

Activities from *Nova Scotia Science 10*
- Think About It Activity 5-1F: Creating the Illusion of Motion, p. 218
- Conduct an Investigation 6-2A: Investigating Canadian Contributions to Motion, p. 258

Life Science: Sustainability of Ecosystems (25%)

Introduction

The focus on protecting the environment has grown substantially since the 1950s. Many would argue not only that the focus is too late but that it is not nearly enough to reverse the damage caused by the spend now, pay later attitude that has been so prevalent in our society. Due to a change in environmental attitudes, today's students are much more aware of the fragile nature of the environment. Despite technological advances, which allow more efficient use of natural resources and systems, the drive to be economically competitive puts stress on the delicate environmental balance. Much of the economy in Atlantic Canada is based on harvesting within fragile ecosystems. Examining how external factors affect the dynamic equilibrium that exists in an ecosystem provides valuable information. This process will be extended to encompass both equilibrium and sustainability of the environment within a province, region, country, and global biosphere. This unit allows students to relate our understanding of local ecosystems to our increasing awareness of ecosystems on a global scale, and the need to sustain ecosystem health.

Focus and Context

Students explore the concept of sustainability and ideally move toward a more sophisticated level of global thinking. Through observation and inquiry of the local environment and economy, students can accomplish many outcomes with a decision-making focus. Students gather and evaluate data, leading them to determine personal opinions and attitudes about the concept of sustainability.

Science Curriculum Links

Sustainability of ecosystems connects with other clusters in the science curriculum to varying degrees. Through elementary grades, students learn about the needs and characteristics of living things, air and water in the environment, soils, and habitats and communities. The Diversity of Life unit in Science 6 is directly linked to this unit as it considers how the characteristics of living things permit systems of classification and how varying conditions relate to adaptations. More directly linked is the Science 7 unit Interactions within Ecosystems. This unit concentrates on the flow of energy and matter through food webs in observable ecosystems. Biology 11 and Biology 12, Agriculture/Agrifoods 11, Oceans 11, Food Science 12, and Geology 12 are available in grades 11 and 12. Consider developing the connection among this unit, Chemical Reactions, and Weather Dynamics.

Curriculum Outcomes

The following outcomes have been developed from *Common Framework of Science Learning Outcomes K to12*, pan-Canadian outcomes. See Appendix H for the original outcomes from which these were derived.

STSE	Skills	Knowledge
Students will be expected to **114-1** question and analyze how a paradigm shift in sustainability can change society's views **118-9, 215-4, 118-5** identify, investigate, and defend a course of action on a multiperspective social issue **114-5, 116-1, 117-3, 118-1** identify and describe peer review, Canadian research, and global projects where science and technology affect sustainable development	Students will be expected to **213-7, 215-1, 318-4** diagnose and report the ecosystem's response to short-term stress and long-term change **212-4, 214-3, 331-6** predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats	Students will be expected to **318-2, 318-5** distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity **214-1, 318-6** describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability **331-7, 318-3** describe how different geographical locations can sustain similar ecosystems

SUSTAINABILITY

Students will be expected to

- question and analyze how a paradigm shift in sustainability can change society's views (114-1)

Tasks for Instruction and/or Assessment

Performance

- To demonstrate a paradigm shift, take part in a debate between two opposing world views on environmental issues. (114-1)

Journal

- Reflect on a past paradigm (e.g., resources are limitless) by considering the following questions: How is it possible that people thought this way? What factors contributed to this mindset? Are there still large numbers in the general population that think this way? Why do you think we are shifting to a different paradigm? (114-1)
- Read, summarize, and respond to an article about environmental change that has taken place over time. Magazines, newspapers, and archived information may be possible sources. (114-1)

Paper and Pencil

- Many people would say that we are in the midst of paradigm shift today with regard to how we think about the environment. What evidence is there to support this belief? What impact would this shift have on the planet in general and Nova Scotians in particular? Explain why people might not want to make this shift? (114-1)
- Write an example of a past paradigm. What is the new view most people in the community accept today? (114-1)

Presentation

- Pick a method of presentation (poster, skit, poem) to illustrate opposing views on sustainability. (114-1)

Portfolio

- A culminating assignment may ask students to respond to the following: Describe a past paradigm that relates to the environment and sustainability. Describe past activities or practices that reflect that paradigm. Describe what has happened to cause the public to shift its way of thinking. Evaluate the new ways people are thinking about sustainability. Do you think they are paradigms yet? Explain. (114-1)

Elaborations—Strategies for Learning and Teaching

The notions of paradigm shift and change in environmental attitudes and values related to education for sustainable development are common themes throughout this unit.

Students should explore their own paradigms related to the environment, the economy, and society. Students should explore and develop a concept of sustainability. Through an introductory discussion, they can question and reflect on what they value. What is the value of a boreal forest? What if it were to be clear-cut? What is sustainability? Are they willing to sacrifice something to ensure sustainability? Is growth and expansion of the economy at an environmental cost? Does this lead to sustainable practices? How does this affect social issues? What are sustainable practices in various buildings? How do we know when sustainable practices are present?

Paradigm shifts are significant changes in the way humans view the world. They are major changes that are controversial when first proposed but eventually come to be accepted as a major advancement in scientific knowledge and understanding. Examples of paradigm shifts in past scientific world views are such revolutionary ideas that Earth is round, not flat, and that it revolves around the sun. Students can explore the concept of paradigm shifts through discussions, videos, role-playing, etc. Several questions could be posed: Who is affected by a paradigm shift? How is the public affected in the short and long term? Students could explore the possibility of their being in the midst of a paradigm shift related to the environment and sustainability.

Students could examine case studies or issues such as ocean dumping, waste management, and resource management that provide evidence of the effect of a paradigm shift. They should also examine the government and business policies that reflect such a shift. They should look at how this affects society as well.

The resources of the earth (such as soil, water, minerals) and their distribution and role in supporting living organisms can be examined. The interdependence of the health of ecosystems and biomes will be part of this case study discussion. Communicating information and viewpoints effectively in their reports while assessing the nature of bias and different points of view is part of the reports.

Resources/Notes

Portfolios can be used as a means of assessing the entire unit. Many of the assessment suggestions given throughout the unit can be used as part of an overall portfolio assessment. There are many ways in which portfolios can be assembled as an assessment tool; thus the number of items and the specific content can be determined by the students and the teacher. Suggestions for content are experimental results (write-ups, graphs, data, observations, etc.), posters, illustrations, creative writing, videos, photos, group projects, reports, responses, critical thinking exercises, self-assessment, and so on.

Print Resources

Nova Scotia Science 10:
- Science Watch feature "Restoration Ecology," p. 331

Notes

Paradigm Shift Example
Most diseases in the middle ages were treated by bloodletting. A doctor opened a patient's artery or vein to let blood drain. The paradigm, accepted by the medical community and population, was founded in the belief that most diseases left the body in the blood. Today it is acknowledged that a bacterium or a virus is the cause of illness. Most illnesses may be treated with a pharmaceutical regime or medical intervention.

318-2 318-5 214-1 318-6 212-4 214-3 331-6 213-7 215-1 318-4
SUSTAINABILITY OF AN ECOSYSTEM

SUSTAINABILITY OF AN ECOSYSTEM

Students will be expected to

- distinguish between biotic and abiotic factors, determining the impact on the consumers at all trophic levels due to bioaccumulation, variability, and diversity (318-2, 318-5)
- describe how the classification involved in the biodiversity of an ecosystem is responsible for its sustainability (214-1, 318-6)
- predict and analyze the impact of external factors on the sustainability of an ecosystem, using a variety of formats (212-4, 214-3, 331-6)
- diagnose and report the ecosystem's response to short-term stress and long-term change (213-7, 215-1, 318-4)

Tasks for Instruction and/or Assessment

Journal

- Write a biography or diary of an organism to show how it is sustainable and can exist in the studied ecosystem. (214-1, 318-6)
- How is the balance of nature affected by the influence of human activity on bio-geochemical cycles? (331-6)
- Think about the sustainability of the area (e.g., town, ecosystem, park) you are going to study. What things do you value about it? What would you hate to see disappear or be destroyed? (318-6, 118-5)
- Record your experience with, and reaction to, the public meeting process. (213-7, 215-1, 318-4)

Presentation

- Illustrate the nutrient cycle. Show how it is related to the sustainability of an ecosystem by presenting your findings in poster or other form. Remove one substance and comment on the sustainability of the system. (318-2, 318-5)
- Present the characteristics of the development of a society and the impact on the natural environment. (318-2, 318-5)
- Present processes of planning that help the sustainability of an ecosystem. (318-2, 318-5)
- Present your analysis of the data gathered by your group about the sustainability of your exploration, either orally or recorded on site. This evidence should be documented. Different aspects of the study (e.g., biotic factors, abiotic factors, human impact, biodiversity) should be included. Be sure to address sustainability. Is it sustainable? How do you know? (318-5, 318-6)
- Participate in a simulated public meeting. Gather the necessary evidence to support your point of view. (213-7, 215-1, 318-4)

Paper and Pencil

- Collect articles from newspapers, magazines, and the Internet that demonstrate human impact on the sustainability of an ecosystem. These articles should demonstrate a range of positive and negative interactions between humans and the environment. Write a brief summary of the content of the article, highlighting the impact of humans. Attach this summary with a copy of the article. (212-4, 214-3, 331-6)

Elaborations—Strategies for Learning and Teaching

Sustainability involves the environment, the economy, and society working together. An in-depth study of the sustainability of a local ecosystem (pond, lake, tidal pool, field, forest) could be undertaken to collect data. The selected ecosystem could be used for the topic of a public meeting discussed later in this unit.

Alternatively, students may be able to create an ecosystem of their own in jars or pop bottles and observe its components and interactions. In constructing these sustainable ecosystems there should be some student decision making: What type of organisms must be included? Why? What makes a system sustainable? Explain why biodiversity is important. Computer simulations could also illustrate the basic components and interactions in an ecosystem.

For further development throughout this unit, regardless of the chosen ecosystem, students will have to examine fundamental aspects of an ecosystem. This ecosystem might be local, national, and/or global. The implications of the distribution of resources could be discussed and documented with regard to the nature of society and the rate of economic development. They would have to examine abiotic factors (space, temperature, oxygen, light, water) and biotic factors (disease, reproductive rates, predator/prey, competition, symbiosis). Classify organisms into trophic levels, bioaccumulation, resource limits, impact of external factors, importance of biodiversity to an ecosystem, flow of energy, cycling of materials, etc. In some cases, this might involve a review of some of these topics previously dealt with in previous science courses. (DDT and the osprey would be an example of bioaccumulation effects.)

After researching the pathways along which energy and matter flow through ecosystems, students can identify the resource limits of the constructed ecosystem. If an open system is also considered, the resource limits of the open system could be compared to those of a closed system.

Pose questions that require students to predict the effects of external factors on the sustainability of the ecosystem. For example, predict the effect of sulphur being burned inside the closed ecosystem.

By applying definitions of environment, community, development, and technology to local, national, and global experiences, students should be able to compare the aspects concerning ecological and human environments. Balanced information and critical analysis are to be used to help develop hypotheses.

It is suggested that an ecosystem, that is significant to your community be selected to form the context of this unit. The choice may be determined by geographical location, the economic base, and demographics of the area. A simulated public meeting to discuss a proposed project might serve as the vehicle to reach the outcomes.

Choose a project that will affect the ecosystem, such as the construction of a new highway, electrical transmission line, gas pipeline, shopping mall, residential subdivision, alternative agricultural use, or industrial facility. Challenge students to develop a way of assessing human impact. Identify the external factors. What baseline data must be gathered? How will the impact be determined? Over what time periods should the impact of these effects be monitored? Have students discuss plans of action to lessen this impact.

Both good and bad stress can help to sustain an ecosystem. Determine what defines short-term stress, (e.g., seasonal peaks in temperature, water supply, or sudden but limited human impact). Determine long-term change (e.g., climate change, permanent human influence, infestation by foreign flora and fauna). How do these affect the environment, economy, and social issues?

Challenge students to define the critical questions and issues, to conduct research into the present conditions and potential impact, and to collect evidence to support a given interest group. By role-playing a public meeting, students will practise skills of research, presentation, and communication. A field trip to a pristine area, and then to an area that has been impacted, might enable students to assess the impact on the sustainability of an ecosystem. Students could examine actual reports from public meetings or Environmental Impact Assessments on local issues. Resource people from various interest groups could be interviewed. Students could also apply to make a presentation at a local public meeting about an environmental issue.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 45: Snow
- Activity 46: Water: Is It Drinkable?
- Activity 48: Populations
- Activity 49: Connecting Links
- Activity 51: Mapping an Ecosystem
- Activity 52: Extending Science

Activities from *Nova Scotia Science 10*
- Launch Activity 7: Visualizing Seven Billion, p. 279
- Think About It Activity 7-1A: Similar Ecosystems Around the World, p. 285
- Find Out Activity 7-2A: Graphing Population Change, p. 291
- Think About It Activity 7-2B: Supporting a Country's Ecological Footprint, p. 296
- Conduct an Investigation 7-2C: Populations and Sustainable Ecosystems, p. 297
- Conduct an Investigation 7-2D: What Happens When Food Is Limited?, pp. 298–299
- Conduct an Investigation 7-3A: Fertilizers and Algae Growth, p. 310
- Launch Activity 8: Vernal Pools and Citizen Science, 315
- Think About It Activity 8-1A: Ecotourism and Butterflies, p. 323
- Find Out Activity 8-1B: Nova Scotia's Most Wanted—Not!, p. 328
- Conduct an Investigation 8-1C: Is the Winter Skate Endangered in Nova Scotia?, pp. 332–333
- Conduct an Investigation 8-1D: Resilience of a Grassland Ecosystem, p. 334
- Think About It Activity 8-2B: Sustainability, Biodiversity, and Legislation, p. 343
- Conduct an Investigation 8-2C: Investigating a Local Environmental Project, p. 348

Print Resources

Nova Scotia Science 10:
- Science Watch Feature “Dust on the Move,” p. 286
- Science Watch Feature “Pollution in the North,” p. 309

Videos

The following videos can be ordered from the Nova Scotia Department of Education Learning Resources and Technology Services website, http://lrt.EDnet.ns.ca (See Appendix B):
- *Web of Life: Producer to Predator*, 24 min. (23222)
- *Biodiversity/Garbage*, 50 min. (23115)
- *Fiddles on the Tobique*, 23 min. (V2560) [DVD]
- *Baltzer’s Bog*, 23 min. (V2559) [DVD]
- *Maple Tree: Climate*, 24 min. (23077)

31-7 318-3 118-9 215-4 118-5 114-5 116-1 117-3 118-1
STSE AND SUSTAINABLE DEVELOPMENT

STSE AND SUSTAINABLE DEVELOPMENT

Students will be expected to

- describe how different geographical locations can sustain similar ecosystems (331-7, 318-3)
- identify, investigate, and defend a course of action on a multiperspective social issue (118-9, 215-4, 118-5)
- identify and describe peer review, Canadian research, and global projects where science and technology affect sustainable development (114-5, 116-1, 117-3, 118-1)

Tasks for Instruction and/or Assessment

Journal

- Conduct a research study using the Internet or local sources on an advancement in the agricultural industry. Discuss the advantages and disadvantages of this advancement in terms of the ecosystems that it has affected. (331-7, 318-3)
- Conduct a print or electronic search on the topic of sustainability. Was there evidence of peer review? Comment on the importance of peer review of scientific work. Is information on the Internet reviewed by experts? Give evidence to support your answer. (114-5, 116-1, 117-3, 118-1)
- Comment on a controversy surrounding the industry you researched. (114-5, 116-1, 117-3, 118-1)

Interview

- Record an interview of a local scientist to discuss the importance of peer review in his or her studies of sustainable issues. (114-5, 116-1, 117-3, 118-1)
- Present and/or record an interview of a career that you might like (such as a mechanic, electrician, forester, engineer, food producer) and connect the questions to the economy, environment, and social issues. (114-5, 116-1, 117-3, 118-1)

Presentation

- Research a case study and present your findings in the form of a radio or television documentary about a significant sustainable issue. (331-7, 318-3)
- Develop and present various evaluation choices that may be used to assess a debate or public information on sustainability. (118-9, 215-4, 118-5)

Elaborations—Strategies for Learning and Teaching

The context for this cluster of outcomes is global in nature and could have social and/or economic importance. The focus is intended to emphasize the shift from environmental attitudes and to thinking toward sustainability. Resource-based sectors, or industries such as forestry or food production, may be used here. Given our region's environmental diversity, there are several contexts in which resource management encourages sustainability, including farming, land use, forestry, tourism, fishing, and aquaculture.

As the world's population grows, there is an increasing demand for food on our agricultural systems. Students have had experience with the science of soils and should be able to describe how soil composition affects crop production. This prior knowledge could be a springboard to begin discussions on the risks and benefits that scientific and technological advancements have on the food production industry and the world. Students should predict the detrimental effects that natural and synthetic fertilizers could have on an ecosystem.

Students could examine case studies that present the technological, environmental, and economic advantages and disadvantages of food production industries and resource-based industries such as forestry and mining. Students should examine the careers that are connected to sustainability.

Students could examine the development of sustainable projects from which an industry grew. Questions to consider might include which agency sponsored the project, how it was funded, how the project was managed, when the research changed from pure to applied, and at what stage business adopted responsibility for the project.

Students could participate in a debate or a simulated hearing about the introduction of a new industry or the expansion of an existing one. Students should research and report on areas where science and technology affect sustainable ecosystems.

Resources/Notes

Activities

Activities from *Science 10: A Teaching Resource*
- Activity 47: Acadian Forest Research Project
- Activity 50: Resumé

Activities from *Nova Scotia Science 10*
- Think About It Activity 7-1A: Similar Ecosystems Around the World, p. 285
- Think About It Activity 7-2B: Supporting a Country's Ecological Footprint, p. 296
- Think About It Activity 8-1A: Ecotourism and Butterflies, p. 323
- Find Out Activity 8-1B: Nova Scotia's Most Wanted—Not!, p. 328
- Conduct an Investigation 8-1C: Is the Winter Skate Endangered in Nova Scotia?, pp. 332–333
- Think About It Activity 8-2A: Using Biodiesel in Municipal Vehicles, p. 340
- Think About It Activity 8-2B: Sustainability, Biodiversity, and Legislation, p. 343
- Conduct an Investigation 8-2C: Investigating a Local Environmental Project, p. 348

Print Resources

Nova Scotia Science 10:
- Science Watch Feature "You Can Make a Difference", p. 347

Videos

The following videos can be ordered from the Nova Scotia Department of Education Learning Resources and Technology Services website, http://lrt.EDnet.ns.ca (See Appendix B):

- *The Forest*, 48 min. (23271)
- *Deer: Forest and Vegetation Management,* 24 min. (23075)
- *Sustainable Environments*, 35 min. (23010)
- *Acid Rain*, 30 min. (23254)
- *World's Biomes: Desert to Rainforest*, 28 min. (23292)

Appendices

Appendix A: Equipment/Materials

School Materials

This suggested materials list consists of items that each school should have to do the hands-on, minds-on science activities outlined in this guide.

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
Supply List				
air pump	✓			
alcohol thermometers	✓			✓
balance, preferably electronic	✓	✓	✓	✓
basin	✓			
beaker, 150 mL		✓		✓
beaker, 250 mL (4)	✓	✓		✓
beaker, 400 mL	✓	✓		✓
beaker, 500 mL	✓	✓		✓
beaker, 1000 mL		✓		✓
bean bags			✓	
Beral pipette		✓		
Boggle cubes		✓		
bowl (small)		✓		
bromothymol blue		✓		
Bunsen burner		✓		
calcium chloride		✓		
calcium piece		✓		
calculator			✓	
camera (video and digital)	✓			
ceramic plate		✓		

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
chemistry reaction games, various		✓		
chemistry tiles, set		✓		
clipboard			✓	✓
computer with Internet connection	✓			
container, covered, 1500 mL		✓		
cooking pot	✓			
copper(II) carbonate		✓		
copper(II) sulphate pentahydrate		✓		
copper foil		✓		
copper sulphate pentahydrate		✓		
copper sulphate		✓		
crucible tongs		✓		
dominoes		✓		
flowchart			✓	
glasses (clear, tall, heat safe)		✓		
graduated cylinder, 10 mL		✓		✓
hot plate	✓	✓		
hydrochloric acid		✓		
indicator strips		✓		
iron(III) chloride		✓		
iron(III) sulphate		✓		
kettle		✓		
labels		✓		✓
lamps with 100-watt bulbs	✓			✓
lead(II) nitrate		✓		
magnesium ribbon		✓		
markers (various colours)				✓

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
measuring cup (glass)	✓	✓		✓
measuring spoons		✓		✓
medicine droppers (2)		✓		
metre stick	✓		✓	✓
metronome			✓	
molecular model kits		✓		
mortar and pestle		✓		
motion sensor			✓	
needle valve	✓			
oven mitts	✓			
pegboard			✓	
polyatomic ion table		✓		
potassium iodide		✓		
printer	✓			
protractors			✓	
ramp			✓	
recording timers, tape, and carbon discs			✓	
ring stand and clamps				✓
rubber bands (heavy duty)	✓			✓
rulers (plastic)	✓		✓	
safety glasses		✓		
scanner	✓			
scissors	✓		✓	✓
scoopula		✓		
shovel				✓
sieve		✓		
silver nitrate		✓		

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
soccer ball or basketball	✓			
sodium sulphide		✓		
sodium phosphate		✓		
sodium chloride		✓		
sodium hydrogen carbonate		✓		
software (various programs)	✓			
spatula		✓		
spoons		✓		
steel wool		✓		
stirring rod		✓		
stop watch (or clock with second hand)	✓	✓	✓	✓
temperature probe	✓			
test tube, 15 x 180 mm (7), 150 mm		✓		✓
test tube holder		✓		
thermometers	✓			✓
ticker-tape timer			✓	
ticker tape			✓	
toy car (numbered)			✓	
weighing boats		✓		
weight			✓	
well plate		✓		
wood splints		✓		
wooden stir sticks	✓			
word bank			✓	
zinc acetate		✓		
zinc piece		✓		

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
Recyclables and Collectables				
ball or can	✓		✓	
bob			✓	
bottle	✓			
broomhandle or stand			✓	
golf tees			✓	
knife and cutting board		✓	✓	
newsprint			✓	
slow-moving toy with wheels			✓	
string, 0.5 m			✓	
Consumables				
antacid tablets (Tums, Rolaids)		✓		
apple		✓		
baking soda		✓		
bathroom cleaner		✓		
carbon paper disc			✓	
charcoal				✓
clear plastic food trays with lids	✓			
cotton balls				✓
coloured chalk			✓	
cream of tartar		✓		
cups, paper, 5 oz.	✓			
distilled water		✓		
drinking straw	✓			✓
Epsom salt		✓		
filter paper				✓
grapefruit juice		✓		

	Weather Dynamics	Chemical Reactions	Motion	Sustainability of Ecosystems
grid paper (graph paper)			✓	
ice	✓	✓		
index cards (unlined)	✓			
instant coffee		✓		
laundry detergent		✓		
lemon juice		✓		
lime juice		✓		
masking tape	✓		✓	✓
milk		✓		
molasses	✓			
nylon mesh				✓
oil (cooking, 3-in-1, motor)	✓	✓		
orange juice		✓		
paper (plain and colour)	✓		✓	
plants (various)	✓			✓
plastic bags (zipper, sandwich)		✓		
plastic wrap	✓			
potting soil	✓			
red cabbage		✓		✓
salt (rock, table, or pickling)	✓	✓		
sand	✓			✓
shampoo		✓		
small plant	✓			
soft drinks		✓		
sugar cubes		✓		
tape	✓		✓	
vinegar		✓		

Appendix B: Video Resources

Education Media Library

The Education Media Library is part of the Learning Resources and Technology Services (LRTS) division of the Public Schools Branch of the Nova Scotia Department of Education. LRTS works in partnership with branch divisions and school boards towards integrating technology into the classroom, and distributing digital learning resources for teachers and students in public schools.

To support that mandate, the Education Media Library has a collection of over 5,000 educational videos and provides access to over 9,000 online video resources to support grades P–12 in all subject areas of the Nova Scotia curriculum.

The Media Library has three video collections: lending, duplication, and online video. Videos from the lending collection can be borrowed for up to 10 days at no cost (return postage is provided); videos from the duplication collection are sold to schools at "cost recovery" prices ($1.41 plus tax for a DVD) and belong to the school as a shared resource for all teachers; online titles are available to Nova Scotian teachers and students, and can be accessed from the Education Media Library website video streaming platform (http://medialibrary.EDnet.ns.ca/). Online titles are also available to Nova Scotian teachers from the Education Portal (https://edapps.EDnet.ns.ca/eduportal).

Educational videos have been evaluated for curriculum fit and bias and may be used by educators to support the Nova Scotia public school program. In addition, public performance rights have been purchased for all titles so that all videos can be legally shown in Nova Scotian classrooms to students and educators.

In addition to educational videos, the Education Media Library website provides access to an online catalogue, links to databases, information about copyright and using video in the classroom, and a variety of curriculum-related resources to help teachers in their classrooms.

Title	Description
Earth and Space Science: Weather Dynamics	
Air: Climate (23340) 20 min., 2000	When it comes to weather and climate, Canada has it all. From the humid rain forests of British Columbia to the badlands of Alberta; from the Arctic to fertile farmland of the Great Lakes and St. Lawrence River region. This program takes students on a tour of the regions and seasons, illustrating extremes of weather and climate. Closed-captioned.

Title	**Description**
Atmosphere Below (23105) 28 min., 1999	Oceanography, climatology, and meteorology come into play as this segment explores the phenomena of global warming, the hole in the ozone layer, and El Niño in Earth's atmosphere. Research that scientists are conducting in space helps them understand the atmospheric mutations Earth is experiencing.
Blowing Hot and Cold (22829) 25 min., 1993	Only now are we beginning to realize the importance of Antarctica as the world's greatest weather factory. The size of the United States and Europe combined and covered in an ice sheet sometimes two miles thick, the Antarctic has the power to create deserts of jungles as far away as the equator. Human activity also has the power to trigger those changes.
Cyclone! (21636) 60 min., 1995	This video chronicles some of the world's most shocking storms with gripping footage and scenes of real-life drama. From twisters sweeping across the Midwest's Tornado Alley to the vicious force of Florida's Hurricane Andrew, to the deadly powerful typhoons of the Pacific, cyclones are among the most powerful forces on Earth. Closed-captioned.
Hurricane: Earth's Greatest Storm (22251) 20 min., 1991	Witness the incredible energy unleashed by one of nature's most dramatic weather systems.
Maple Tree: Climate (23077) 24 min., 1999	The sugar maple undergoes major changes to adapt to shifts in temperature. Human activities also vary with climate. In this program, we will visit a maple grove in a museum where the artificial climate is like the greenhouse effect threatening Earth.
The Hydrologic Cycle: Water in Motion (23099) 21 min., 1993	This program provides an examination of basic steps involved in the movement of water throughout Earth's hydrosphere. With graphics and live action, journey through the water cycle to understand this precious resource that covers nearly three-quarters of Earth.
Thunderstorms (23098) 20 min., 1991	Superb footage combined with animated computer graphics explain how thunderstorms develop to produce rain, hail, and lightning. See how meteorologists use sophisticated forecast tools to track major storms that produce weather phenomena such as microbursts, tornadoes, and floods.
Water Cycle: Oceanography (23119) 50 min., 1998	This video has two 25-minute programs featuring Bill Nye, the Science Guy. "Water Cycle: Did you know that most of the water on the planet is the same water that's been here since Earth was formed?" Using a whimsical model made of a tiny staircase, wind-up penguins, and a bicycle tire, Bill Nye demonstrates the phases of the water cycle: evaporation, condensation, precipitation, and collection. Science kids hit the streets to show us some easy things we all can do to keep the water supply clean and healthy. "Oceanography: Surf's up!" Get the current information as Bill Nye explains why oceans are salty and explores the ocean currents.
Weather and Climate (21332) 15 min., 1991	This program answers questions that students ask concerning weather and climate. Examples: What is weather? What causes the changes in seasons? What is atmosphere? What is subtropical climate?

Title	**Description**
Physical Science: Motion	
Motion (23111) 20 min., 2000	Through riding in a race car, snowboarding in a half pipe, and observing a wide variety of athletes in action, students will observe applications of the principles of motion. The basic concepts of speed and acceleration are calculated. Terminology and concepts include frame of reference, speed, velocity, acceleration, momentum, and conservation of momentum.
Life Science: Sustainability of Ecosystems	
Acid Rain (23254) 30 min., 1993	This program discusses the history of acid rain from its origins during the Industrial Revolution to its devastating effects on today's woodlands, aquatic ecosystems, and wildlife. Students study the effects of acid rain on outdoor statues in Philadelphia. An air quality specialist demonstrates how air and water quality are measured and how fossil fuel emissions are contributing to dangerous precipitation. The video examines energy alternatives to reduce acid rain. Department of Natural Resources video collection.
Baltzer's Bog (DVD) (V2559) 23 min., 2004	Meet Belinda Manning, who discovered truck loads of foulsmelling materials dumped in a bog near her home in the Annapolis Valley, Nova Scotia. Belinda was not able to get the answers she needed from her municipal government or the provincial environmental department. This CBC *Land and Sea* episode shows the struggle that Belinda and her neighbours raised about their environmental concerns and the bog. Dr. Martin Willison, of Dalhousie University, Halifax, found a layer of ancient tree stumps deep beneath the peat, and the scientists discovered an archive of ten thousand years of information about weather and environment.
Biodiversity/Garbage (23115) 50 min., 1998	This video has two 25-minute programs featuring Bill Nye, the Science Guy. "*Biodiversity*" In any given environment there are hundred of varieties of plants and animals living together, creating ecosystems. Bill Nye, sets up shop in an ocean, a forest, and a field to commune with nature and show what happens when one link falls out of nature's chain. "*Garbage*" By digging up the dirt on garbage in everexpanding landfills from New York to Florida, Bill Nye exposes the vast amounts of nonbiodegradable waste humans create.
Deer: Forest and Vegetation Management (23075) 24 min., 1999	This program studies the habitat of deer. It looks at successful natural habitats as well as habitats that are altered with new forest management techniques. Some balances are vital to both the deer population and to renewal of coniferous forests.
Fiddles on the Tobique (DVD) (V2560) 23 min., 2004	Bill Miller and four generations of his family have lived along the Tobique River, near Nictaux, New Brunswick. Once, the Tobique was a sportsman's paradise for salmon fishing, but the salmon population has collapsed and so has the Tobique economy. Bill Miller builds handcrafted wooden canoes, now the oldest canoe company in Canada. The Tobique is a shallow river with lots of rocks, so the canoe has to be flexible and strong and easy to handle. This CBC *Land and Sea* episode features a unique annual event, Fiddles on the Tobique, a celebration of traditional music, canoes, and the beauty of the Tobique.

Title	**Description**
Sustainable Environments (23010) 35 min., 1997	This video is a thorough and interesting exploration of sustainability. You will learn how some of nature's loops and interdependencies work toward sustainability, and how we can follow similar patterns in the built environment. There are sections on transportation, buildings and landscapes, diet and agriculture, and lifestyles and work.
The Forest (23271) 48 min., 1992	This program features scientists and forestry workers from various parts of Canada discussing environmental and economic concerns of forest harvest and sustainable development, and in conservation and providing habitat for all types of wildlife. (Department of Natural Resources video collection)
Web of Life: Producer to Predator (23222) 24 min., 1996	This video explores the ecosystems, biomes, and communities of living matter, the elements required for life, energy transfer, population limits, and relationships. Other topics include decomposers, competition, predatorprey, and the types of symbiotic relationships in the ecosystem structure.
World's Biomes: Desert to Rainforest (23292) 28 min., 1996	The various abiotic factors that affect a particular biome are presented, and then a summary of the abiotic influences of each of the different biomes on their biotic component is given. Major biomes introduced include tundra, coniferous forest, temperate forest, rain forest, desert, grassland, and aquatic.

Appendix C: The Research Process

The research process involves many different skills and strategies grouped within phases or stages. The process is cumulative, each stage laying the groundwork for the next. The phases or stages are commonly identified as
- planning (or pre-research)
- accessing and gathering information (or information retrieval)
- evaluating and interacting with information
- organizing information
- creating new information
- preparing, sharing, and presenting information
- evaluating the research process

Students' use of the information process is not linear or purely sequential. A new piece of information, artifact, or conversation with a resource person might lead a student to revise a question under consideration, determine a perspective or point of view from which to examine critically the information available, or develop an alternative plan.

Planning

During the introductory stage of the research process, students usually
- identify the topic or question—decide on a general area of interest that warrants further investigation, then clarify or narrow the area of focus to make it manageable
- formulate broad and specific questions to guide their research
- identify a variety of potential sources of information
- decide what strategies they will use to record information and keep track of the sources they use

Accessing and Gathering Information

Students access appropriate resources (print, multimedia, human, community). The actual resource is located, and the information is found within the resource. Students will use a range of skills:

- locate resources (e.g., community, text, magazines, artifacts, websites) and determine appropriate ways of gaining access to them
- search (with direction) a library catalogue and the Internet to identify potential information resources
- select appropriate resources in a range of media
- use organizational tools and features within a resource (e.g., table of contents, index, glossary, captions, menu prompts)

- interpret information to determine the point of view or perspective from which the content is organized and presented
- determine whether the content is relevant to the research question
- determine whether the information can be effectively shaped and communicated in the medium the students will use to complete the project

Teachers should help students realize that fewer appropriate resources are better than a multitude of inappropriate resources.

Interacting with Information

Students continue critical evaluation of the information they find to determine if it will be useful in answering their questions. Students apply reading, viewing, listening, and critical thinking skills to

- question, skim, read (QSR)
- use text features such as key words, bold headings, and captions
- use navigation features or software
- use pause points or topic shift points in video
- read and interpret charts, graphs, maps, and images
- listen for relevant information
- scan videos, bookmark websites
- compare and evaluate content from multiple sources and media
- determine accuracy, relevance, and completeness of information

Teachers should help students develop a range of strategies for recording the information they need to explore their topic and answer their guiding questions. Simple point-form notes (facts, key words, phrases) should be written or recorded symbolically (pictures, numerical data) in an appropriate format such as a concept map, matrix sheet, chart, computer database, spreadsheet, or website. Teachers might also have to assist students in citing sources of information accurately and acknowledge copyright when using the images, data, sounds, and text they reference or include in their work.

Organizing Information

Students may use a variety of strategies to organize the information they have collected while exploring their topics and answering their guiding questions:

- numbering
- sequencing
- highlighting notes according to questions or categories
- establishing directories of files
- archiving email collaborations using subject lines and correspondents' names
- creating a database of images and sound files

Before creating their products, planning their performances or presentations, or exhibiting their work, students should review their information with regard to their guiding questions and the stated requirements of the activity to determine whether they need additional information or further clarification. They might have to re-frame the research in light of information and sources gathered.

Sharing Information

Students review and reflect on the information they have collected, connecting new ideas with their prior knowledge and evaluating new information that might not fit with their previous understandings. As they integrate new information into their current knowledge, students develop new understandings and draw conclusions. Teachers might have to help students decide how best to convey the results of their research process to the intended audience. Students should have many opportunities to share with a variety of audiences what they have learned, discovered, and created. They should have opportunities to examine carefully the responses of those audiences to their work.

Evaluating the Research Process

Students should reflect on the skills and learning strategies they are using throughout the research process and examine and discuss the skills and strategies they used. Teachers and library professionals can help students with evaluation by

- providing time and encouragement for reflection and metacognition to occur (e.g., What did we/you learn about gathering information?)
- creating a climate of trust for self-assessment and peer-assessment of process, creation, or performance (students tend to be realistic and have high expectations for their own work)
- asking questions, making observations, and guiding discussions throughout the process
- providing opportunities for student conferencing in small groups
- monitoring and providing feedback on student progress (e.g., demonstrated ability to organize notes)

Media Analysis

The development of media analysis skills is an important component of Science 10. Media studies can be integrated into the curriculum as a source of current information, as a means to stimulate student interest and discussion, and as a vehicle to present real-world issues and situations to students. It is important for students to be able to evaluate media critically. Students should be able to distinguish fact from opinion and propaganda from responsible, objective reporting. Analysis of media products requires students to consider the following:

- the purpose and qualification of the author(s)
- the type of source and how that source is monitored (e.g., an established newspaper as opposed to an article appearing on an interest group's site on the Internet)
- the type of audience to which the information is directed
- the reasons a particular target audience was chosen
- the ways the author(s) chose to reach that audience
- identification of inaccuracies, contradictions, or illogical reasoning
- the presentation of opinions
- evidence of bias in the work
- the source(s) of information and the interpretation of that information by the author
- the presentation of unsupported ideas and conclusions

When analyzing advertising, students should focus their attention on the use of unsupported conclusions, testimonials by unknown or unqualified people, and the use of unsubstantiated events or quotations to draw conclusions.

Appendix D: Journals and Logbooks

Journals and logbooks are a part of many occupations and as such are highly reflective of the world of work. Many highly successful people keep a daily journal as a habit that helps them develop insights into their work. A journal can include sketches, diagrams, notes, quotes, questions, excerpts, and drafts. Scientists recording this way are keeping track of all of their observations. This is their "private science."

The journal or logbook may be used to develop a final product—such as a report, design, profile, fictional text, or dramatization—or it may be a way of tracking progress and developing ideas and insights. The final product is the young scientist's "public science."

Students need to see the value of their science-log writing, not only through frequent responses from the teacher, including assessments that "count," but also through assignments that provide links to previous and subsequent learning or that meet specific learning or personal needs for students.

Since the journal or logbook can contain very personal thoughts and ideas, stimulated by thought-provoking questions, teachers must make provisions to honour the confidentiality of students' work, except where legally required to do otherwise.

Appendix E: Portfolios

A portfolio is a selection of work samples and other items that demonstrate students' interests, talents, skills, and achievements. The purpose of a portfolio is to show others—teachers, counsellors, parents, peers, and possible employers—what students have learned, accomplished, and produced. Students should frequently update their portfolios and reflect on their progress and growth. Reflective writing is a key component of portfolios.

Portfolios at the high school level can be used to display and summarize a range of achievements and can serve to help students

- identify and acknowledge personal growth and achievement
- demonstrate their achievements to families, potential employers, and others
- apply to post-secondary institutions
- apply for scholarships and bursaries
- obtain a volunteer position
- make decisions concerning career path choices

Creating Portfolios

Following are four basic types of portfolios:

Student Portfolios demonstrate the skills, accomplishments, and achievements of students' academic careers over a specific time period. The portfolio can represent one area of study, or it can encompass a broad range of disciplines. Students are often encouraged to include materials that represent accomplishments and interests outside the classroom.

Project Portfolios are designed to outline the steps or progress of a specific project or independent study. Students are required to record and comment on the process and outcome of their efforts.

Career Portfolios identify students' skills and accomplishments related to their career interests. This type of portfolio is becoming popular as a useful addition to the standard resumé.

A **Personal Portfolio** is designed in a format similar to a scrapbook or a personal journal. It reflects the personal interests, ideas, and aspirations of the student. The most important factors for a successful portfolio format are durability, accessibility, and presentability. Whether a portfolio is in a binder, scrapbook, or folder, or on computer disks, multimedia CD-ROMs, videotapes, or audiotapes, it must be easy to transport, showcase, and understand.

Students must be able to organize and maintain their portfolios effectively. The decision of what to include in a portfolio depends entirely on the purpose of the portfolio. Following are some of the materials that could be included:

- art and design work
- articles, newspaper clippings
- awards
- certificates
- essays, position papers
- evaluations and reviews
- letters of invitation/thanks
- photographs
- poems, songs/music, stories
- reflective writing
- rubrics, test results, assessment information

Assessing Portfolios

Teachers should discuss and negotiate the assessment of portfolios with students before the students start to create them. Assessment criteria often reflect the design and purpose of the portfolio. The most important form of feedback to students might be in the form of dialoguing and conferencing. General qualities that students should be aiming to achieve include the following:

- clean format—easy to read and understand
- clear representation of learning goals and achievements
- creativity
- thoughtful organization
- thoughtful self-evaluation

Appendix F: Project-Based Science

What Is Project-Based Science?

Project-based science, often referred to as "real science," is a science instruction method that has students and teachers completing projects in a fashion similar to the research methods of "real" scientists. Through individual and collaborative research, students are provided with the opportunity to construct science knowledge through hands-on, self-directed experiences. The project-based method enables teachers to examine students in a variety of different activities and situations that address a variety of different learning styles and cognitive strengths. Through this process, students cover a number of science curriculum outcomes as well as outcomes for other curriculum programs.

A project-based science activity can be designed to fit any science classroom. It can be a small activity that covers a few classes a full course investigation that results in a project to be presented to the class, at a public presentation such as PTSA night, or in an electronic journal, or entered in a local or regional science fair. Whatever the end result, project-based science activities all include the following common components:

- **A focus question or driving question:** When students create a driving or focus question, they become the key figure(s) in a project from the beginning. With a clear focus question, students can organize the methods that they will use to direct their research in order to arrive at an answer to their question. The focus question also provides students with a reference point for reflection throughout their study. The question may be revised throughout the course of study as directed by the students' research.
- **Investigation:** In project-based science the student's focus question leads directly into authentic problem solving through textual and online research, experimental design and operation, data collection and analysis, estimation, discussion and debate, group interaction, summarizing and drawing conclusions, and refining and examining the original question.
- **Artifacts:** Throughout the course of a project, students will produce a number of reports, devices, and displays that show a true understanding of their focus question.
- **Collaboration:** Whether working alone or in groups, students will be collaborating with others throughout a project-based exercise. Working in class, sharing new discoveries, questioning others' conclusions, and participating in classroom presentations allow students to explore avenues in their research that they may not follow on their own and further expand the study of the focus question.
- **Technology and telecommunications:** Modern technology allows students to explore science in a wide variety of ways. Communication with professional scientists, discussions with other students from around the region or the world, and the accessibility of vast amounts of information allow students to completely explore the answers to their questions and share the information that they have collected.

Incorporating Project-Based Science in the Classroom

Project-based science is a rewarding method of instruction that allows students and teachers to interact in ways that are not common in traditional science classrooms. It is recommended that the teacher also does a project to model the behaviour with the students. By doing a project along with the students, the teacher has the control over timelines, the opportunity to lead by example, and the chance to assess and examine students exploring science with their classmates. Hands-on, minds-on science will be developed throughout the project.

The role of the teacher in a project-based science activity changes from a person who provides the knowledge to a person who facilitates research. The teacher models the processes expected of the students, makes suggestions on the direction of student research, and encourages students to follow their successes and explain their questions. This change in instructional method offers teachers an opportunity to examine the content of their courses in a different light and helps them prepare students to be students after high school.

Teachers must fully adopt the project-based science concept when completing an activity with their classes. The teacher changes from a person who asks questions to a person who facilitates the answering of questions. It is important for teachers to be aware of where their students are throughout the entire investigation. Teachers can guide the students' research without controlling the topics, methods, or focus questions just by being aware of the current status of each student's project.

Planning

The initial organization of a project-based science classroom can be time consuming and labour intensive; however, once the initial guidelines are established, this time becomes minimal for future project-based activities. When properly organized, a project-based activity will run smoothly and achieve its goals for all students, as well as provide a number of opportunities for student assessment. The following are some suggested steps for beginning a project-based activity in the classroom:

1. **Decide on the type of project.** Project-based learning can be used for short-term activities like exploring a specific topic in a unit or a complete unit. It may also be used for elaborating long-term activities that students may use to summarize their learning in a course or use to compete in local or regional science fairs.
2. **Establish a timeline for the project.** No matter what type of project is ongoing in a classroom, a well-defined and adhered-to timeline for the activity is key to its success. When students are aware of the time expectations on them, they are less likely to fall behind. The teacher project and class time are important to help keep all students on task and to ensure that all are where they are supposed to be with their individual projects. A checklist can be created for teachers and students to keep track of their progress during the project. Some sample timelines can be found at the end of this section.

3. **Organize the teacher project.** Teachers must decide upon a project to carry out as a model for the students. By going step by step through a project with the class, a teacher will emulate the work habits expected of students as well as keep the class on time and on task. Modelling your project a week/day ahead of the students will allow students to see how you are progressing and provide opportunity for questions.
4. **Determine the methods of evaluation that will be used.** Project-based science creates many opportunities for the evaluation of student work. If the value of the project in the overall marking scheme is clearly stated, students may be motivated to accept the challenge of a project and work hard to succeed. A clearly designed rubric should be created for updates and activities completed during project assessment, as well as a rubric for the culminating activity. Some sample rubrics can be found at the end of this section.
5. **Prepare a list of books or a website containing project ideas.** Once the format of a project has been determined, teachers should create a list of possible resources that will aid students in the beginning stages of a project.
6. **Establish cross-curricular links with other teachers.** Project-based science requires a wide variety of skills in order to be complete. Students will not only be meeting science outcomes through the project process, but will also cover language, art, mathematics, and other course outcomes. Teacher collaboration in the planning stage of a project will allow for a broad-based assessment of student projects.
7. **Establish mentorship links.** Professional or academic mentorships are a useful tool for students in long-term research. Arranging for student mentors before a project begins will assist in the initialization of a project and will provide students with someone to contact if questions come up through research.
8. **Organize a project showcase.** Presentation time and space should be allotted for students to showcase their project work. Booking a time and space well in advance will give the students a clear target date and give the projects a clear focus for the cumulating activity.

Keeping a Research Log

One of the best ways to keep a project running smoothly from start to finish is through the upkeep of a research log or journal. A research log that is kept up to date will allow students to look back at what they have done, examine and reflect upon results, and change the research direction of their future research. The research log should have two components that are kept up to date throughout the time of study.

The first part is the personal reflection on discoveries to date. Here students can examine what they have discovered, relate it to their current knowledge, and explore how it applies to their projects. The reflection also provides students with an opportunity to sort through the information they have collected and filter out the parts that do not relate to their focus question, thus making the end goal of their research more clear. The entries in the reflection section should all be dated in order for students and the teacher to keep up to date on the research timeline.

The second part is the data. Regardless of whether the project is a study, an experiment, or an innovation, a student is going to collect data of one form or another. A well laid-out research log provides students with a place to collect, organize, and analyze their data. The end result of a project should contain a conclusion based on the data, but need not contain every piece of information collected throughout the course of study.

Research logs provide an excellent opportunity for students to assess their work to date and use this assessment to further develop their study. The logs also provide a teacher with a tool to assess how well the students worked on their project from start to finish.

A research log should be maintained from day one of a project until it is completed. Teachers may set up the format of the research log for their students, and all research logs should be organized in a way that fits the topic or method of study chosen by the student and teacher.

Sample Projects and Timelines

The following pages contain some sample documents that you may use to set up project-based science in the classroom. The samples include rubrics, timelines, required mathematics skills, and some resources available to teachers. Some of the examples are content specific, and others are generic ones that may be used as guidelines to set up individual investigations.

Section or Topic Project

Section or topic projects are short-term activities that are designed to quickly investigate a particular subject in a science classroom. This type of project allows students to obtain some background information about a topic before the class completes a full investigation. These activities my be used to introduce a chapter or to summarize a recently completed topic area.

Timeline

Four one-hour periods will be set aside to complete the following project.

Period	Activity	Comments	Checklist
1	Introduction, class discussion, and topic research	Students should be given information about the topic that is being covered and the opportunity to explore and create focus questions.	By the end of the period all students will have a focus question for their research.
2	Focus question refinement and data collection	Students will review the focus question suggestions provided by the teacher and begin research with the focus question as the core of their research.	By the end of the period all students will have a complete focus question, an overview of the data they still need to collect, and a summary of the information collected so far.
3	Research completion	Students will finish their data collection and finalize plans for the presentation of their discoveries.	By the end of the period all students will have a summary of their discoveries and a description of the artifacts they will use to share the information with the class.

Period	Activity	Comments	Checklist
4	Project completion	Students will prepare the artifacts for the project.	By the end of the period all students will hand in a completed project report and artifacts.

Unit Project

A unit project may address all or part of a unit. The project may be used to cover topics that are more difficult to cover using traditional methods, or to provide a variation from traditional science teaching methods.

Timeline

Nine class hours will be set aside over the next six weeks to complete and present the following project.

Period	Activity	Comments	Checklist
1	Introduction and topic research	Students should be given information about the topic that is being covered and the opportunity to explore and create focus questions.	By the end of the period, all students will have a rough draft of their focus question.
2	Focus question refinement	Students should share their focus questions with the teacher and other students and begin to outline their project design.	By the end of the period, all students will have a finalized focus question and a draft outline of their project design.
3	Research tools and project design	Students will begin their research by locating resources and creating a bibliography of sources they plan to use. Students will also finalize their project design.	By the end of the period, all students will have a completed project design and a list of five resources they will have on hand to research their focus question.
4	Research and experimental design and set-up	Students will continue research into their focus question and, if appropriate, set up their experimental equipment in order to complete their study.	By the end of the period, all students will have a collection of data or summarized information that describes their focus question.
5	Continued research and experimentation	Students will continue with their research and data analysis.	By the end of the period, all students will have a record of collected data and research to be completed.
6	Research completion	Students will conclude their research and data collection.	By the end of the period, all students will have completed all research and experimentation necessary to complete their project.

Period	Activity	Comments	Checklist
7	Project organization	Students will have all of the materials necessary to bring their project together as a cumulative reporting of their study. This may include papers, display posters, or websites.	By the end of the period, all students will have a completed project
8–9	Presentations	Students will present their projects to their teacher and their peers.	By the end of the period, all students will have presented to and/or evaluated the projects of their classmates.

Long-Term Project

A long-term project can address a multitude of science topics. A long-term project requires a lot of work both from the teacher and the students and should be valued to reflect its importance. As with any project-based science activity, the teacher should participate by completing a project with the students. This helps the students keep on task and interested in the work and provides the teacher the opportunity to demonstrate skills such as research methods, experimental design, and data collection, which are not always involved in traditional science teaching.

Timeline

One period of each Friday will be set aside for science project work. In the 16th week there will be an in-school public presentation.

Timeline for Research

Week	Activity	Comments	Checklist
1	Introduction and topic research	Students should be given information about the topic that is being covered and the opportunity to explore and create focus questions.	By the end of the period, all students will have a rough draft of their focus question.
2	Focus question refinement and project design	Students should share their focus questions with the teacher and other students and begin to outline their project design.	By the end of the period, all students will have a finalized focus question and a draft outline of their project design.
3	Research tools and project design	Students will begin their research by locating resources and creating a bibliography of sources they plan to use. Students will also finalize their project design.	By the end of the period, all students will have a completed project design and a list of five resources they will have on hand to research their focus question.

Week	Activity	Comments	Checklist
4	Research list preparation	Students are to complete and pass in a list of resources and a description of how these resources will be applied to their research question.	By the end of the period, all students will have passed in a list of resources they plan to use in their study.
5	Project design completion	Students are to complete a concept map for their project with suggested timelines, necessary equipment and resource materials, and experimental or laboratory components.	By the end of the period, all students will have passed in a concept map with timelines for their project.
6–9	Research and experimentation	Students will carry out research and carry out experiments to evaluate their hypothesis and reassess their discoveries and predictions.	Students will maintain a data log in which they record their discoveries and refinements to their project.
10	Progress report	Students will be reminded that they are two thirds of the way through their projects will prepare progress reports.	By the end of the period, all students will have passed in a progress report that includes a summary of discoveries, changes to the project design, new resources, and a diagram or description of the display layout for the project.
11–12	Continued research and experimentation	Students will begin to finalize their projects by assessing the discoveries made to date and deciding what needs to be done to complete the project. Students will also correlate and analyze data collected.	Students will maintain a data log in which they record their discoveries and refinements to their project.
13	Report completion	Students will put the finishing touches on their written reports and prepare 50-word summaries of their discoveries.	By the end of the period, all students will have passed in their project reports and 50-word summaries.
14	Display completion	Students will put the finishing touches on their project displays and seek out advice from teachers and fellow students.	By the end of the period, all students will have passed in their completed project displays.
15	Project sharing	Students will set up their projects and share them with classmates in order to prepare for the science fair.	By the end of the period, students will be prepared to present their science fair projects.
16	Public presentation	Students will present their projects to judges, teachers, and the public.	By the end of the day, students will have effectively presented their project.

Assessment and Evaluation

The assessment of a project-based science activity provides teachers with a unique opportunity to evaluate student learning in science. There are a variety of STSE, scientific skill, and knowledge outcomes that may be covered through a project. Providing students with the opportunity to assist in the creation of evaluation tools for projects gives them an opportunity to examine how to design a project that fits the project they are working on.

Assessment *of* Learning

Assessment *of* learning is the method of evaluation that is most familiar to teachers. This type of assessment involves looking back at what students have covered and determining how well they have internalized the information. The completed project should represent the learning of students at all stages of project development. A good rubric or set of rubrics makes the assessment of a student project quick and effective to complete. Rubrics are useful tools in the final assessment of a physics project. Rubrics should include the assessment of all aspects of the student project, including focus question quality, research effectiveness, effort, and the overall quality of all artifacts produced through research.

Assessment *for* Learning

Assessment *for* learning involves the use of effective assessment tools to help develop knowledge through the act of assessment. A project-based investigation that includes clearly focused assessment guidelines that involve students in all aspects of the assessment creates unique learning opportunities for both students and teachers. Students should be involved in the creation of rubrics, the creation of questions based on their research, and the evaluation of their work from start to finish. The opportunity to be part of the assessment of a project from start to finish empowers students and creates conditions that allow them to capitalize on every learning opportunity provided by a project.

Rubrics

A complete scoring rubric, which addresses all aspects of a project, is one of the most effective and efficient ways to evaluate a project. A rubric can be developed with students and should be completed by both students and teachers throughout the course of a project. There are a number of online resources available to help with the creation of scoring rubrics for any project.

Sample Scoring Rubric

Teacher name: ______________________________

Student name: ______________________________

Category	4	3	2	1
Idea	Independently identified a question that was interesting to the student and that could be investigated.	Identified, with adult help, a question that was interesting to the student and that could be investigated.	Identified, with adult help, a question that could be investigated.	Identified a question that could not be tested/investigated or one that did not merit investigation.
Hypothesis Development	Independently developed an hypothesis or focus question well substantiated by a literature review and observation of similar phenomena.	Independently developed an hypothesis or focus question somewhat substantiated by a literature review and observation of similar phenomena.	Independently developed an hypothesis or focus question somewhat substantiated by a literature review or observation of similar phenomena.	Needed adult assistance to develop an hypothesis or focus question or to do a basic literature review.
Description of Procedure	Procedures were outlined in a step-by-step fashion that could be followed by anyone without additional explanations. No adult help was needed to accomplish this.	Procedures were outlined in a step-by-step fashion that could be followed by anyone without additional explanations. Some adult help was needed to accomplish this.	Procedures were outlined in a step-by-step fashion, but had one or two gaps that require explanation even after adult feedback had been given.	Procedures that were outlined were seriously incomplete or not sequential, even after adult feedback had been given.
Data Collection	Data was collected several times. It was summarized, independently, in a way that clearly describes what was discovered.	Data was collected more than one time. It was summarized, independently, in a way that clearly describes what was discovered.	Data was collected more than one time. Adult assistance was needed to clearly summarize what was discovered.	Data was collected only once, and adult assistance was needed to clearly summarize what was discovered.
Conclusion-Summary	Student provided a detailed conclusion clearly based on the data and related to previous research findings and the hypothesis statement(s).	Student provided a somewhat detailed conclusion clearly based on the data and related to the hypothesis statement(s).	Student provided a conclusion with some reference to the data and the hypothesis statement(s).	No conclusion was apparent, OR important details were overlooked.
Student Participation	Student participated actively in the creation, development, and all research aspects of the project.	Student participated actively in parts of the project with which they feel comfortable.	Student participated periodically in the research aspects of the project.	Student did not participate in the development of the project.

Appendix G: Engaging Learners

As teachers select learning experiences that engage and motivate, they must remember that they are not just teaching a group of students; they are teaching a group of individuals, many of whom take great pride in being—and staying—unique. The individuality of each student must be considered as teachers look for ways to engage them. A "one-size fits all" approach will likely have little effect. Tackling engagement starts with knowing the students—each of them.

The *Public School Programs* (Nova Scotia Department of Education 2012), Principles of Learning state: "Learners must see themselves as capable and successful." The challenge for teachers is to provide curricula that support this principle and are engaging in content, delivery, and relevance to the lives of learners. Beyond the student believing in his or her own abilities and capabilities, teachers must believe as well, and communicate their belief through the efforts they make to include students as partners in their learning.

Teachers should consider the following suggestions for engaging learners:

- Seek to know the person within the student. Although student surveys or inventories can be helpful, nothing beats a face to face conversation. Each of us appreciates when someone shows sincere interest in our lives, in who we are, and in what matters to us. For disengaged youth in particular, this is critical. Be willing to share a little about yourself—as a person. Letting students know who we are helps build trust, the foundation for the teacher-learner relationship.
- Incorporate opportunities for students to have a voice. Many disengaged students feel that they have been excluded from or ignored by the school system. Invite their views and opinions in meaningful contexts and create genuine opportunities for them to see their voices in action.
- Establish criteria for learning and for individual assignments collaboratively. Your involvement will ensure that certain goals are included, but inviting student input, will increase ownership in the learning and related tasks, and learning, interest, motivation, and engagement will increase.
- Set goals that are attainable and that will promote a sense of accomplishment and self-satisfaction. Inviting the student voice to be part of setting learning goals is extremely important.
- Offer choice, whenever possible: of reading material, of methods to present knowledge and information, and of assignment topic or focus within a topic.
- As important as it is to be positive and encouraging in our response to student work, it is equally important to be honest and sincere in order to develop a trusting relationship.

Taking the time to read the research and the discourse behind these strategies will help teachers understand why certain strategies work, how to make suitable adaptations, and how to create their own supports that make learning more interesting and relevant to all students.

By designing and delivering a program that is grounded in knowing our students, that connects with their world beyond school, and that invites them as partners in the classroom, we are creating learning opportunities that will engage students. Sharing the voice and the control allows teachers to use “the energy of their connections to drive us through the content.” (Christensen 2000)

Appendix H: Pan-Canadian Outcomes

The following outcomes are from *Common Framework of Science Learning Outcomes K to 12* (Council of Ministers of Education, Canada 1997) that were used as guidelines for this science document.

Earth and Space Science: Weather Dynamics

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **114-6** relate personal activities and various scientific and technological endeavours to specific science disciplines and interdisciplinary studies **115-6** explain how scientific knowledge evolves as new evidence comes to light **Relationships between Science and Technology** **116-1** identify examples where scientific understanding was enhanced or revised as a result of the invention of a technology **Social and Environmental Contexts of Science and Technology** **117-6** analyze why scientific and technological activities take place in a variety of individual and group settings **117-10** describe examples of Canadian contributions to science and technology **118-2** analyze from a variety of perspectives the risks and benefits to society and the environment of applying scientific knowledge or introducing a particular technology **118-7** identify instances in which science and technology are limited in finding the answer to questions or the solution to problems	Students will be expected to **Initiating and Planning** **212-1** identify questions to investigate that arise from practical problems and issues **Performing and Recording** **213-3** use instruments effectively and accurately for collecting data **213-6** use library and electronic research tools to collect information on a given topic **213-7** select and integrate information from various print and electronic sources or from several parts of same source **Analyzing and Interpreting** **214-3** compile and display evidence and information, by hand or by computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots **214-10** identify and explain sources of error and uncertainty in measurement and express results in a form that acknowledges the degree of uncertainty **214-11** provide a statement that addresses or answers the question investigated in light of the link between data and the conclusion **Communication and Teamwork** **215-5** develop, present, and defend a position or course of action, based on findings	Students will be expected to **331-1** describe and explain heat transfer within the water cycle **331-2** describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents **331-3** describe how the hydrosphere and atmosphere act as heat sinks within the water cycle **331-5** analyze meteorological data for a given time span and predict future weather conditions, using appropriate methodologies and technologies

Physical Science: Chemical Reactions

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **114-8** describe the usefulness of scientific nomenclature systems **Relationships between Science and Technology** **116-3** identify examples where technologies were developed based on scientific understanding **116-5** describe the functioning of domestic and industrial technologies, using scientific principles **Social and Environmental Contexts of Science and Technology** **117-5** provide examples of how science and technology are an integral part of their lives and their community **117-7** identify and describe science- and technology-based careers related to the science they are studying	Students will be expected to **Initiating and Planning** **212-3** design an experiment identifying and controlling major variables **212-8** evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making. **Performing and Recording** **213-2** carry out procedures controlling the major variables and adapting or extending procedures where required **213-5** compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data **213-9** demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials **Analyzing and Interpreting** **214-5** interpret patterns and trends in data, and infer or calculate linear and non-linear relationships among variables **Communication and Teamwork** **215-6** work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise	Students will be expected to **319-1** name and write formulas for some common ionic and molecular compounds, using the periodic table and a list of ions **319-2** classify substances as acids, bases, or salts, based on their characteristics, name, and formula **321-1** represent chemical reactions and the conservation of mass, using molecular models and balanced symbolic equations **321-2** describe how neutralization involves tempering the effects of an acid with a base or vice versa. **321-3** illustrate how factors such as heat, concentration, light, and surface area can affect chemical reactions

Physical Science: Motion

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **114-3** evaluate the role of continued testing in the development and improvement of technologies **114-6** relate personal activities and various scientific and technological endeavours to specific science disciplines and interdisciplinary studies **115-4** describe the historical development of a technology **Social and Environmental Contexts of Science and Technology** **117-8** identify possible areas of further study related to science and technology **117-10** describe examples of Canadian contributions to science and technology **118-3** evaluate the design of a technology and the way it functions on the basis of identified criteria such as safety, cost, availability, and impact on everyday life and the environment	Students will be expected to **Initiating and Planning** **212-2** define and delimit problems to facilitate investigation **212-7** formulate operational definitions of major variables **212-9** develop appropriate sampling procedures **Performing and Recording** **213-3** use instruments effectively and accurately for collecting data	Students will be expected to **325-1** describe quantitatively the relationship among displacement, time, and velocity **325-2** analyze graphically and mathematically the relationship among displacement, time, and velocity **325-3** distinguish between instantaneous and average velocity

Life Science: Sustainability of Ecosystems

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **114-1** explain how a paradigm shift can change scientific world views **114-5** describe the importance of peer review in the development of scientific knowledge **Relationships between Science and Technology** **116-1** identify examples where scientific understanding was enhanced or revised as a result of the invention of a technology **Social and Environmental Contexts of Science and Technology** **117-3** describe how Canadian research projects in science and technology are funded **118-1** compare the risks and benefits to society and the environment of applying scientific knowledge or introducing a technology **118-5** defend a decision or judgment and demonstrate that relevant arguments can arise from different perspectives **118-9** propose a course of action on social issues related to science and technology, taking into account human and environmental needs	Students will be expected to **Initiating and Planning** **212-4** state a prediction and a hypothesis based on available evidence and background information **Performing and Recording** **213-7** select and integrate information from various print and electronic sources or from several parts of the same source **Analyzing and Interpretation** **214-1** describe and apply classification systems and nomenclature used in the sciences **214-3** compile and display evidence and information, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, graphs, and scatter plots **Communication and Teamwork** **215-1** communicate questions, ideas, and intentions and receive, interpret, understand, support and respond to the ideas of others **215-4** identify multiple perspectives that influence a sciencerelated decision or issue	Students will be expected to **318-2** describe the mechanisms of bioaccumulation, and explain its potential impact on the viability and diversity of consumers at all trophic levels **318-3** explain why ecosystems with similar characteristics can exist in different geographical locations **318-4** explain why different ecosystems respond differently to shortterm stresses and longterm changes **318-5** explain various ways in which natural populations are kept in equilibrium and relate this equilibrium to the resource limits of an ecosystem **318-6** explain how biodiversity of an ecosystem contributes to its sustainability **331-6** analyze the impact of external factors on an ecosystem **331-7** describe how soil composition and fertility can be altered and how these changes could affect an ecosystem

Appendix I: Digital Support

CONNECTSchool

Nova Scotia Science 10 digital resources are available through McGraw-Hill's *CONNECTSchool* website. CONNECTSchool is a web-based program that includes a searchable eBook, interactive teaching and learning tools, and customizable planning and study tools.

CONNECTSchool for Teachers includes
- complete digital student text
- complete digital teacher's resource, including modifiable activity sheets and lesson plans
- editable PowerPoint lessons
- ability to create quizzes and tests using the assignment builder
- videos, audio glossary, and interactives, organized by chapter

CONNECTSchool for Teachers allows you to
- share important dates
- create teaching plans
- highlight key portions of text and make notes
- indicate sections for review with sticky notes for students

CONNECTSchool for Students provides access to
- complete digital student text
- video clips, audio glossary, and interactive tools
- customizable study plans
- ability to create personal reminders with digital sticky notes
- ability to bookmark key pages
- ability to highlight important information
- ability to copy/paste images and text

Learning Resources and Technology Services

Digital support can also be obtained from the Nova Scotia Department of Education, Learning Resources and Technology Services at http://lrt.EDnet.ns.ca/ including
- videos from the Media Library (See the curriculum for a list of specific video resources available for each unit.)
- curriculum-related website links (Link: Computers & Software)
- curriculum materials (Link: Teacher Resources)

Science Passages

Science 10 Passages: Online Science 10 passages were created as a literacy project. These resources complement the Science 10 curriculum and are embedded with literacy strategies. Teachers may access these passages at http://science10.EDnet.ns.ca (username and password required).

Science 10 Collection

Science 10 Collection comprises 65 books for classroom instruction and student learning and enjoyment. Each resource has been selected to address curriculum outcomes in Science 10. The straightforward text of the non-fiction titles delivers clear and fascinating information that invites readers to learn about Earth—its fiercest disasters, the impact of global warming, its weather and climate, its energy sources, and much more. Some books include explanatory diagrams, charts, and graphs that support understanding of science concepts. The rich, naturalistic, full-colour photographs of the picture books combined with informative text engages students to experience all the wonders of the living, breathing world of science around us.

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