Atlantic Canada Science Curriculum

New Brunswick
Department of Education
Educational Programs & Services Branch

Science

Grade 10

CURRICULUM

2002

Additional copies of this document (*Science Grade 10*) may be obtained from the Instructional Resources Branch.
Title Code (842330)

Acknowledgements

The Departments of Education of New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island gratefully acknowledge the contribution of all the teachers and other educators and stakeholders across Atlantic Canada who contributed to the development of the Science 10 curriculum guide.

Foreward

The pan-Canadian *Common Framework of Science Learning Outcomes K to 12*, released in October 1997, assists provinces in developing a common science curriculum framework.

New science curriculum for the Atlantic Provinces is described in *Foundation for the Atlantic Canada Science Curriculum (1998).*

This curriculum guide is intended to provide teachers with the overview of the outcomes framework for science education. It also includes suggestions to assist teachers in designing learning experiences and assessment tasks.

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The placement of the units in this curriculum guide is not meant to suggest coverage sequence. Units can be covered in any order.

Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* 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*.

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 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, analyse, 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 they engage in, the discourse in which they participate, and the settings in which these activities occur. Students' disposition towards science is also shaped by these factors. Consequently, the aim of developing scientific literacy requires careful attention to all of 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 to 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 better record, organize, and understand information from a variety of sources. The process of creating webs, maps, charts, tables, graphs, drawing, 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. It is through opportunities to talk and write about the concepts they need to learn that students come to better understand both the concepts and related vocabulary.

Learners will need explicit instruction in, and demonstration of, the strategies they need to 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 need 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/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, analysing 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/or 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 class. 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 various learning styles.

As well, teachers must not only remain aware of and avoid gender and cultural biases 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 underrepresented 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 provide 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 for the processes described below.

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

Evaluation is the process of analysing, 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.

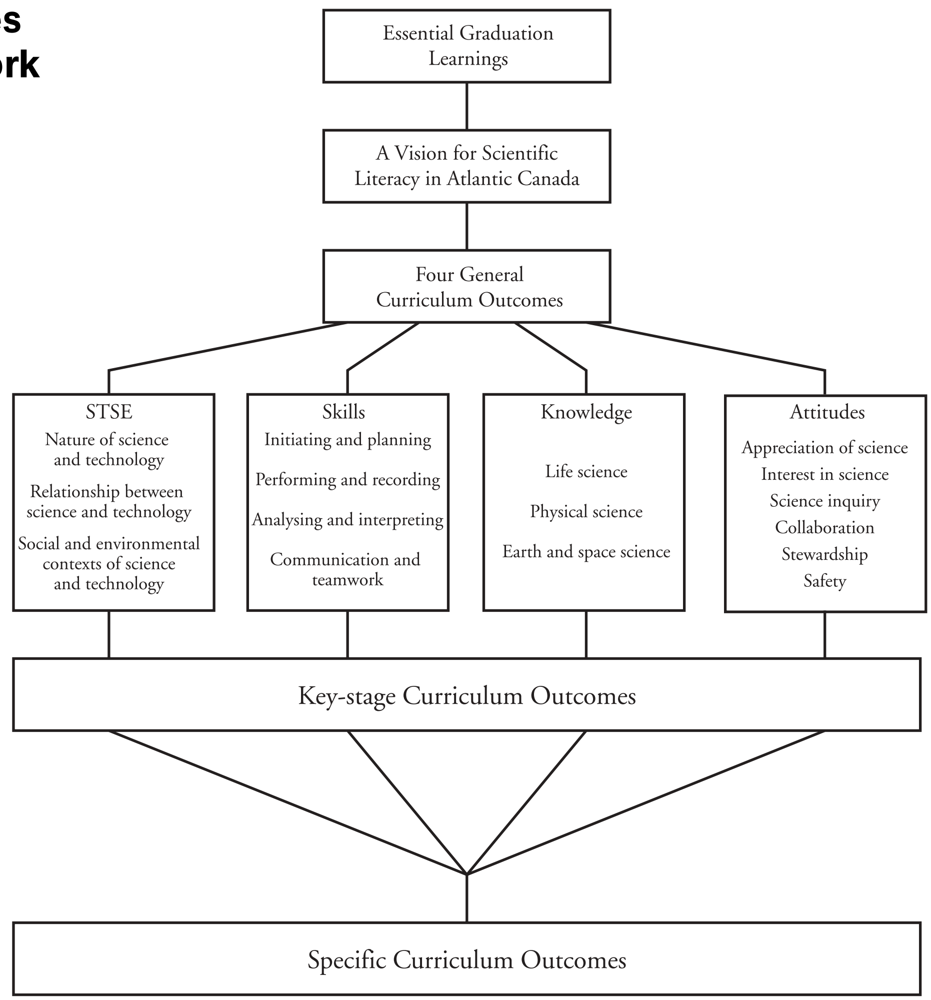
The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When assessing student progress, it is helpful to know some activities/skills/actions that are associated with each process of science learning. Student learning 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*. The diagram below provides the blueprint of the outcomes framework.

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 to 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:

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

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 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 for Science Learning Outcomes K–12*.

Specific Curriculum 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 assisting students to achieve the key-stage curriculum outcomes, the general curriculum outcomes, and ultimately, the essential graduation learnings.

Specific curriculum outcomes are organized in units for each grade level.

Attitude 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 sections 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 a 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.

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

From grades 10 to 12 it is expected that students will be encouraged to . . .

Appreciation of science

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 an STSE issue
- 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

Interest in science

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

Scientific inquiry

442 confidently evaluate evidence and consider alternative perspectives, ideas, and explanations

443 use factual information and rational explanations when analysing 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

Common Framework of Science Learning Outcomes K to 12
Attitude Outcome Statements

For grades 10 to 12 it is expected that students will be encouraged to . . .

Collaboration

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 and consider diverse perspectives
- accept constructive criticism when sharing their ideas or points of view
- criticize the ideas of their peers without criticizing the persons
- evaluate the ideas of others objectively
- 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

Stewardship

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

Safety

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 materials that are 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 like cuts, burns, or unusual reactions
- keep the work station uncluttered, with only appropriate lab materials present

Curriculum Guide Organization

Specific curriculum outcomes are organized in 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 may introduce a concept that is then extended in a subsequent unit. Likewise, one unit may 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 may 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, and/or 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 will understand 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-Environment (STSE) outcomes
200s—Skills outcomes
300s—Knowledge outcomes
400s—Attitude outcomes (see pages 12–14)

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

The Four-Column Spread

All units have a two-page layout of four columns as illustrated below. In some cases, the four-column spread continues to the next two-page layout. Outcomes are grouped by a topic indicated at the top of the left page.

Two-Page, Four-Column Spread

CURRICULUM OUTCOMES

Interactions within Ecosystems: Components of an Ecosystem

Outcomes

Students will be expected to

- identify, delimit, and investigate questions related to a local ecosystem (208-2, 208-3)
- use instruments effectively and accurately to investigate components of an ecosystem (209-3)
- organize and record data collected in an investigation of an ecosystem (209-4)
- describe interactions between biotic and abiotic factors in an ecosystem (306-3)
- identify the roles of producers, consumers, and decomposers in a local ecosystem and describe both their diversity and their interactions (304-2)
- classify organisms as producers, consumers, and decomposers (210-1)

Elaborations—Strategies for Learning and Teaching

Questions directed to vhe students concerning local habitats and the changes or proposed changes to them can elicit interest and discussion at the beginning of the unit of study—questions, such as "What do you think will happen to the wildlife in an area if a baseball field is built?" or "What kinds of animals would a community attract if a proposed landfill site were built?"

Students should develop questions to investigate, such as "What types of species live in a particular ecosystem?" Students have investigated and studied components and elementary relationships of and in ecosystems in grades 4 and 6. A K-W-L (What I Know–Want to Learn–Learned) chart can be started. With this approach, previous knowledge and understanding can be assessed and areas of common interests can be identified.

Students will need to visit a local habitat in order to make observations. They may visit an area that is or is going to be modified in order to gain an appreciation of how changes might affect the ecosystem.

At this level, activities exploring the interactions and the environment should be limited to the following physical or abiotic factors in the environment: temperature, moisture, light, aeration, and salinity. A class discussion of the area and a visit to the area will permit the students to observe and note what is there. Students can use instruments such as magnifying glasses, field binoculars, and hand-held microscopes to closely observe organisms in the ecosystem. Students can use thermometers to compare temperatures at different locations in the area being investigated. Light meters can also be used by some students to investigate any differences in light intensities. Upon return to class, students can attempt to classify the features and components of the ecosystem they observed which may lead to an emergent understanding of the biotic and abiotic factors in the area studied.

By discussing the roles and the needs of the living things identified in the ecosystem, students can extend their understanding of the roles and relationships among the producers, consumers, and decomposers. Students should know that one of the most important roles green plants have in any ecosystem is that of being a food (energy) source for consumers and decomposers. The process of photosynthesis can be explored by placing seedlings in light and darkness for several days to see the effect light has on plants. Glass containers can be placed on small plants to view the transpired water condensed on the inside of the glass. Small squares of cardboard or aluminium foil can be carefully attached to both sides of a leaf on a plant and removed several days later to observe its effects.

20 ATLANTIC CANADA SCIENCE CURRICULUM: GRADE 7

CURRICULUM OUTCOMES

Interactions within Ecosystems: Components of an Ecosystem

Tasks for Instruction and/or Assessment

Observation

- Does the student use the instrument for collecting data (e.g., magnifying glass) appropriately and safely? (209-3)

Journal

- The thing that surprised me the most when I visited our ecosystem was ... (304-2, 306-3)
- Two questions I would like to investigate related to my local ecosystem are ... (208-2, 208-3)

Paper and Pencil

- Explain what might happen to plants if the atmosphere were to be polluted by dust from a major volcano eruption or air pollution. (306-3)
- Choose a biotic factor and an abiotic factor and describe their interaction. (306-3)
- How do you interact with biotic and abiotic factors in your environment? Think of how you affect biotic and abiotic factors in your environment. (306-3)
- Draw/sketch a particular ecosystem and note some of the interactions that take place. (306-3)
- Personify an abiotic factor and describe its possible interactions with other abiotic and biotic factors (creative writing). (306-3)
- Create a classified list of organisms from your field study and describe how the organisms interact in the ecosystem. (209-4, 210-1, 304-2)

Interview

- Is soil necessary for plant growth? Explain your answer. (306-3)

Presentation

- Work in small groups to create a bulletin-board display to show how abiotic factors affect living things. (306-3)

Resources/Notes

ATLANTIC CANADA SCIENCE CURRICULUM: GRADE 7 21

Column One: Outcomes

The first column provides the specific curriculum outcomes. These are based on the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*. The statements involve the Science-Technology-Society-Environment (STSE), skills, and knowledge outcomes indicated by the outcome number(s) that appears in parenthesis after the outcome. Some STSE and skills outcomes have been written in a context that shows how these outcomes should be addressed.

Specific curriculum outcomes have been grouped by topic. Other groupings of outcomes are possible and in some cases may be necessary to take advantage of local situations. The grouping of outcomes provides a suggested teaching sequence. Teachers may prefer to plan their own teaching sequence to meet the learning needs of their students.

Column One and Column Two define what students are expected to learn, and be able to do.

Column Two: Elaborations—Strategies for Learning and Teaching

The second column may include elaborations of outcomes listed in column one, and describes learning environments and experiences that will support students' learning.

The strategies in this column are intended to provide a holistic approach to instruction. In some cases, they address a single outcome; in other cases, they address a group of outcomes.

Column Three: Tasks for Instruction and/or Assessment

The third column provides suggestions for ways that students' achievement of the outcomes could be assessed. These suggestions reflect a variety of assessment techniques and materials that include, but are not limited to, informal/formal observation, performance, journal, interview, paper and pencil, presentation, and portfolio. Some assessment tasks may be used to assess student learning in relation to a single outcome, others to assess student learning in relation to several outcomes. The assessment item identifies the outcome(s) addressed by the outcome number in brackets after the item.

Column Four: Resources/ Notes

This column provides an opportunity for teachers to make note of useful resources.

Although Science 10 (Nelson) is the text that is primarily referred in the column, teachers are encourage to seek other resources to help address a particular outcome.

All audiovisual movies stated can be obtained through Instructional Resources, New Brunswick Department of Education.

Grade 10 Science: Introduction

As with science curriculum at other grades, this consists of four units: one Life science, one Earth and Space science, and two Physical science units. The Common Framework of Science Learning Outcomes considered this to be the final science course that all students would be expected to follow. It is intended to help students prepare for selecting optional science courses at high school.

It is suggested that each unit be allocated approximately one quarter of the time available for the course.

Life Science: Sustainability of Ecosystems

This unit extends the concepts gained by analysing habitats and ecosystems to the issue of sustainability. The learners are challenged to think about large-scale systems and the flow of matter and energy within those systems. It is intended that students recognize the earth as essentially a closed system, which means sustainable use of resources becomes a major concern.

Earth and Space Science:

This unit is designed to guide the learner to understand major concepts associated with atmospheric conditions that produce our weather. Students may construct weather data collection instruments and collect, analyse, and interpret their data, as well as those from a variety of other sources. The influence of matter and energy exchanges on weather system development is central to the unit. Students are also encouraged to attempt weather forecasting and consider how weather affects our society.

Physical Science: Chemical Reactions

This unit builds on the previous study of atomic structure and the significance of the periodic table by asking students to observe some chemical reactions. How these reactions are initiated and proceed, and what products result are considered. In preparation for later chemistry courses, these investigations require students to name and write formulas and to begin representing chemical reactions in symbolic form.

Physical Science: Motion

This unit offers the first opportunity for students to observe, measure, and describe motion in a mathematical fashion. Analysis is restricted to one dimension only with uniform (constant) motion and uniformly accelerated motion. As the unit develops, direction becomes important with vector notation being introduced. The learning outcomes encourage a study of motion in contexts which are familiar to students in this age group.

Unit 1
Life Science:
Sustainability of Ecosystems

Unit Overview

Introduction

The focus on protecting the environment has grown substantially since the 1950s. Many would argue that not only is the focus too late, but it is not nearly enough to reverse the damage caused by the spend now/pay later attitude which has been so prevalent in our society. Owing 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/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 which 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 understand the interrelationship of local ecosystems, our increasing awareness of ecosystems on a global scale, and the need to sustain the health of ecosystems at all levels.

Focus and Content

Many outcomes can be accomplished by using a decision-making focus, thereby moving students to think globally at a more sophisticated level, and to explore the concept of sustainability for the first time. Activities in the unit also provide an opportunity to focus on observation/inquiry. The local environment and economy may be conducive to an extensive ecosystem study. Time allocated for this unit will greatly affect the depth and scope of investigation. A spring or autumn time frame might be best for field work.

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" and "Air and Water in the Environment," "Exploring Soils" and "Habitats and Communities." "Diversity of Life" in grade 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 grade 7 "Interactions within Ecosystems" unit. This unit concentrates on the flow of energy and matter through food webs in observable ecosystems. In grades 11/12 the optional courses provide Life Science opportunities in the units "Evolution," "Change and Diversity," and "Interactions Among Living Things." *Consider developing the connection between this unit and "Chemical Reactions"* and "*Weather Dynamics,"* also in grade 10.

Curriculum Outcomes

Students will be expected to

STSE

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 human invention of a technology

Social and Environmental Contexts of Science and Technology.
117-2 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 new 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

SKILLS

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

213-8 select and use apparatus and material safely

Analysing 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 science-related decision or issue

KNOWLEDGE

318-1 illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen, and oxygen

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 short-term stresses and long-term 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 analyse 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

Life Science: Sustainability of Ecosystems
How does sustainability fit into your paradigm and society's paradigm?

Outcomes

Students will be expected to

- explain how a paradigm shift can change scientific world views in understanding sustainability explore and develop a concept of sustainability (114-1)
- communicate questions, ideas, and intentions and receive, interpret, understand, support, and respond to the ideas of others with respect to environmental attitudes (215-1)

Elaboration – Strategies for Learning and Teaching

The notions of paradigm shift and change in environmental attitudes and values related to sustainability should be common themes throughout this unit.

Students should explore their own paradigms related to the environment. Through an introductory discussion, students can reflect on what they value about nature. 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 the economy one of growth and expansion at any environmental cost? Does this lead to sustainable practices? What are sustainable practices in your home? How do we know when they are present?

Paradigm shifts are rare and significant changes in the way humans view the world. They are major changes which 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 the revolutionary ideas that the earth is round not flat and that it rotates around the sun. Students can explore the concept of paradigm shifts through such activities as discussions, viewing videos, and role-playing. Several questions may be posed - Who is affected by a paradigm shift? How is the general public affected in the short and long term? Students can explore the possibility of their presently being in the midst of a paradigm shift related to the environment and sustainability. Has the old world view that the earth and all things on it exist for the sole benefit of humans changed? Has western civilization been created on the premise of the unlimited exploitation of the earth? Overall, has the focus shifted to environmental issues and concerns? Are we (individuals, provinces, countries, continents, global community) now shifting toward the concept of sustainability? Is the shift real or perceived?

Students can examine case studies (for example, Easter Island) of issues such as ocean dumping, resource management, and waste management that provide evidence of the effect of old world views, the paradigm shift that has occurred, and the government and business policies that reflect this shift.

Life Science: Sustainability of Ecosystems

How does sustainability fit into your paradigm and society's paradigm?

Tasks for Instruction and/or Assessment

Performance

Take part in a debate between two opposing world views on environmental issues. *This would demonstrate students' understanding of paradigm shift.* (114-1)

Journal

Reflect on a past paradigm (for example, resources are limitless) by considering the following questions: How is it possible that people thought this way? What factors contributed to this mind-set? Are there still large numbers in the general population that think this way? Why are we 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)

Presentation (114-1)

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

Portfolio

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 teacher. Suggestions for content are experimental results (write-ups, graphs, data, observations, for example), posters, illustrations, creative writing, videos, photos, group projects, reports, responses, critical thinking exercises, self-assessment, and so forth. 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 and/or practices that reflect that paradigm. Describe what has happened to cause the general public to shift their way of thinking. Evaluate the new ways people are thinking about sustainability. Do you think they are paradigms yet? Explain. (114-1, 215-1)

Resources

Science 10

- pages 10-13
  Sec 1.1 (114-1)
- pages 16-19
  Sec 1.3 (114-1)
- pages 20-21
  Sec 1.4 (215-1)

Many other opportunities to address outcome 215-1 exist in the text. Choose wisely or incorporate as a unit project.

AV

"Sustainable Development" NFB #704488, VH (114-1)

"Wolves..." Film W #705789, VH (215-1)
great complement to Sec 1.4

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem?

Outcomes

Students will be expected to

- explain biotic and abiotic factors which keep natural populations in equilibrium, and relate this equilibrium to the resource limits of an ecosystem (318-5)
- describe and apply classification systems and nomenclature with respect to trophic levels in ecosystems: (214-1)
  - classify organisms as producer, consumer, autotroph, heterotroph, decomposer, herbivore, carnivore, omnivore, saprobe
- describe the mechanisms of bioaccumulation, and explain its potential impact on the viability and diversity of consumers at all trophic levels (318-2)
- explain how biodiversity of an ecosystem contributes to its sustainability (318-6)
- illustrate the cycling of matter through biotic and abiotic components of an ecosystem by tracking carbon, nitrogen, and oxygen (318-1)
- plan changes to, predict the effects of, and analyse the impact of external factors on an ecosystem (331-6,213-8, 212-4)

Elaboration – Strategies for Learning and Teaching

Ideally, an in-depth study of a local ecosystem (pond, lake, tidal pool, field, forest) may be undertaken to collect data. The selected ecosystem can be used for the topic of a public meeting discussed later in this unit. However, students may be able to observe an ecosystem, its components and interactions, by creating an ecosystem of their own.

As an alternative to a field study, students can construct their own ecosystem, using jars or pop bottles. The construction of a model ecosystem would focus the study on either terrestrial or aquatic. (An aquatic ecosystem allows for microscope work, if this is a priority). In constructing these ecosystems, there should be some student decision making: What type of organisms need to be included and why? What makes a system sustainable? Why is biodiversity important? Computer simulations can also illustrate the basic components and interactions in an ecosystem.

Regardless of the ecosystem chosen, many fundamental aspects of an ecosystem have to be examined for further development throughout this unit. There should be an examination of abiotic factors (space, temperature, oxygen, light, water) and biotic factors (disease, reproductive rates, predator/prey, competition, symbiosis). Additionally, classification of organisms into trophic levels, bioaccumulation , resource limits, impact of external factors, importance of biodiversity to an ecosystem, flow of energy, and cycling of materials should be included. In some cases, this may involve a review of some of these topics previously dealt with in grade 7. (D.D.T. and the osprey would be an excellent example of bioaccumulation effects.)

After researching the pathways along which energy and matter flow through ecosystems, students should diagram the cycling of carbon, nitrogen, and oxygen in their ecosystem. Have students identify the resource limits of the constructed ecosystem. If an open system is also considered, the resource limits of the open system can be compared to those of a closed system.

Pose questions that require students to predict the effects of external factors on the ecosystem. For example, predict the effect of sulphur being burned inside the closed ecosystem. Have students simulate acid rain, and the effects of sulphur, by burning sulphur in a deflagrating spoon within their own ecosystem. *Note: link to chemistry and weather units*

Life Science: Sustainability of Ecosystems

What are the factors affecting the sustainability of an ecosystem?

Tasks for Instruction and/or Assessment

Journal

Write a biography or diary of an organism that exists in the studied ecosystem. (318-6)

How is the balance of nature affected by the influence of human activity on bio-geochemical cycles? (331-6, 318-1)

Presentation

Present your analysis of the data gathered by your group from the ecosystem exploration. This may be done either orally or videotaped on-site. Each member of the group is responsible for a different aspect of the study for presentation (for example, biotic factors, abiotic factors, human impact, biodiversity). Ensure you address the sustainability of your ecosystem. Is it sustainable? How do you know? (331-6), (318-5), (318-6)

Illustrate a food web or nutrient cycles that exist in the ecosystem, in poster or other form. (214-1, 318-1, 318-2)

Resources

Science 10

- pages 22-23
  Sec. 1.5 (318-5)
- pages 24-26
  Sec 1.6
  or
  pages 30-31
  Sec 1.9 (318-5)
- pages 32-39
  Sec 1.10 and Sec 1.11
  (214-1)
- some of pages 40-41
  (214-1)
- pages 42-45
  Sec 1.12
  (318-06, 331-6, 213-8, 212-4)
- pages 146-147 (318-6)
  *using a marine ecosystem example
- pages 52-57
  Sec 2.2 (318-2)
- pages 50-51
  Sec 2.1 and
  pages 62-67
  Sec 2.5 and 2.6 (318-1)
  *Do quickly
- pages 70-73
  Sec 2.7 and 2.8
  (318-1, 331-6, 213-8, 212-4)
- Work the Web p. 44 to help cover 318-6, 331-6, 213-8, 212-4

AV

"Biology Fieldwork" parts 1 and 2, Martin #705336, VH, #705337, VH (318-5)

"Ecosystems and Biosphere", Majic #705448, VH (318-1, 331-6, 213-8, 212-4)

"Threats to Biodiversity", Kinetic #705392, VH (318-6)

Life Science: Sustainability of Ecosystems
Sustainability Issues in an Ecosystem

Outcomes

Students will be expected to

- analyse the impact of external factors on the ecosystem (331-6)
- explain why the ecosystem may respond differently to short-term stress and long-term change (318-4)
- select, compile, and display evidence and information from various sources, in different formats, to support a given view in a presentation about ecosystem change (214-3, 213-7)
- communicate questions, ideas, and intentions, and receive, interpret, understand, support, and respond to the ideas of others in preparing a report about ecosystem change (215-1)

Elaboration – Strategies for Learning and Teaching

An ecosystem which is significant to your community should 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 can serve as the vehicle to reach the outcomes.

Choose a project that will affect the ecosystem, such as the construction of a new highway, an electrical transmission line, a gas pipeline, a shopping mall, a residential subdivision, an alternative agricultural use, or an 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 ameliorate this impact.

Determine what defines short-term stress; for example, seasonal peaks in temperature and water supply have sudden but limited human impact.

Determine long-term change; for example, climate change, permanent human influence, infestation by foreign flora and fauna.

Challenge students to define the critical questions and issues, conduct research into the present conditions and potential impact, and marshal evidence in order to support a given interest group. By role-playing in 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 severely impacted may enable students to assess the impact on the sustainability of an ecosystem.

Students can examine actual reports from public meetings or Environmental Impact Assessments (EIA) on local issues. Resource people from various interest groups can be interviewed. Students can also apply to make a presentation at a local public meeting about an environmental issue.

Life Science: Sustainability of Ecosystems
Sustainability Issues in an Ecosystem

Tasks for Instruction and/or Assessment

Journal

Think about the ecosystem you are going to study. What things do you value about it? What would you hate to see disappear or destroyed? (215-1)

Record your experience with, and reaction to, the public meeting process. (215-1)

Presentation

You must will be participating in a simulated public meeting. Ensure that you have gathered the necessary evidence to support your point of view. *This would be reviewed by panels of peers and a report would be written by presenters and by each panel. A rating scale could be used to mark the presentation. A student's mark may be composed of two parts- the presentation and panel report.* (331-6, 318-4, 214-3, 213-7)

Resources

Science 10

These outcomes are better addressed via a project or "challenge".

- Forestry Project pages 114-120

or

- Fisheries Project pages 150-153

or

- Agriculture Project pages 150-153 including "Work the Web" page 113

or

- Challenge # 1 page 158 (218-4, 214-3, 213-7, 215-1)

AV

"Athabasca - Case Study", Access #703209, VH

Can serve as a starting point for a project (318-4, 214-3, 213-7, 215-1)

Life Science: Sustainability of Ecosystems
Extension to the biosphere.

Outcomes

Students will be expected to

- describe how soil composition and fertility can be altered and how these changes could affect an ecosystem (331-7)
- compare the risks and benefits to the biosphere of applying new scientific knowledge and technology to industrial processes (118-1)
- explain why ecosystems with similar characteristic can exist in different geographical locations (318-3)
- describe how Canadian research projects in environmental science and technology are funded (117-3)
- propose and defend a course of action on a multi-perspective social issue (118-9, 215-4, 118-5)
- describe the role peer review has in the development of scientific knowledge (114-5)

Elaboration – Strategies for Learning and Teaching

The context for this cluster of outcomes may be an issue which has social/economic importance and is global in nature .The focus is intended to emphasize the shift in environmental attitudes and thinking towards 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 acquaculture.

As the world's population grows, there is an increasing demand for food on our agricultural systems. Students should be able to describe how soil composition and fertility can be altered to increase crop yield. This can be a springboard to begin discussions on the risks and benefits of scientific and technological advancements for the food production industry and the world.

Students should predict the improper use of natural and synthetic fertilizers that may cause detrimental effects on the ecosystem. Students can examine case studies which present the technological, environmental, and economic advantages and disadvantages of food production industries (for example, fish farming) and resource-based industries such as forestry and mining.

The studies should include an investigation of the aquaculture industry in other countries (Norway, Scotland, Chile, for example). Students should examine the environmental factors that exist in the different countries to see why the same type of fish is farmed in geographical locations other than Atlantic Canada. Each study should consider why the environments are similar (for example, climate, water conditions, geographical features).

Students can examine the development of aquaculture projects from which the salmon farming industry grew. Questions to consider may 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 a business adopted responsibility for the project.

Students can participate in a debate or a simulated hearing about the introduction of a new, or the expansion of an existing, salmon farm. Students can represent or role-play fish farmers, local fishers, the town council, the chamber of commerce, environmental groups, and Depts. Of Fisheries/Environment.. Farming some varieties of shellfish is not new. The threat to stocks of other fish species has made farming these species viable. Students might research and present information about discussion in the scientific community regarding the viability of and support for farming certain types of fish. Consider the changes that take place in attitudes.

continued...

Life Science: Sustainability of Ecosystems

Extension to the biosphere.

Tasks for Instruction and/or Assessment

Journal

Record your perceptions and observations of a case study in resource management. (118-1, 116-1)

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. *Students may conclude that information on the Internet may not be reviewed by experts.* (114-5, 213-7)

Interview

Record an interview of a local scientist to discuss the importance of peer review in their studies of environmental issues. (114-5)

Presentation

Research a case study and present your findings in the form of a radio or television documentary about a significant environmental issue. (117-3, 118-5, 118-9)

Students could be assessed on their participation in a debate or group project. Checklists, observation records, self-evaluation, and peer evaluation could assist in the evaluation. (118-9, 118-5, 215-4)

continued...

Resources

Science 10

- pages 97-99
  Sec 3.3 (331-7)
- pages 102-103
  Sec 3.5 (331-7)
- pages 106-110
  Sec 3.7 (118-1)
- pages 88-95
  Sec 3.1 and 3.2 (318-3)
  *Do quickly

Project ideas listed on page 27 will help address outcomes 118-9, 215-4, 118-5 and 116-1.

Website for National Science and Engineering Research Council of Canada http://www.nserc.ca can help address 117-3 and 114-5

AV

"Our Soil" NRCAN
#705745, VH (331-7)
"Jumping to Conclusions" THA
#703434, VH (114-5)

Life Science: Sustainability of Ecosystems
Extension to the biosphere (cont'd)

Outcomes

Students will be expected to

- identify examples where scientific understanding about an ecosystem was enhanced or revised as a result of human invention or related technologies (116-1)

Elaboration – Strategies for Learning and Teaching

Part of the debate about the efficacy of fish farming on a large scale is its impact on the surrounding environment with regard to artificial food supply, waste products settling from the cages, use of antibiotics, and the potential escape of transgenic stocks.

Through study of fish farm sites before and during operation, it becomes possible to assess the potential for bioaccumulation in local and global systems, and to estimate the carrying capacity of a system before harmful levels of bioaccumulation develop.

The economic drive to increase production through these facilities has led to improved technologies and the need to better understand development of various fish species. Have students research examples of improved science and technology that have developed from this context.

Life Science: Sustainability of Ecosystems
Extension to the biosphere (cont'd)

Tasks for Instruction and/or Assessment

Journal

Comment on a controversy surrounding the aquaculture industry. (116-1, 118-9)

Resources

See page 29 for 116-1

AV

"Fragile Harvest" NFB #702874, VH (116-1)

Unit 2
Earth and Space Science: Weather Dynamics

Unit Overview

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 because of weather conditions?”; “How are our lives affected by changing weather conditions (short-term) and changing climate (long-term)?”; and “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 may cause significant snow melt; clear and dry weather in summer raises the risk of grassland/forest fires; autumn sees the arrival of storms from the Caribbean; 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

By considering questions that you and your students generate, various learning and assessment activities will meet specific curriculum outcomes. Although this unit focusses on decision making, there are opportunities for observation and inquiry as well as problem solving and design technology. Sections in the unit ask students to consider heat energy and its transfer, energy exchange within and between systems, and to observe weather data and the impact of weather forecasting.

Curriculum Links

“Weather Dynamics” connects with other clusters across many grade levels, such as “Daily and Seasonal Change” (grade 1); “Air and Water in the Environment” (grade 2); “Weather” (grade 5), which includes the water cycle, changes in air caused by heating, and patterns of change in local conditions. “Heat” (grade 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” (grade 8) links ocean currents to regional climates and the influence of polar icecaps. This unit will support optional studies in grades 11-12 such as Life Science: “Interaction of Living Things”; Chemistry: “Thermochemistry”; Physics: “Force, Motion, Work,” “Energy, Momentum, and Waves”; Earth and Space Science: “Earth Systems and Processes.”

Prior to grade 10, students have also considered weather and climate in our region through the social studies curriculum introduced in 1998.

Curriculum Outcomes

Students will be expected to

STSE

Nature of Science and Technology

114-6 relate personal activities and various scientific and technological endeavours to specific science disciplines and interdisciplinary studies

115-2 illustrate how science attempts to explain natural phenomena

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 analyse 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 analyse 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

SKILLS

Initiating and Planning

212-1 identify questions to investigate that arise from practical problems and issues

Performing and Recording

213-2 carry out procedures controlling variables and adapting or extending procedures where required

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

Analysing 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 the 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

KNOWLEDGE

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

331-4 describe and explain the effects of heat transfer within the hydrosphere and atmosphere on the development, severity, and movement of weather systems

331-5 analyse meteorological data for a given time span and predict future weather conditions, using appropriate methodologies and technologies

Earth and Space Science: Weather Dynamics

How are changes in the hydrosphere and atmosphere observed and measured?

Outcomes

Students will be expected to

- relate personal activities and technology used with meteorology in the design of a weather station (114-6)
- identify questions to investigate that arise from the operation and findings of the weather station (212-1)
- use weather instruments effectively and accurately for collecting local weather data (213-3)
- use print and electronic sources to collect weather data from regional and national weather observational networks (213-6, 213-7)
- analyze meteorological data for a given time span and predict future weather conditions, using appropriate technologies and methodologies (331-5)

Elaboration – Strategies for Learning and Teaching

To frame students' thinking about this unit, they may work in groups to develop concept maps about weather and climate. Individually, have them prepare a "Know - Want to know- have Learned" (KWL) chart about weather and its influence on society.

These outcomes will be attained throughout this unit. Students will collect weather data early in the unit, but will make interpretations or predictions later.

Students can 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, level of precipitation. If feasible at the school, students should become confident in using available equipment to measure and record data.

Students can 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. Later in the unit, activities that investigate heat flow in gases and liquids and the effect of heat on matter will help students understand the causes of the weather changes they observe.

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. Students may use this evidence to form conclusions about and explain large scale heat energy transfer within the atmosphere. It should also be possible to see how large bodies of water influence weather patterns that pass across them.

Earth and Space Science: Weather Dynamics

How are changes in the hydrosphere and atmosphere observed and measured?

Tasks for Instruction and/or Assessment

Paper and Pencil

Form student groups and assign the following: 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 allow comparisons over the time period. Compare the record of your group with that presented by local newspaper/radio/t.v. reports. Assess the process to organize data collection, graphical presentation, and the way in which the comparison was made. (331-5)

Presentation

Produce a weather chart similar to this example: weather feature (wind velocity); measuring instrument (anemometer); recorded data (50 km/h, from west); date. Assessment will include the style, clarity, accuracy, and completeness.

Your group is to present the comparison of data from the previous exercise. It is important that you illustrate the developing patterns through the five-day period. Assess the quality of report findings, comparisons made, and if students appreciate that readings from a given location illustrate the dynamic nature of weather patterns. (114-6, 331-5)

Interview

The assessment used in the above Presentation can also be achieved by interviewing student(s). This allows dialogue to clarify uncertainties. (214-3, 331-2)

Portfolio

Describe how changes in air density and air pressure cause movement of weather systems. (212-1)

Resources

Science 10

A project on building a weather station that measures weather using thermometers, hydrometer, barometer, anemoneter and rain gauge will address 114-6, 212-1, 213-3-331-5

- Challenge 1 page 650 will help.
- Supplemental materials in TR will be available.
- pages 546-548 Sec 14.2 (213-6, 213-7)
- pages 550-551 Sec 14.3 (213-6, 213-7)

AV

"Meteorology", VEC #703612, VH (213-3, 331-5)

Earth and Space Science: Weather Dynamics

What energy source drives the Water Cycle?

Outcomes

Students will be expected to

- identify questions to investigate that arise from considering the energy transferred within the water cycle (212-1)
- describe examples that illustrate that the atmosphere and hydrosphere are heat sinks in the water cycle (331-3)
- explain how scientific knowledge evolves about changing weather patterns with new evidence about changes in ocean temperature (115-6)
- conduct experiments to compare the specific heats of common earth materials, and draw conclusions about the effect of solar radiation on water and land surfaces (213-2, 214-11)

Elaboration – Strategies for Learning and Teaching

Students' questions about energy and the water cycle should generate investigations. Discussion in small groups can be summarized in graphical ways such as concept maps. Included may be questions such as

How does the water cycle influence the seasonal high/low temperatures for inland and coastal communities?

Why is the arrival of a snowstorm normally linked to a rise in air temperature? How and why do clouds form?

Why does it rain or snow?

What mutual interactions occur between the atmosphere and large bodies of water such as the ocean or lakes?

Groups of students can research and present for discussion possible explanations for the questions generated by the above activity.

The hydrosphere is a heat sink, and the energy stored in the ocean influences many systems. There are examples of this influence in our region. Students may choose to identify and explain examples of new knowledge in such areas as changing fish stocks in given areas, the timing and routes of wildlife migrations, possible cash crops grown in microclimates, patterns of coastal erosion, transport in "iceberg alley," airborne pollution and its effects. 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.

Once students are comfortable with the concept of heat sink, challenge them to relate this property to their previous 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. Students should recognize the significant heat storage by water, caused by its high value of specific heat, and how this heat energy is transferred between the hydrosphere and atmosphere.

continued...

Earth and Space Science: Weather Dynamics
What energy source drives the Water Cycle?

Tasks for Instruction and/or Assessment

Students should consider how to estimate the specific heat of air, water, sand, and soil by heat absorption techniques (*analysis of precise calorimetry is too difficult at this stage but ensure the high value of specific heat for water is recognized*).

Performance
Once the experiments have been designed and the intentions declared, there is an opportunity for assessing how students actually perform the intended activity. Do they follow the plan, use correct techniques, and work safely in estimating specific heat values? (214-3, 214-11)

Journal
Enter in your journal two concepts you have learned about energy exchanges that take place during the water cycle. 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? (212-1)

Paper and Pencil
You have seen a video that describes cloud formation and how lakes and oceans are sources of water vapour. From the notes you made, identify the important factors in cloud formation.

Describe an investigation that tests the assumptions made in the video about each of these factors. (212-1)

Interview
As students plan experiments to find specific heat capacities, interview them about their plans and how they intend to measure identified variables. Look for understanding of the tasks, clarity of thought, and creative ways to solve practical problems. (214-10)

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.

Present the data and conclusions of your specific heat / heat absorption experiments. Explain why you made certain decisions in planning and conducting the experiment. Ask other groups to offer improvements in your design and data collection and add them to your notes. (212.1, 214-3, 214-11)

Portfolio
As this is a significant activity, encourage students to select materials from their presentation as a record of the practical achievements. Have them give reasons for their selections. (214-3, 214-11)

continued...

Resources

Science 10
- pages 32-33
  Sec 1.10 (212-1)
- The water cycle can be done by understanding
  - Evaporation (pages 501 and 535
  - Condensation (pages 530-534)
  - Precipitation (pages 556-557)

  (212-1)
- pages 522-5247
  Sec 13.8 (212-1, 331-3)
- pages 612-615 and page 526
  Sec 15.12 (115-6)
- Supplemental materials from TR will need to be done to fully cover 213-2 and 214-11

AV
"Hydrologic Cycle", FILMID #704617, VH (212-1, 331-3)

Earth and Space Science: Weather Dynamics
What energy source drives the Water Cycle? (cont'd)

Outcomes

Students will be expected to

- discuss the design of experiments that compare the magnitude of the specific heat for water with that of its latent heat of fusion and vaporization (214-3)
- identify and explain the uncertainties in measurement and express them in a form that acknowledges the degree of uncertainty (214-10)
- using scientific theory, illustrate and explain heat energy transfers that occur in the water cycle (115-2, 331-1)
- compile and display data, using these to support conclusions, from experiments which investigate heat energy storage by, and heat exchange between, water and air masses (214-3, 214-11)

Elaboration – Strategies for Learning and Teaching

Teachers should emphasize that latent heat values exceed the value of specific heat for a given material. It is the THINKING process rather than the performance of extending the practical challenge which is important here. Use guided discussion to design experiments which can "estimate" values of latent heat (fusion and vaporization), thus allowing comparison with specific heat. Encourage students to solve the challenge of estimating the magnitude of the heat energy. During change of state, the factors to consider include source of heat energy, rate of supply, minimizing heat exchange with surroundings, equipment to be used, and that evidence showing temperature remains constant. The discussion should be open-ended *(numerical analysis of this calorimetry is NOT expected or required)*.

With guidance, encourage students to plan and run these experiments in order to determine specific heat. Students should consider their experimental technique in order to refine the accuracy of information obtained. They should investigate factors such as type of container for test materials (shape, colour, material), mass, surface area, closed container, open container, air conditions surrounding the container (still or moving). Have students assess the accuracy of measurement possible with the experimental technique used.

Demonstrate the significant difference in energy between specific heat for water and its latent heat. In qualitative terms, encourage students to recognize the importance of fusion, condensation, and vaporization in the water cycle and its influence on weather.

Ask students to explain examples of weather-related phenomena which are large-scale illustrations of heat storage through specific heat capacity and latent heat (of water), such as

(I) fog formed by warm moist air over snow cover

(II) fog formed by cold air over warm lakes/the sea

(III) cloud formation in the atmosphere with condensation into rain or freezing into ice/snow

Encourage students to compare heat storage/exchange data measured in their controlled, small-scale experiments to those quantities estimated to be in naturally occurring, large-scale weather systems.

By observing how weather patterns change as they pass over large bodies of water, and having access to values of water temperature, students can make some conclusions about heat exchange within bodies of water, their effects on currents, and the magnitude of heat exchanges between bodies of water and the air above them.

Earth and Space Science: Weather Dynamics

What energy source drives the Water Cycle? (cont'd)

Tasks for Instruction and/or Assessment

Paper and Pencil

Write a paragraph (200 words maximum), an autobiographical account of a water molecule, together with its "friends," as it experiences a phase change in the water cycle. Teachers can assess either/both the creative writing and/or the understanding of energy exchanges at both molecular and macroscopic levels. (115-2)

Presentation

Your group will prepare and present to the class a demonstration/description that connects a concept of physics (for example, heat, latent heat, density, pressure) and a weather phenomenon. These might include dew point, change of state, pressure gradient, humidity, and formation of precipitation. Assessment will be based on the parameters given, preparation of materials, creative use of equipment, type of medium, understanding of concepts. (115-2)

Portfolio

Develop a written essay or a photo-essay to describe a significant example you have experienced of the connection between water cycle (phase change) and a weather phenomenon. (115-2)

Resources

Science 10

- 214-3 and 214-10 will be addressed in Supplemental Materials in TR
- pages 504-507
  Sec 13.2 (115-2, 331-1)
- pages 530-533
  Sec 13.11 (115-2, 331-1)
- pages 536-537
  Sec 13.13 (214-3, 214-11)

AV

"Earth Essentials - Chaos", KINECTIC #705414, VH (115-2, 331-1, 214-3, 214-11)

Earth and Space Science: Weather Dynamics

Heat energy, its transfer, and Weather Dynamics - is there a Connection?

Outcomes

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 (214-3, 331-2)
- select and integrate information about weather from a variety of sources. Compile and display this information to illustrate a particular hypothesis about weather in the Atlantic region (213-7, 214-3, 215-5)
- illustrate how science attempts to explain seasonal changes and variations in weather patterns for a given location (115-2)

Elaboration – 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 (trade winds, westerlies, and so on) and water currents cause these heat transfers.

Students should use various sources of information-anecdotal, print and electronic-in order to make brief presentations on specific examples of notable weather events. It is important that students are able to relate these historical accounts to the concept of energy exchanges within the systems. Intense weather events have human or societal impact. The hypothesis might be the relationship between habitation patterns in the region and weather patterns, or trends in sectors of the economy of our region and weather events.

Latitude of a location and incline of the earth's axis (in terms of incident solar radiation) play a major role in seasonal change. Students may better appreciate these effects if they design a three- dimensional model and use it to illustrate these effects (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. (An extension activity might compare the average solar radiation density incident to a specific area, on a given latitude and date. Have student groups model this comparison by using the energy from the flashlight incident to a measured area of the globe for other locations in the world such as those listed above.) This activity promotes an appreciation of seasonal changes across the globe, the skill of estimating, and the assumptions that limit the accuracy of calculations.

The consequences of these differences should contribute to students' understanding of 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 motion of air currents relative to the rotation of the earth (Coriolis Effect).

Earth and Space Science: Weather Dynamics

Heat energy, its transfer, and Weather Dynamics - is there a Connection?

Tasks for Instruction and/or Assessment

Paper and Pencil

Write a poem or song to describe how atmospheric temperature and pressure differences cause the "Trade Winds."

In prose or poetry, write a brief description of seasonal change and relate it to the sun's energy. (115-2)

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. The presentation will be assessed for clarity, accuracy, and delivery in the allotted time.

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/ball at various locations. Consider

a) daily changes with globe axis fixed
b) seasonal changes with change in globe axis

Assessment will include the competency of the explanation, clarity of the concept, and appreciation for limitations of the model.

Use models (print, three-dimensional) and/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. (214-3, 331-2, 115,2)

Portfolio

Design a "Weather Dynamics - Heat Transfer" concept map for your portfolio. Explain how this map improves your understanding of the topic.

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. (214-3, 331-2, 115-2, 115-6)

Resources

Science 10

- ocean currents
  pages 525-527
  Sec 13.9
  wind currents
  pages 516-517
  Sec 13.6
  (214-3, 331-2)

- Outcomes 213-7, 214-3, 215-5 are addressed in TR supplemental materials

  however

  pages 553-555
  Sec 14.4
  and
  pages 632-633
  Sec 16.5 can help

- pages 508-509
  Sec 13.3 (115-2)

AV

"The Sun - Weather Maker", Magic #705390, VH (214-3, 331-2, 115-2)

"Maritime Climate", Martin #704092, VH (213-7, 214-3, 215-5)

Earth and Space Science: Weather Dynamics

What is the evidence for movement of heat energy and matter in global systems?

Outcomes

Students will be expected to

- using scientific theory, describe and explain heat transfer and its consequences in both the atmosphere and hydrosphere, relating this science to natural phenomena (115-2, 331-2)
- describe and explain the effects of heat transfer on the development, severity, and movement of weather systems (331-4)
- describe weather satellite imaging, its benefits to society, and Canada's contribution to this technology (117-10)

Elaboration – Strategies for Learning and Teaching

To better appreciate heat flow and its consequences, students should experiment with various activities designed to illustrate heat flow (convection, conduction, and radiation) through gases and liquids. These will illustrate movement of energy and account for density and pressure changes that lead to the movement of air masses over the surface of the earth. Have students identify and describe the principal characteristics of layers found in the atmosphere, particularly the lower layers. The identity and distribution of common gases (oxygen, nitrogen, water vapour, carbon dioxide) should be included. Investigating the relationship between altitude, temperature, and atmospheric pressure will help students understand weather patterns and changes.

Student groups can research, prepare, and present demonstrations of radiation, conduction, and convection as each applies to one or more of the following:

- movement of heat energy
- unique micro-climates at high altitudes
- the effect of atmospheric pressure on air movement, transfer of weather systems, transfer of airborne pollution
- consequences in the atmosphere of ash from volcanoes and smoke from large forest fires
- welling up/down of ocean water, its impact on krill population (which are vital to ocean food chains), the effect of water temperature and breeding of fish stocks, and the supply of heat energy and water vapour to drive the water cycle
- comparing the four major air masses (tropical, polar, maritime, and continental)
- development of low-pressure systems at mid-latitudes and their associated weather fronts
- development of high-pressure systems and the associated weather patterns

It is important that all students develop a basic understanding of satellite imaging, and the importance of timely and accurate information. This understanding will help them to 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 should identify how imaging technology has improved decision making about projects in which weather systems can have significant economic impact.

Earth and Space Science: Weather Dynamics

What is the evidence for movement of heat energy and matter in global systems?

Tasks for Instruction and/or Assessment

Observation

Having assigned the presentation below, if class time is given for its development, the teacher could select some groups and observe their research and design skills for the exercise. (115-2, 331-2, 331-4)

Journal

Write a journal entry that summarizes what new concepts you have learned in this section. Complete the following introduction: (a) I now realize other people respond to weather conditions differently because... (b) I am a carbon dioxide molecule in the air in Boston; tomorrow I might be in (_________) because... (115-2, 331-2, 331-4)

Paper and Pencil

Give students a sequence of weather satellite images for our region. Study the sequence of satellite images provided, complete one of the following, and give reasons for your conclusions:

- Describe the weather conditions at the indicated locations.
- On the blank map indicate the cloud conditions you would expect to see six hours later.
- As a farmer-fisher-forester suggest what are the positive-negative consequences of these images?
- As a sports or tourist director, what are the positive-negative consequences of these images?
- Write a brief autobiography of a nitrogen molecule in this weather system as it may be taken between the two indicated points.
- Write a brief autobiography of a jelly fish for the given location resulting from the weather shown in these images.

Prepare a brief article/flyer that explains the advantages of weather satellite technology compared to methods used in the mid 20th century. (117-10)

Presentation

With your partner, prepare a three-minute presentation on a selected example that relates heat/matter transfer and weather patterns. This may be presented directly to the class and/or made into a video format for a selected audience (adult, middle, or elementary grades).

This may be assessed for its content only, research and presentation process only, or both. Students should know this before the exercise. (115-2, 331-2,331-4)

Resources

Science 10

- pages 510-513 Sec 13.4 (115-2, 331-2)
- pages 546-549 Sec 14.2 (331-4)
- pages 567-569 Sec 14.9 (117-10)
- Work the Web page 570 (117-10)

AV

“Weather Systems” MCI #704342,VH (115-2, 331-2)

Earth and Space Science: Weather Dynamics
Accurate weather forecasting - What is its impact?

Outcomes

Students will be expected to

- Identify examples where improved data gathering technology has resulted in better understanding of weather systems and of forecasting. (116-1)
- Describe the impact of Canadian contributions to the field of meteorology. (117-10)
- Describe the limitations of scientific knowledge and technology in making predictions related to weather. (118-7)
- Relate both personal activities and scientific/ technological processes to weather and climate research and the application of the research. Identify why some activities tend to be individual or group oriented. (114-6, 117-6)
- Identify the impact of severe weather systems on economic, social and environmental conditions.(118-2)

Elaboration – Strategies for Learning and Teaching

Have students individually, or as groups, research a technology that has improved the collection and/or analysis of data related to weather forecasting. Such technologies might include Doppler Radar, infra red 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 such regions as the Rocky Mountains, the Arctic, and the Prairies.

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

The last four outcomes in this section allow students to 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 analyse its effects on a selected community. This can be presented as a written account, a photo/visual image essay, or perhaps as a "news" report.

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

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

Earth and Space Science: Weather Dynamics

Accurate weather forecasting - What is its impact?

Tasks for Instruction and/or Assessment

Observation

During a discussion intended to distinguish weather from climate, identify students who can clearly express their ideas and make the distinction. (214-2)

Performance

Show a group of younger students how to research information about a severe weather event, identifying the physical data and reports which indicate the social impact of the event. (118-2)

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 these?

If or when I move away from here, how will climate conditions influence my choice of where to live and work? (114-6, 118-2, 214-2)

Interview

Give one example of Canada's contribution to meteorology and how it benefits society.

Tell us one example that illustrates the limitations of predicting weather conditions. (117-10, 118-7)

Presentation

Your group will give a four-minute presentation about a technology that has improved the accuracy of weather forecasting. You may use a variety of media during the presentation. (214-2, 116-1)

Portfolio

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

Resources

Science 10

- pages 567-570
  Sec 14.9 (116-1)
- Outcomes 114-6, 117-6 and 118-7 will be covered if students performed weather station project. Look in TR supplemental materials.
- pages 580-607 contain many sections that can be used to cover 118-2. Choose carefully.

AV

"Living with Disasters"
NV Media
#703640, VH (118-2)

Unit 3
Physical Science:
Chemical Reactions

Unit Overview

Introduction

After students have developed an understanding of atomic structure and the periodic table in grade 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 emphasizes the social and environmental contexts of science and technology associated with air and water pollution, and should have a principal focus of observation and inquiry. However, there are opportunities for decision making as well as design technology in the laboratory 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 owing 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.

Curriculum Links

The study of chemical reactions in grade 10 connects readily with topics covered as early as grade 1 where students are introduced to materials and their senses, as well as in grade 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 grade 5 as properties and changes in materials are studied. By grade 7, students cover in some detail the concept of mixtures and solutions. As mentioned in the above paragraph, there are very strong links between the topics of atomic structure in grade 9 and the chemistry studied in grade 10. For those who pursue chemistry in grade 11 and 12, the material covered in grades 7, 9 and 10 offers 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

Students will be expected to

STSE

Nature of Science and Tech.
114-8 describe the usefulness of scientific nomenclature systems

Relationships between Science and Technology
116-3 identify examples where technologies were developed on the basis of scientific understanding

116-5 describe the functioning of domestic and industrial technologies, using scientific principles

Social and Environmental Contexts of Science and Technology
117-1 compare examples of how society influences science and technology

117-5 provide examples of how science and technology are an integral part of their lives and community

117-7 identify and describe science- and technology-based careers related to the science they study

118-5 defend a decision or judgment, and demonstrate that relevant arguments can arise from different perspectives

SKILLS

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

Analysing and Interpreting
214-5 interpret patterns and trends in data, and infer or calculate linear and non linear relationships among variables

214-15 propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each, and select one as the basis for a plan

Communication and Teamwork
215-6 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise

KNOWLEDGE

319-1 (I) name and write formulas for some common molecular compounds, including the use of prefixes

319-1 (II) 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

319-2 (I) classify substances as acids, bases, or salts, based on their characteristics

319-2 (II) classify substances as acids, bases, or salts, on the basis of their names and formulas

319-3 illustrate, using chemical formulas, a wide variety of natural and synthetic compounds that contain carbon

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: Chemical Reactions

Investigating chemical reactions is a key to understanding nature.

Outcomes

Students will be expected to

- provide examples of how science and technology are an integral part of their lives and their community by investigating common examples of combustion (117-5)
- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for handling and disposing of lab materials (213-9)
- evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring, and decision making by investigating the properties of acids, bases, and salts (212-8)
- classify substances as acids, bases, or salts, on the basis of their characteristic properties [319-2 (I)]
- describe how neutralization involves tempering the effects of an acid with a base and vice versa (321-2)

Elaboration – Strategies for Learning and Teaching

Students should observe and describe several chemical reactions such as combustion of candle wax leading to carbon dioxide and water, and combustion of sulphur (in a fume hood) leading to sulphur dioxide, followed by the 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 laboratory activities in this unit, be sure students recognize WHMIS standards.

Students should 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, are available, their use should be encouraged at this point. Students can test common substances in the home to see if they are acidic, basic, or neutral. A microscope can also be used with a paramecium culture and dilute sulphurous acid to see the effects of acid rain on micro-organisms.

A detailed study of acids, bases, pH, and so forth is not expected at this point, but students should have a basic understanding of simple diagnostic tests associated with acids, bases, salts, and the major products of combustion. This activity should include the information that acids 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, and 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. Check the pH with either pH paper or a pH meter as you proceed with each step. Electronic equipment such as CBLs or Sense and Control units can also be used here if available.

Physical Science: Chemical Reactions

Investigating chemical reactions is a key to understanding nature.

Tasks for Instruction and/or Assessment

- *This unit requires practical experiences in the laboratory and several factors may contribute to student assessment.*

Performance

Research, list, and present the various forms of fuels used for domestic heating in your home community. (117-5)

Bring household chemicals from home, and, with permission from your teacher, test them to classify them as acid, base, or salt. Record your results in a chart. Indicate the instruments and techniques used to achieve this. (319-2 (I), 212-8)

Journal

Write your own definitions of acids and bases based on your laboratory exercises. [319-2(1)]

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 these chemicals should be handled and stored. Record your findings in a group table and post it on the wall. (213-9)

Resources

Science 10

- pages 230-231
  Sec 6.6 (117-5)
- pages 172-174
  Sec 5.1 (117-5)
- pages 658-659
  (213-9)
- pages 290-301
  Sec 8.1-8.4
  (212-8, 319-2(1))
- pages 305-307
  Sec 8.6
  (212-8, 319-2(1))
- pages 314-321
  Sec 8.9-8.11 (321-2)

Work on salts will be in supplemental materials in TR.

AV

"Acids, Bases and Salts"
Magic
#700545, VH
(212-8, 319-2(1), 321-2)

Physical Science: Chemical Reactions

An introduction to formula writing.

Outcomes

Students will be expected to

- describe the usefulness of IUPAC scientific nomenclature systems to convey chemical information (114-8)
- name and write formulas for common molecular compounds, including the use of prefixes [319-1 (I)]

Elaboration – Strategies for Learning and Teaching

Use molecular models to demonstrate correct naming and writing of molecular formulas for a variety of molecular compounds such as methane, water, hydrogen peroxide, ozone, sucrose, ethanol, and methanol. Be sure to cover not only common names such as methane, CH_4 , but also the systematic approach of using prefixes mono, di, tri, and so on for binary compounds such as sulphur dioxide and sulphur trioxide. Through using IUPAC nomenclature students should start to appreciate the usefulness of a common naming system. Point out to the students that molecular compounds consist of non-metals while ionic compounds consist of metals and non-metals. Also note that acids usually start with hydrogen.

Students will be expected to have some knowledge of ions and their relationship to atomic structure and the periodic table from grade 9. However, a review of these points should be done at this time.

- 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 [319-1 (II)]

Students should practise naming and writing of ionic formulas such as CaO [calcium oxide], $Ca(OH)_2$ [calcium hydroxide] , $CaCO_3$ [calcium carbonate], $CaSO_4$ [calcium sulphate], associated with acid rain, along with others such as NaCl [sodium chloride], 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 aides such as ion clips would be very helpful at this point.

This topic is important for chemistry courses that follow. Involve students in finding a variety of ways to gain a knowledge of nomenclature.

continued...

Physical Science: Chemical Reactions

An introduction to formula writing.

Tasks for Instruction and/or Assessment

Journal

Research the introduction of the IUPAC naming system, as well as the ACS (American Chemical Society) naming system, and determine their roles in naming compounds. Debate the need for a standard system for naming compounds. (114-8)

Design a flowchart to be used for naming compounds. (319-1)

Paper and Pencil

In order to ensure a good understanding of nomenclature, it is advisable that the teacher give several quizzes, followed by a major test.

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, 3-D models to determine the names of, and so forth. (319-1)

Presentation and 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)

continued...

Resources

Choosing carefully from pages 184-198 and 201-204.

Sections 5.5 (review)
5.6
5.7 (optional)
5.8 (important)
5.9 (important)
5.11 (important)

(114-8, 319-1(1), 319-1(11))

AV

"Atoms and their Electrons" C-Video #705259, VH
(119-8, 319-1(1), 319-1(1))

Physical Science: Chemical Reactions
An introduction to formula writing. (cont'd)

Outcomes

Students will be expected to

- classify simple acids, bases and salts on the basis of their names and formulas: [319-2 (II)]
  - name and write formulas for some common acids and bases, using the periodic table, a list of ions, and rules for naming acids
- illustrate, using chemical formulas, a variety of natural and synthetic compounds that contain carbon (319-3)

Elaboration – Strategies for Learning and Teaching

Students should be able to write the formulas of some common acids {for example, HCl (aq) [hydrochloric acid] , H_2SO_4 (aq) [sulphuric acid], HNO_3 (aq) [nitric acid]}, bases {for example, NaOH , $Ca(OH)_2$} and salts {for example, NaCl, CaO, $CaCO_3$}. They should also be introduced to the rules for writing and naming common acids.

No systematic naming of organic chemicals is required at this point. Illustrations, by drawing and building models, should be limited to common organic compounds such as: methane [CH_4], propane [C_3H_8], butane [C_4H_{10}], octane [C_8H_{18}], ethanol [C_2H_5OH]. However, consider having a discussion about common, but complex, compounds such as CFCs and polyethylene.

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

Physical Science: Chemical Reactions

An introduction to formula writing. (cont'd)

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 versus organic. Explain the basis upon which you made your decision. (319-3)

Journal

Keep a record of the chemicals you use during a typical day. Compare your list to the findings of your classmates and identify these chemicals as organic or inorganic. (319-3)

Paper and Pencil and Performance

Use the Internet to search out some examples of organic compounds, as well as some organic reactions. Present your findings to the class. (319-3)

Resources

Secience 10

- See page 53 in this guide to help address 319-2(11)
- pages 205-210
  Sec 5.12-5.13 (319-3)

AV

"Carbon Chemistry" C-Video
#704475, VH (319-3)

Physical Science: Chemical Reactions

An introduction to equation writing

Outcomes

Students will be expected to

- represent chemical reactions and the conservation of mass, using molecular models, and balanced symbolic equations (321-1)
  - write and balance reactions that illustrate a variety of reaction types, including combustion, formation, decomposition, single replacement, and double replacement

Elaboration – Strategies for Learning and Teaching

Students should balance different types of chemical reactions and confirm the conservation of atoms, using molecular models. They should be introduced to identifying reactants and predicting 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 3-D 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 grade 10, but molecular models should be used so that the students have some knowledge of which atoms are attached to which atoms.

Students should be able to predict products for simple chemical reactions by the time they have finished this section.

Physical Science: Chemical Reactions

An introduction to equation writing

Tasks for Instruction and/or Assessment

Performance

Encouragement should be given to making and using 3-dimensional models for presentations and balancing chemical equations. Three-dimensional models constructed by students can be assessed by the teacher for correctness with regard to the attachment of atoms to other atoms and the conservation of atoms in chemical reactions. (321-1)

Paper and Pencil

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

1. H_2O (l) → H_2 (g) + O_2 (g)
2. Cl_2 (g) + LiI (aq) → LiCl (aq) + I_2 (s)
3. KOH (aq) + H_3PO_4 (aq) → K_3PO_4 (aq) + H_2O (l)
4. butane (gas) + oxygen (gas) → carbon dioxide (gas) + water (vapour)
5. solid sodium + chlorine (gas) → solid sodium chloride (321-1)

Resources

- choose carefully (due to time restraints) pages 216-245 Sec 6.1-6.12

Do not attempt all sections but attempt to condense and do 1 or 2 investigations.

Physical Science: Chemical Reactions

A qualitative introduction to rates of chemical reactions

Outcomes

Students will be expected to

- design, carry out, and control variables to illustrate how factors such as heat, concentration, and surface area can affect chemical reactions (321-3, 212-3, 213-2)

Elaboration – Strategies for Learning and Teaching

Students should study factors that affect reaction rates, such as heating, surface area, and concentration, by observing the reactions of calcium carbonate (marble) and dilute sulphuric or nitric acids. This reaction is intended to simulate destruction caused by acid rain, which is the example context of the unit. This will serve to illustrate the concept of controlling variables, and designing an experimental procedure. Overall it is expected that the study of factors affecting reaction rates be studied in a qualitative manner (slow, medium, fast) in grade 10.

For enrichment, some simple theoretical discussion of reaction rates using particle theory could take place.

Physical Science: Chemical Reactions

A qualitative introduction to rates of chemical reactions

Tasks for Instruction and/or Assessment

Performance

Students can be given a reaction between two compounds which involves a heat evolution or absorption and a colour change. They can then be asked to describe and perform an experiment to decide which two compounds give heat and which give colour changes. Also students can describe what effect surface area will have on the reaction. Formal write-ups can be done on this activity. (212-3, 213-2, 321-3)

As a culminating exercise, a concluding assessment to this section may include a simple practical exam. This should be designed around simple skills and knowledge acquired in the suggested activities. (212-3, 212-8, 213-2, 213-5, 213-9, 214-15)

Resources

Science 10

- pages 256-257 Sec 7.1
- pages 258-259 Sec 7.2
- pages 260-263 Sec 7.3
- pages 268-269 Sec 7.5

Do 7.2 and pick one of 7.1, 7.3 or 7.5 (321-3, 212-3, 213-2)

Optional

- pages 270-273 Sec 7.6-7.8
- pages 276-277 Sec 7.9 (321-3, 212-3, 213-2)

Physical Science: Chemical Reactions

(*OPTIONAL*)

What are some of the effects of industrialization and associated pollution?

Outcomes

The following outcomes should be covered as an independent student project which may extend beyond the time lines of the chemistry section of Grade 10 Science.

Students will be expected to

- work co-operatively with a team to research and describe the relationship between domestic and industrial technologies and the formation of acid rain (116-5, 215-6, 116-3)
- compile and organize data on acid precipitation (pH) in order to interpret patterns and trends in these data, and infer or calculate linear and non-linear relationships among variables such as pH versus time and location (213-5,214-5)
- propose alternative solutions to the problem of acid precipitation, assess each, and select one as the basis for a plan of action, defending the decision (214-15, 118-5)
- identify and describe science-and technology-based careers related to airborne pollution (117-7)
- compare examples where society has used the presence of airborne pollution to influence decisions concerning science and technology (117-1)

Elaboration – Strategies for Learning and Teaching

Have student teams research the sources (for example, 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 with team members to develop and carry out a plan that includes compiling and organizing their data in order to infer patterns or trends in the data.

Use Internet sites and e-mail to contact other areas which are associated with acid precipitation. Use this information and library research to write a balanced (that is, 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 position with relevant arguments from different perspectives, and include examples of how society supports and influences science and technology. They should also identify examples where technologies were developed on the basis of scientific understanding.

Physical Science: Chemical Reactions **(*OPTIONAL*)**

What are some of the effects of industrialization and associated pollution?

Tasks for Instruction and/or Assessment

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).

Informal/Formal Observation and Presentation

Present your research on acid precipitation to the whole class. (118-5)

Journal and Portfolio

Group activity rubrics can be designed (or used) to assess the research projects; students can be asked to report in journals about their research projects; or students can be asked to write a summary of their work for their portfolios. (213-5, 214-5, 215-6)

Paper and Pencil and Presentation

Longer term projects on acid precipitation should be assessed in terms of the quality of the research, preparation, and the final presentation. This presentation can take various forms such as a web-page design, an information flyer or a brochure, a newspaper advertisement or a radio spot. Remember that students should see examples or be following a stated rubric. Assessment should extend beyond science content to include use of language, the manner in which ideas are expressed, and the ways in which different media are used for research and presentation. (117-1, 117-7, 118-5, 213-5, 214-5, 214-15)

Resources

Addison-Wesley's
One Minute Readings:
Issue 36: Acid Rain
Issue 37: Air Pollution
ISBN #: 201-23157-3

Real Science, Real Decisions
NSTA publication
ISBN #: 0-87355-097

Decisions Based on Science
NSTA publication
ISBN #: 0-87355-165

Unit 4
Physical Science:
Motion

Unit Overview

Introduction

The concept of motion allows students to investigate and develop their interest in the sports that are part of their daily lives. Students will not only have opportunities to investigate the principles of kinematics but will also be encouraged to apply its development into 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 should have two principle focuses- inquiry and problem solving. Students will be able to examine questions which inquire into the relationships between and among observable variables that affect motion. Once these relationships are understood, design investigations can begin to address the problems associated with those questions. By applying mathematical and conceptual models to qualitative and quantitative data collected, motion can be graphically represented. This will provide 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.

Curriculum Links

Prior to grade 10, the study of motion receives little depth of treatment. Indirect connections are found with "Forces and Simple Machines" in grade 5 and "Flight" in grade 6. In grades 11 and 12, those students who pursue studies in Physics 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" included the collection, display, and analysis of data.

Curriculum Outcomes

Students will be expected to

STSE

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 endeavors to specific science disciplines and interdisciplinary studies

115-1 distinguish between scientific questions and technological problems

115-4 describe the historical development of a technology

Relationships between Science and Technology

116-7 analyse natural and technological systems to interpret and explain their structure and dynamics

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

SKILLS

Initiating and Planning

212-4 state a prediction and hypothesis based on available evidence and background information

212-6 design an experiment and identify specific variables

212-7 formulate operational definitions of major variables

212-9 develop appropriate sampling procedures Performing and Recording

213-3 use instruments for collecting data effectively and accurately

213-4 estimate quantities

Analysing and Interpreting

214-5 interpret patterns and trends in data, and infer or calculate linear and non-linear relationships among variables

214-8 evaluate the relevance, reliability, and adequacy of data and data collection methods

214-10 identify and explain sources of errors and uncertainty in measurement, and express results in a form that acknowledges the degree of uncertainty

Communication and Teamwork

215-2 select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate ideas, plans, and results

KNOWLEDGE

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

325-4 Describe quantitatively the relationship among velocity, time, and acceleration

Physical Science: Motion
Investigate velocity

Outcomes

Students will be expected to

- devise a method of representing the linear motion of two moving people or objects (215-2)
- develop appropriate sampling procedures for determining the speed of an object's linear motion (212-9)
- use instruments such as ticker timers, photogates, or motion sensors effectively and accurately for collecting data (213-3)
- identify and explain sources of errors and uncertainty in distance, time, and speed measurements and express results in a form that indicates the limits of accuracy (214-10)
- describe quantitatively the relationship among distance, time and average speed of an object's linear motion (325-1, 212-7)

Elaboration – Strategies for Learning and Teaching

Throughout this unit, it is important that the differences between speed-velocity, distance-displacement, and average velocity-constant velocity be recognized and the names consistently used. Also, if students are provided with various examples of motion to investigate, they will begin to develop a thorough understanding of the concepts of displacement and velocity. The suggested way to introduce this cluster of outcomes is to investigate the linear motion of an Olympic runner. However, the study of motion can easily be applied to many Olympic events, personal interests such as skiing, swimming, snowmobiling, bicycling or orienteering, or the motion of objects. Note, in grade 9 mathematics, students have been exposed to data collection, graphing and its analysis.

In small groups, students will identify a type of motion that can be investigated, with the provision that it must include two moving objects. As they develop their method students will address key questions such as, What kind of data will we collect? How will we represent the motion?

Given measuring tapes and stopwatches, students will work in groups to collect data on the forward motion of a group member. Students should use equal time intervals and collect at least five distance data points, for example, the distance travelled by a runner at the end of two-second intervals for a total of ten seconds.

It is important to review the expected process of establishing sampling procedures for collecting data, format of data charts and graphs. A brief review of metric units may be necessary as it relates to the context of the problem being discussed. The data should be graphed on a distance / time graph (m/s) with the plotted data points joined to show the motion. Note with the students that the distance measurement for each data point is measured from the starting point. Significant digits are important to recognize the accuracy of calculated answers. Students should acknowledge that measurements have limitations. *This should be discussed in context and not as a distinct outcome*. Ensure students are familiar and consistent with their practices.

The average speed for each time interval can be determined. Students should recognize that the average speed during a time interval can be calculated by determining the slope of the line between time intervals, or from the data directly, by the mathematical equation: speed (ave)= Dd/ Dt where Dd is the change in distance and Dt is the corresponding change in time. Data on a second student's motion can be collected using the same time intervals and average speeds calculated. Both results can be analyzed quantitatively and presented to the class.

continued...

Physical Science: Motion
Investigate velocity

Tasks for Instruction and/or Assessment

Performance
Construct a data table of collected values. Data points are to be plotted on a distance/ time (d/t) graph (m/s) and joined by a line representing the motion. (212-9)

Measure and record time and distance, using the proper measuring instrument or device. Measurements should reflect the precision of the measuring instrument. (213-3)

While collecting and recording data in a chart, write all values in a form that recognizes the precision of the measurements. Calculations using collected data should recognize significant digits. (214-10)

Interview
In a group, students will research potential sources of error in data collection. A member(s) from each group will be asked to name the sources of error and how each affected the data collected. (214-10)

Presentation
Present a method of representing 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. (215-2)

Use data to construct a distance/ time (d/t) graph from which two methods may be used to determine quantitatively, the average speed of a student's or object's motion. (325-1, 212-7)

continued...

Resources

Science 10

- pages 352-359
  Sec 9.4 and 9.5
  (215-2, 212-9, 213-3, 214-10)

- pages 362-365
  (325-1, 212-7)

- pages 372-373
  (213-3, 325-1, 212-7)

Physical Science: Motion
Velocity (cont'd)

Outcomes

Students will be expected to

- predict the time taken for a moving object to complete a course on the basis of initial measurements, estimated values, and an understanding of the displacement, time, and velocity relationship (212-4, 213-4)
- analyse graphically and mathematically the relationship among displacement, time, and velocity:
  - distinguish between scalar and vector quantities
  - distinguish between distance-displacement, speed-velocity
  - slope of the displacement/ time graph related to velocity (325-2)
- distinguish between average velocity and instantaneous velocity (325-3)
- distinguish between uniform and non-uniform motion (acceleration). (325-4)
- formulate an operational definition for velocity (212-7)

Elaboration – Strategies for Learning and Teaching

Students can apply their understanding of motion to compare two runners in a 5000 metre race. Given the time at various displacement intervals early in the race, and calculating the average velocities, students can predict the final results of the race. Knowing the remaining displacement for the slower runner, students can calculate the time required to complete the race.

Often running events have 'false starts' which require the runner to return to the start, wait, and then re-run the event. Analysis of this motion sequence will include the variables of motion having zero velocity and motion towards the original starting point. Students should conduct an investigation to collect data and plot motion that has a combination of forward motion, stop motion (no displacement), and reverse motion. Ensure that students use constant time intervals over which the displacement is measured. Motion back towards the starting point may require the teacher to illustrate that the displacement (from the start point) may actually be less than a previous data point, and that it may become negative if it is behind the start point.

Students should calculate the average velocity between the time intervals and present their analysis. Measures of average velocity, its graphical representation, and the motion it describes should be included.

Students should recognize that motion is not abrupt changes in velocity but is more accurately represented by a curve on a displacement/ time graph. Given a graph, average velocity over a time interval is determined similarly (slope of the line between points on the curve, or by calculating using the mathematical equation: $v_{(ave)}=\Delta d/\Delta t$, which symbolically represents Average velocity= displacement/ corresponding time interval). Clarify that average velocity represents motion over a time period, whereas instantaneous velocity represents the velocity at a specific time.

Have students identify instruments used to measure instantaneous velocity such as radar guns, speedometers, and photogates. Discuss their limitations and degree of precision. If such equipment is available, ask students to determine the instantaneous velocity of a moving object. Another method of calculating the instantaneous velocity is to determine the slope of a straight-line tangent to the curve at that specific time. *Note: The operational definition for velocity will develop complexity as the students' study of motion evolves.*

Physical Science: Motion
Velocity (cont'd)

Tasks for Instruction and/or Assessment

Journal

Enter into your portfolio an operational definition for velocity. Provide examples that affect your daily life. (212-7)

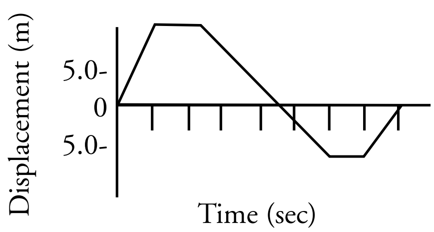
Paper and Pencil

Predict finishing times for both runners to complete a 5000 metre race, using data representing the initial displacements. This can be done graphically on a d/t graph and verified mathematically. (212-4, 213-4)

What is the distance remaining for Sally when Mary crosses the finish line? How long does it take Sally to cross the finish line after Mary? Develop a chart so that individual time values are given for distances of 1000 metre increments. What assumptions are made? (212-4, 213-4)

Analyse graphically and mathematically the relationships among displacement, time, and velocity for a motion sequence. What assumptions have to be made? (325-2)

Using displacement/ time (d/t) graphs representing different motion sequence, identify and distinguish between average and instantaneous velocities. (325-3)



Presentation

Illustrate graphically the motion sequence for an object. This should include stop (no motion), motion forward and away from the original starting point. (325-2)

Resources

Science 10
- pages 446-451
  Sec 12.1 (212-4, 213-4)
- pages 414-415 and 418-419 (325-2)
- pages 432-434
  Sec 11.7
  (325-3, 212-7)
- pages 384-395
  Sec 10.3-10.5 (325-4)

Physical Science: Motion

Investigate the relationship between velocity, time and acceleration

Outcomes

Students will be expected to

Elaboration – Strategies for Learning and Teaching

Introduce accelerated motion by discussing the motion of a student sprinting over 50 metres. Note, unlike constant velocity, the runner will travel a greater distance in each succeeding time interval until maximum velocity is reached. This non-uniform velocity results from acceleration (or, if slowing down, deceleration). Students should be aware of the effect of forces on the velocity; however, the concept of an unbalanced force causing acceleration should be limited in its development to only its resultant effect.

- devise a method of representing the uniformly accelerated linear motion of two moving people or objects (215-2)

In small groups, students can design an investigation to show a type of accelerated motion that must include two accelerating objects. As they develop their method, students will address key questions such as What kind of data will they collect? How will we represent the motion? How can this representation be analysed qualitatively, quantitatively?

- formulate an operation definition for acceleration (212-7)

As the section on acceleration develops, the students' operational definition will continue to develop complexity.

- design an experiment to investigate factors that affect acceleration (212-6, 212-9)

Students should conduct an experiment to study the factors that affect acceleration (starting position, use of starting blocks, type of footwear) by determining their effect on a sprinter's run over 50 metres. This is meant to serve as an illustration of controlling variables and designing an experimental procedure.

- use instruments for collecting data on uniformly accelerated linear motion effectively and accurately. (213-3)

Graph the data for each series of variables on a displacement/ time (d/t) graph for comparison purposes. For example, data related to starting position- a) standing and b) four-point sprint position, should be graphed on the same d/t graph. Constant time intervals should be used for observations. Students should recognize that a smooth curve through these points is a more accurate representation than straight lines. Draw tangents (representing instantaneous velocity) to each slope at one-second time intervals for each graph (up to where maximum velocity is reached). Acceleration can be introduced as the rate of change of velocity per unit time. Students should be able to translate this qualitatively by examining the slope of each tangent and its relative change at each time interval. Analysis of the graphs should suggest which factors resulted in a greater change of velocity per unit time (acceleration).

- analyse a natural or technological structure that can affect the acceleration of a moving object (116-7)

Students can investigate any one of the factors that affected acceleration. For instance, with 'use of starting blocks,' students will analyze their structure and how they are adjusted to suit the needs of the runner. This could lead into a brief study of Newton's laws and how the force from the body's musculature can be maximized to increase the acceleration of the runner.

continued...

Physical Science: Motion

Investigate the relationship between velocity, time and acceleration

Tasks for Instruction and/or Assessment

Performance

Measure and record time and displacement, using the proper measuring instrument or device. Measurements should reflect the precision of the measuring instrument. Plot a displacement-time graph and use it to find the acceleration. (213-3)

Interview

In a group, research information on a particular aspect that may affect the acceleration of a runner. A member(s) from each group will be asked to report on their findings. (116-7)

Presentation

Present a method of representing the linear accelerated 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. Suggest the kinds of qualitative and quantitative analysis that can be completed. (215-2)

Portfolio

Enter into your portfolio an operational definition for acceleration. Provide examples of acceleration in daily life. Leave space so that it can be updated as your study of acceleration continues. (212-7)

Prepare for your portfolio, a formal write-up for the experiment designed and conducted to study the factors affecting acceleration. (212-6, 212-9)

continued...

Resources

Science 10

- pages 384-395
  Sec 10-3-10-5
  (215-2, 212-7)

- See Appendix for a lab idea to help cover 212-6, 212-9, 213-3

- pages 458-459
  Sec 12.3
  Including Work the Web
  (116-7)

Physical Science: Motion

Investigate the relationship between velocity, time and acceleration. (cont'd)

Outcomes

Students will be expected to

- identify potential sources of error in collecting data on linear acceleration (214-10)
- evaluate and suggest possible improvements to data collection methods while determining acceleration (214-8)
- interpret patterns in data collected for motion and identify intervals of uniform motion and accelerated motion . (214-5)
- describe quantitatively the relationship among velocity, time and acceleration:
  - calculate the area under a velocity/ time (v/t) graph and relate it to an object's displacement
  - given data for two of three variables in the formula $a = \Delta v / \Delta t$ (change in velocity/ corresponding change in time), calculate the third
  - determine the acceleration of an object from a velocity/ time (v/t) graph (325-4)

** *Acceleration is limited to basic calculations only (see Note)*

Elaboration – Strategies for Learning and Teaching

Students should identify and assess limitations of equipment used to collect data on an accelerating runner. Suggestions for possible improvements in experimental design, procedure, or data collection methods should be discussed.

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. This is a context for using significant digits to show the degree of accuracy of measured or calculated values. The differences between accuracy and precision (of data) should be developed.

Review with students, both uniform (constant velocity) and non-uniform motion (constantly <uniformly> accelerated), using a graphical analysis. Show how the slope of a d-t graph, at any time, represents the instantaneous velocity. Calculate the instantaneous velocity value for at least two time points, one on each graph.

Illustrate how these velocity-time values are used as data to construct a velocity-time (v-t) graph for each motion. Draw in a line to represent a constant slope. Compare the slope of the v-t graph to its corresponding displacement-time (d-t) graph and draw generalizations for each type of motion. Develop the concept that the slope of a v-t graph represents the acceleration ((m/s)/s or m/s^2) and that it can be represented mathematically as average acceleration= change in velocity/ change of time ($a_{(ave)} = \Delta v / \Delta t$). Also, v-t graphs with negative slopes should also be analyzed.

Demonstrate to students how accelerated motion problems can be solved mathematically using the equations: $a_{(ave)} = \Delta v / \Delta t$ and $v = \Delta d / \Delta t$. Illustrate how the area under the curve of a v-t graph, between two times, represents the displacement during this time period.

Note: While students at this grade level can find the slope of a velocity/ time graph (v/t) to get acceleration (a), they are not required to fully understand the underlying mathematical principles.

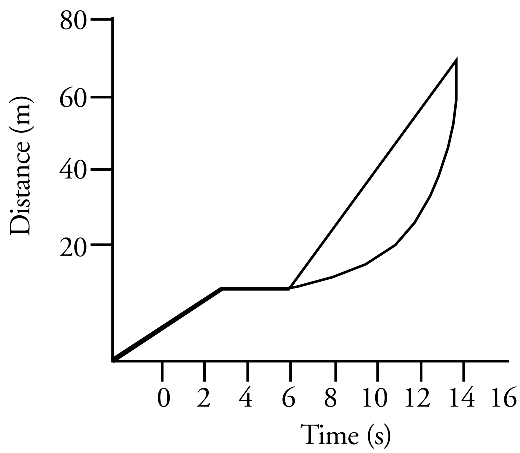
Physical Science: Motion

Investigate the relationship between velocity, time and acceleration. (cont'd)

Tasks for Instruction and/or Assessment

Paper and Pencil

(Given a series of graphs) Identify the patterns that indicate uniform and non-uniform (accelerated) motion. Describe the motion represented by the graph. Calculate the velocity at t= 2, 6, 10, 12, 14 s (214-5)



Interview

In a group, identify potential sources of error in data collection. A member(s) from each group will be asked to name the sources of error and how each affected the data collected. (214-10)

Presentation

In a group, present suggestions on ways to improve the method by which data is collected and recorded. Possible presentation formats may include video, role-playing or demonstration. (214-8)

Use data to construct a displacement/ time (d/t) and velocity/ time (v/t) graphs. Describe quantitatively two methods to determine acceleration. Calculate the acceleration and compare the results. (325-4)

Time (s)	John : Total Displacement [A] (m)	Joel : Total Displacement [A] (m)
0	0	0
2	3.0	1.6
4	6.0	6.4
6	9.0	14.4
8	12.0	25.6
10	15.0	40.0

[A] Represents total displacement from start during the time interval

Resources

Science 10

- pages 460-461
  Sec 12.4
  (214-10, 214-8)

- pages 462-473
  Sec 12.5-12.6
  (214-5, 325-4)

* Please limit to basic calculations

* Do not go as far as using displacement equations for uniformly accelerated motion as the textbook does.

Physical Science: Motion

Technological improvements based on design testing and analysis

Outcomes

Students will be expected to

- distinguish between scientific questions and technological problems related to a motion research topic (115-1)
- describe the historic development of a motion technology (115-4)
- evaluate the design of a motion technology and the way it functions with relation to safety, construction, and cost (118-3)
- evaluate the role of continued testing in the development and improvement of a motion technology (114-3)

Elaboration – Strategies for Learning and Teaching

This cluster of outcomes can be introduced by examining the relationship between science and technology. Discuss with students the need to have a scientific question resolved into a technological problem. For instance, a scientific question "What is the effect of the track surface on the performance of a runner's footwear?" is restated into a technological problem "How can the design of a runner's footwear be modified to take into account the track's surface?"

Using student teams, research the development of various designs of footwear that have been used by runners. Categorize and describe those designs now available and analyse each category for design features and function (that is, track event, track surface, indoor-outdoor). Evaluate the design of the footwear on the basis of safety (preventing injury), overall construction, reliability, and cost.

Identify the features of footwear design that would be considered important to develop improvements. Evaluate the role of continued testing in their development and improvement.

The suggestions provided can easily be applied to other interest areas. Similar investigations might be made into the technology of ice skates, snowboards, bicycles, skis, skateboards, or cars.

Physical Science: Motion
Technological improvements based on design testing and analysis

Tasks for Instruction and/or Assessment

Although the following strategies use the context of athletic footwear, they provide a model which can be applied to other topics.

Observation
Students are asked to wear athletic footwear to class and are divided to form heterogeneous groups. Find and record similarities and differences among the footwear.

Students are then asked to regroup homogeneously on the basis of similar footwear (for example, basketball).

Find and record similarities and differences among the footwear.

In this research group, identify how technology has modified the footwear design to suit its intended purpose. Your participation in this investigation will be based on a 5-step rating scale. (115-1)

Performance
Present to the research group (based on similar footwear type) findings on the evolution of a specific type of athletic footwear. Peers will evaluate the presentation using a 5-step rating scale. (115-4)

Journal
Respond to a self-developed question regarding the role of continued testing in the development and improvement of footwear. *For example-* As design tries to meet a sport's changing need, what role will continued testing play? (114-3)

Presentation
Research groups will collectively present findings on their type of footwear based on function and design, safety, construction, and cost. The presentation must address the question of whether function determines design or design determines function. (118-3)

Resources

A project on how to improve motion, "Make something faster" for example, can be done to help cover outcomes (115-1, 115-4, 118-3, 114-3)

Elaborations on page 76 has a few project suggestions!!

Science 10

- pages 430-431 and pages 458-459 (115-1, 115-4, 118-3, 114-3)

Physical Science: Motion
Present and future development

Outcomes

Students will be expected to

- relate a research project on motion to studies in specific science disciplines and interdisciplinary studies (114-6)
- identify areas of further study related to science and technology of motion (117-8)
- describe examples of Canadian contributions to science and technology in the area of motion (117-10)

Elaboration – Strategies for Learning and Teaching

Students can develop a Venn diagram or Concept Map to detail each of the following :

1. 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, and mathematics etc.
2. 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.

Students may require teacher direction with the format expected for the Venn diagram or Concept Map and the detail or reference expected.

Students can present examples of Canadian contributions in a specific area of interest. A specific company can be researched with their contribution (for example, Bombardier designs in snowmobiles, trains, and airplanes) or a topic researched (for example, 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.

Physical Science: Motion
Present and future development

Tasks for Instruction and/or Assessment

Journal
Develop a Venn diagram (or Concept Map) to present various science disciplines and interdisciplinary studies for a particular interest in motion. (114-6)

Presentation
In a research group, develop and present a Venn diagram (or Concept Map) which links the study of motion to science and technology. (117-8)

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

Resources

Project can help address 114-6, 117-8

- pages 408, 430, 458 (114-6, 117-8, 117-10)

Sample Pathways

This section contains Sample Pathways of resource material to be used by teachers as they work through the curriculum guide. These are provided as a suggested way to help cover as many outcomes as possible in an allotted time frame that spans approximately 20 class periods per unit. For example, if a teacher decides to follow the16- 20 suggested lessons they will be assured of covering a vast majority of the prescribed outcomes listed in this curriculum guide. Tests and quizzes are not listed in the pathways but they must be part of a teacher's overall unit plan. Some teachers may have an opportunity to cover some of the alternative text sections if they feel those sections cover outcomes better.

Though the sample pathways provided are specific to a resource, teachers are always encouraged to use additional/alternative resources to help address a specific outcome. The blank Pathway sheets are provided so that teachers can photocopy and design their own "pathways" and lesson time-lines. A 4-5 week period is suggested to cover a particular unit of science content.

Teachers are encouraged to use the Pathways in order to allow time for Science Fairs, Science Olympics, and other science related activities that are an important component in helping students develop scientific literacy.

Sample Unit 1
Critical Pathway (Life Science: Sustainability of Ecosystems – Science 10)

Lesson	Text Section(s)	OR *Alternative* Text Section(s)	Outcome(s)
1	1.1		331-6
2	1.3	1.2	318-6
3	1.4		114-1, 215-1
4	1.5		318-5
5	1.6	1.8/1.9	318-5, 214-3, 213-7
6	1.11	1.10	214-1
7	1.12	4.7 (for marine)	318-6, 331-6, 213-8, 212-4
8	2.1		318-1
9	2.2		318-2
10	2.5		318-1, 331-6, 213-8, 212-4
11	2.6		318-1, 331-6, 213-8, 212-1
12	2.7		318-1, 331-6, 213-8, 212-1
13	2.8	2.9/2.10/2.11	318-1, 331-6, 213-8, 212-1
14	3.1/3.2		318-3
15	3.3		331-7
16	3.5	3.4	331-7, 118-1
17	3.7 or 3.9 or 3.10/3.11/3.12 or 4.8/4.9/4.10 or challenge page 158 to be used as a starting point for a project		118-9, 215-4, 118-5

Sample Unit 2
Critical Pathway (Earth and Space Science: Weather Dynamics – Science 10)

Lesson	Text Section(s)	OR *Alternative* Text Section(s)	Outcome(s)
1	TR supplement to build weather station		114-6, 212-1, 213-3, 214-10
2	13.2		115-2, 331-1
3	13.3		115-2
4	13.6	13.4/13.5	214-3, 331-2
5	13.8		115-2, 331-1
6	13.9		214-3, 331-2
7	13.11/13.12		115-2, 331-1
8	13.13		214-3, 331-2, 214-11
9	14.2		213-7, 214-3, 215-5, 331-5, 213-6, 213-7
10	14.3		213-7, 214-3, 215-5, 331-5, 213-6, 213-7
11	14.4	14.6/14.7	213-7, 214-3, 215-5, 331-5, 213-6, 213-7
12	14.9		116-1, 117-10
13	15.1/15.2		114-6, 117-6
14	15.3 or 15.4 or 15.6 or 15.7		331-4
15	15.12		214-3, 331-2, 115-2, 116-1
16	16.10		118-2
17	Allow time for weather station project		

Sample Unit 3
Critical Pathway (Physical Science: Chemical Reactions – Science 10)

Lesson	Text Section(s)	OR *Alternative* Text Section(s)	Outcome(s)
1	5.1	5.2	117-5, 213-9
2	5.7/5.8	5.5/5.6	319-1 (II)
3	5.9	5.10	319-1 (I)
4	5.11		319-1 (I)
5	5.12		319-3
6	6.1		321-1
7	6.2	6.3/6/4	321-1
8	6.5	6.6	321-1
9	6.7/6.10		321-1
10	6.8 or 6.9 or 6.11 or 6.12		212-3, 213-2
11	7.3		321-3
12	7.1 or 7.2 or 7.3		212-3, 213-2
13	8.1		319-2 (I)
14	8.2		212-8, 319-2 (I)
15	8.3		212-8, 319-2 (I)
16	8.4	8.5/8.6	212-8, 319-2 (I)
17	8.9		321-2
18	8.10		321-2, 212-8
19	8.11	8.12	321-2, 212-8

Sample Unit 4
Critical Pathway (Physical Science: Motion– Science 10)

Lesson	Text Section(s)	OR *Alternative* Text Section(s)	Outcome(s)
1	Project Introduction	Look in TR supplemental materials (12.3 can serve as starting point)	115-1, 115-4, 118-3, 114-3
2	9.4		212-9, 213-3, 214-10
3	9.5		325-1, 212-7
4	9.7		325-1, 212-7, 212-4, 213-4
5	9.10		325-1, 212-7, 212-4, 213-4
6	10.2		325-1, 212-7, 212-4, 213-4
7	10.3		212-7
8	10.4		325-2
9	10.5		212-6, 212-9, 213-3
10	10.7		325-3
11	11.7		325-2, 325-3
12	12.1		325-2, 212-4, 213-4
13	12.2		325-2, 212-4, 213-4
14	12.4		325-2, 213-3
15	12.5		325-2, 213-3
16	12.6		325-2, 213-3
17	Project wrap-up		

Sample Unit ____
Critical Pathway (____)

Lesson	Text Section(s)	OR *Alternative* Text Section(s)	→ Outcome(s)
1			
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