Prince Edward Island
CANADA
Department of Education
English Programs

Atlantic Canada Science Curriculum

CURRICULUM

Science

Grade 6

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Foreword

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.

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 life-long 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.

Suggested Teaching Sequence for Grade 6 Science

The grade 6 science curriculum consists of four units: one Life Science, one Earth and Space Science, and two Physical Science units. The following teaching sequence is suggested.

Diversity of Life (September - mid November)

This unit introduces students to the variety of life forms available for observation. By making comparisons it is important to notice features that are common and those which distinguish an organism. Formal calssification is more important in later grades, but developing a system to organize the variety of organisms studied is an important feature of this unit.

Electricity (mid November - January)

This unit builds on previous experiences that involved electrostatic and magnetic forces. Activities are designed to show students what we recognize as electrictiy, how it can be controlled, and how it can be used. Descriptions should be qualitative and encourage students to appreciate the generation, transmission and use of electrical energy.

Flight (February - mid April)

Flight provides opportunities to discover the link between scientific principles and technology. In studying the effect of gravity, lift, drag and propulsion, students are drawn into questions of design and materials. A variety of factors that affect motion through a fluid are open for investigation.

Space (mid April - June)

This unit offers an opportunity to explain why we experience daily and seasonal change on Earth. Studying components of the solar system and beyond will generate interst in seeking better information. This necessitates travel from Earth into space. The challenges presented by space travel are an integral part of this unit.

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 also an instrinsic part of learning in science that can help 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 help 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 but 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 under-represented in science, and indeed, for all students.

While this curriculum guide presents specific outcomes for each unit, it must be acknowledged that students will progress at different rates. Teachers should provide materials and strategies that accommodate student diversity, and should validate students when they achieve the outcomes to the best of their abilities.

It is important that teachers articulate high expectations for all students and ensure that all students have equitable opportunities to experience success as they work toward the achievement of 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 for teachers to know some activities/skills/actions that are associated with each process; for example:

Inquiry

- *define questions related to a topic*
- *select an approciate way to find information*
- *make direct observations*

Problem Solving

- *gather information from a variety of sources*
- *appreciate that several solutions should be considered*
- *plan and design a product or device intended to solve a problem*

Decision Making

- *evaluate the validity of the information source*
- *identify the different perspectives that influence a decision*
- *present information in a balanced manner*

Student learning may be described in terms of ability to perform these tasks.

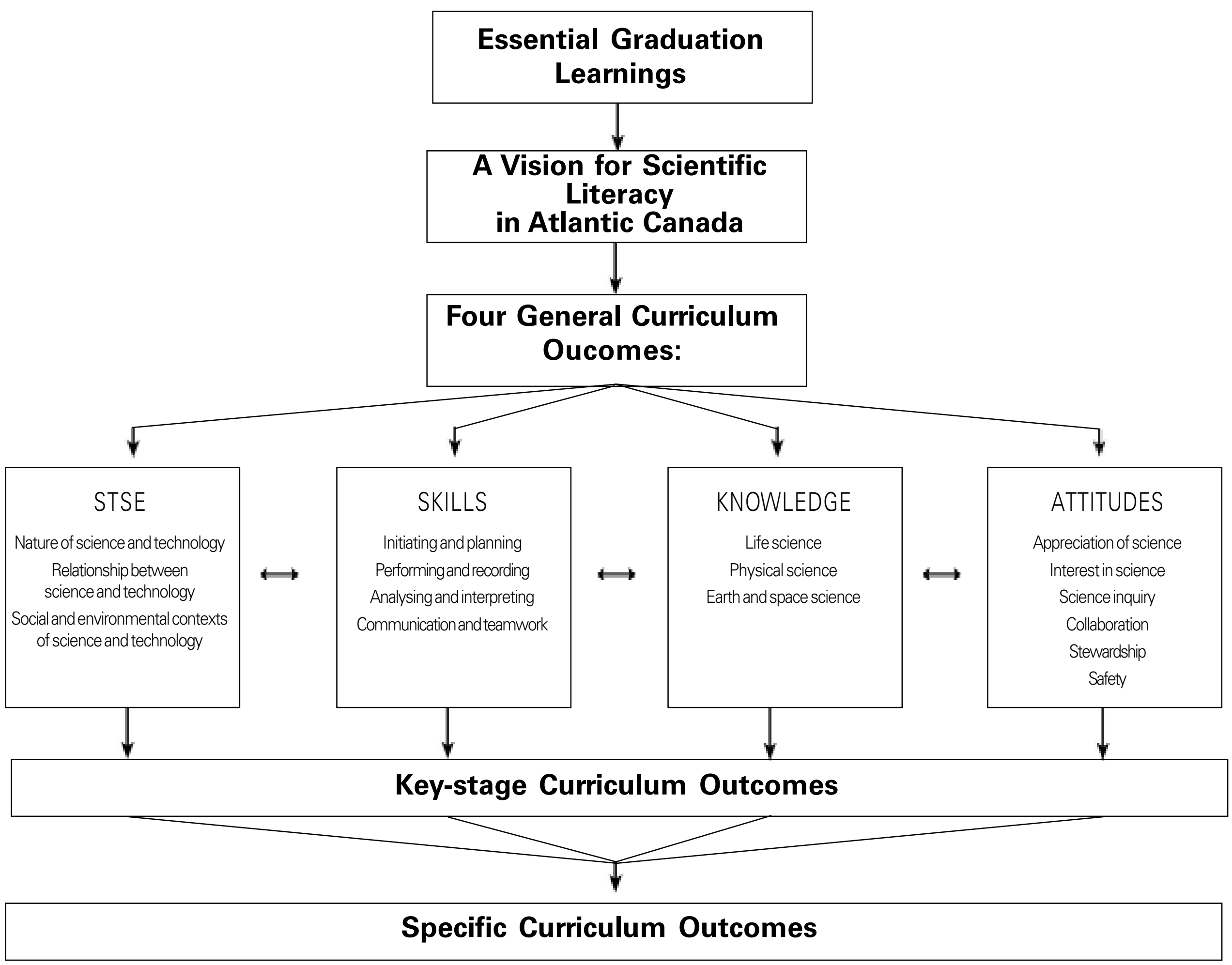
Curriculum Outcomes Framework

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 C*ommon Framework of Science Learning Outcomes K to 12*. Figure 1 provides the blueprint of the outcomes framework.

Outcomes Framework

FIGURE 1



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. These key stage outcomes can be found in the Appendix.

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 three-page synopsis. On the first page, a general overview of the topic is provided. This is followed by sections that specify 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 synopsis provides a table of 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.

- 100s—Science-Technology-Society-Environment (STSE) outcomes
- 200s—Skills outcomes
- 300s—Knowledge outcomes
- 400s—Attitude outcomes (see pages 84–85)

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

The third page contains the PEI/APEF Specific Curriculum Outcomes that teachers will use for daily planning, instructional, and assessment purposes.

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.

LIFE SCIENCE: DIVERSITY OF LIFE

The Role of a Common Classification Scheme for Living Things

Outcomes

Students will be expected to

- identify different ways to classify living things in their local habitat (204-6)
- classify living things in the local habitat and create a chart or diagram that shows the method of classifying (206-1)
- present a selected classification scheme to others (207-2)
- describe how classifications may vary and suggest possible explanations for variations (104-5)
- identify communication problems that arise from the differences in classification schemes for living things, and describe the role of a common classification system (206-9, 300-15)

Elaborations–Strategies for Learning and Teaching

Students should start this unit by going out to a local habitat (forest, seashore, pond, meadow, park, wooded area), and observe and record the wide variety of species that they see. Using other sources, such as magazines, videos, field guides and other media, they can appreciate the greater diversity of life. From their observations and research, students can classify their organisms into groups based on characteristics they select. They may use fairly specific characteristics or more general groupings related to insects, plants, fungi, trees, animals or combinations of each. Students can then attempt to sort them using different characteristics, and come up with a totally different classification scheme. As they compare their schemes with others in the class, they will see that their classification schemes will not be the only way to classify organisms.

Teachers could initiate a discussion around the necessity for a common classification scheme in order for scientists to communicate using the same language and terminology. There are more than one million species of living things, with the possibility of millions more yet to be discovered. This raises questions about how we can simplify the presentation of information about so many different species. Discussion should lead to the advantages of grouping or classification of organisms on the basis of common characteristics, and the necessity of a common classification scheme.

Background: Classification schemes have changed over the years as new information has accumulated. An early classification scheme had all organisms divided into two kingdoms: plants and animals. A more recent classification scheme divides all organisms into five kingdoms (monerans, protists, fungi, plants and animals). At this level, students should be able to identify three of the five kingdoms: animals, plants, and fungi. The other two kingdoms can be grouped together as being microorganisms. These will be further distinguished in high school biology.

See the introductory page for the extent to which organisms will be classified in this unit. The use of the terms kingdom, phylum, and species may be used, but it is not necessary to go into the full formal classification scheme for individual species. It is enough to show the common characteristics of some phyla, and look at some examples of species that belong to them.

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LIFE SCIENCE: DIVERSITY OF LIFE

The Role of a Common Classification Scheme for Living Things

Tasks for Instruction and/or Assessment

Performance

- Collect leaves in your neighbourhood. After careful observation, decide on a way to group the leaves you have collected. In your note book, write or chart the characteristics that you decided on to group the leaves, and then draw pictures of the leaves in each group, or paste the leaves into your book in the appropriate place. Students might be challenged to identify the plant to which they belong. (Classification should be done with a variety of living things, such as insects and flowers). (204-6, 206-1)
- Share your classification scheme with other groups, and compare and contrast the schemes. (207-2)

Journal

- On my trip to the farm (seashore, park, garden centre), I saw many types of organisms ... (Students can continue to write about their experience, recording their point of interest during the trip. Encourage them to organize their journal entry into sections: one for animals, plants, fungi (if appropriate). (206-9, 300-15)

Paper and Pencil

- Here is an example of what could happen if scientists did not group and name organisms the same way: Fred, a scientist, is studying living things in Africa, and he sorts all the frogs, toads, and lizards (cold-blooded creatures) into a group called "grogs". Marie, another scientist doing a similar study, groups frogs, fish, and whales (water creatures) together and calls them "moists".
  a. Are Fred and Marie grouping their living things the same way? Is one better than the other? Explain. Could they compare their results of their investigations?
  b. If every scientist grouped living things the way they wanted, and called their groups by different names, what problems would it cause when they talked to each other about their ideas? (206-9, 300-15)

Interview

- Did your group classify things the same way other groups did? Why or why not? Is there more than one way we can classify organisms? (104-5)

Resources/Notes

Science and Technology 6

Teacher's Guide: Diversity of Living Things

Launch: Diversity at the Zoo, p. 8
1. Methods of Classifying, p. 10
2. Classifying Living Things, p. 13
3. Classifying Trees, p. 16
10. The Key to Classifying, p. 38

Design Project: Classifying Living Things Around Us, p. 46

Project Wild Activity Guide

Wild Words...A Journal-Making Activity, p. 82

Fashion a Fish, p. 197

ATLANTIC CANADA SCIENCE CURRICULUM: GRADE 6 23

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 correlations of outcomes to authorized resoruces.

Life Science: Diversity of Life

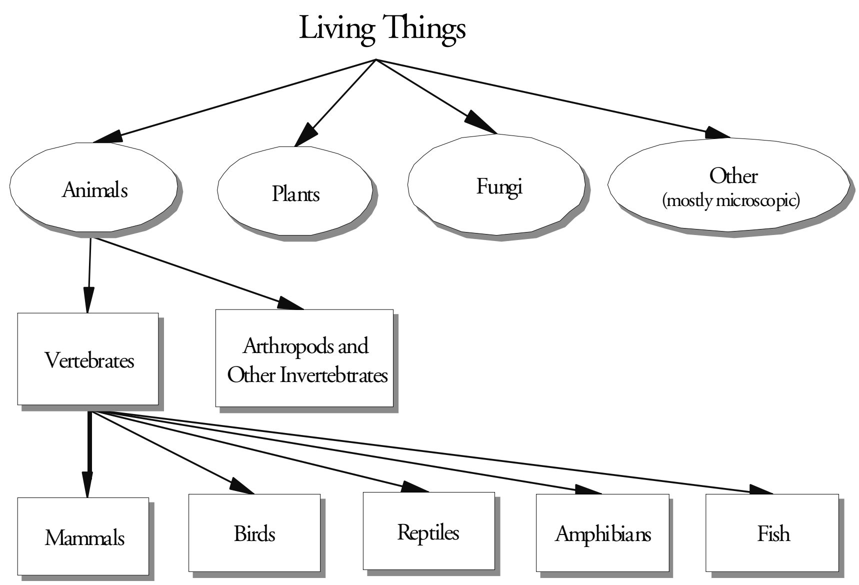
Introduction

Students are able to recognize that living things can be subdivided into smaller groups. As an introduction to the formal biological classification system, students should focus on plants, animals, and microorganisms. Students should have the opportunity to learn about an increasing variety of living organisms, both familiar and exotic, and become more precise in identifying similarities and differences among them.

Focus and Context

Inquiry is the focus in this unit, with an emphasis on observation and classification. Students should be involved in closely observing living things (plants, animals and microorganisms), noting their features, and constructing classification schemes that group organisms with like features. They should also be introduced to formal classification schemes through classification within the animal kingdom. Students will gain an appreciation for the diversity of life in their local habitat, in their province, in the world, and, through fossil studies, over time.

This diagram illustrates the organisms and classifications that will be addressed in this unit. Note that this is **not** a complete, formal biological classification scheme.



Science Curriculum Links

Students have investigated the needs and characteristics of living things, and explored the growth and changes in animals and plants in primary science.

pan-Canadian Science Learning Outcomes

N.B. The fololowing pan-Canadian Science Learning Outcomes were used as the framework in the development of the Atlantic Canada Science Curriculum at this grade level. They are included here to illustrate the three types of science outcomes at the Elementary level: i.e., *STSE*, *Knowledge* and *Skills*. **For planning, instructional, and assessment purposes, teachers should refer to the PEI/APEF Specific Curriculum Outcomes found on the next page.**

STSE	Skills	Knowledge
Students will be expected to	Students will be expected to	Students will be expected to
Nature of Science and Technology	**Initiating and Planning**	**300-15** describe the role of a common classification system for living things
104-5 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations	**204-1** propose questions to investigate and practical problems to solve	**300-16** distinguish between vertebrates and invertebrates
104-8 demonstrate the importance of using the languages of science and technology to compare and communicate ideas, processes, and results	**204-6** identify various methods for finding answers to given questions and solutions to given problems, and select one that is appropriate	**300-17** compare the characteristics of mammals, birds, reptiles, amphibians, and fish
105-1 describe examples of scientific questions and technological problems that are currently being studied	**204-8** identify appropriate tools, instruments, and materials to complete their investigations	**300-18** compare the characteristics of common arthropods
105-5 identify examples of scientific knowledge that have developed as a result of the gradual accumulation of evidence	**Performing and Recording**	**300-19** examine and describe some living things that cannot be seen with the naked eye
Relationships Between Science and Technology	**205-7** record observations using a single work, notes in point form, sentences and simple diagrams and charts	**302-12** describe how microorganisms meet their basic needs, including obtaining food, water, and air, and moving around
106-3 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries	**205-8** identify and use a variety of sources and technologies to gather pertinent information	**301-15** compare the adaptations of closely related animals living in different parts of the world and discuss reasons for any differences
Social and Environmental Contexts of Science and Technology	**Analysing and Interpreting**	**301-16** identify changes in animals over time, using fossils
107-1 describe examples, in the home and at school, of tools, techniques, and materials that can be used to respond to their needs	**206-1** classify according to several attributes and create a chart or diagram that shows the method of classifying	
107-6 provide examples of how science and technology have been used to solve problems around the world	**206-9** identify new questions or problems that arise from what was learned	
107-11 identify examples of careers in which science and technology play a major role	**Communication and Teamwork**	
	207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawing, and oral language	

PEI/APEF Specific Curriculum Outcomes

The Role of a Common Classification Scheme for Living Things

Students will be expected to

- identify different ways to classify living things in their local habitats (204-6)
- classify living things in the local habitat and create a chart or diagram that shows the method of classifying (206-1)
- present a selected classification scheme to others (207-2)
- describe how classifications may vary and suggest possible explanations for variations (104-5)
- identify communication problems that arise from the differences in classification schemes for living things, and describe the role of a common classification system (206-9, 300-15)

The Animal Kingdom: Vertebrates and Invertebrates

Students will be expected to

- classify animals as vertebrates or invertebrates (104-8, 300-16)
- compare the characteristics of mammals, birds, reptiles, amphibians, and fish (300-17)
- record observations while investigating common arthropods (205-7)
- compare characteristics of common arthropods (300-18)
- classify invertebrates as arthropods or "other invertebrates" (206-1)

Microorganisms

Students will be expected to

- identify and use appropriate tools to examine and describe a variety of microorganisms (204-8, 300-19)
- describe how microorganisms meet their basic needs, including obtaining food, water, and air, and moving around (302-12)
- provide examples of how science and technology have been involved in identifying and controlling the growth of microorganisms (107-6)
- describe products and techniques that can be used at home to protect against unwanted microorganism growth (107-1)

Adaptations and Natural Selection

Students will be expected to

- propose questions about the relationship between the structural features of organisms and their environment, and use a variety of sources to gather information about this relationship (204-1, 205-8)
- compare the adaptations of closely related animals living in different parts of the world and discuss reasons for any differences (301-15)
- describe reasons why various animals are endangered, and describe efforts to study their populations size and ensure their continued existence (105-1, 107-6)
- use the fossil record to identify changes in animals over time (301-16)
- identify the theory of natural selection as one that has developed based on the gradual accumulation of evidence (105-5)
- identify palaeontologists as people who study fossils, and describe examples of improvements to some of their techniques and tools that have resulted in a better understanding of fossil discovereies (106-3, 107-11)

The Role of a Common Classification Scheme for Living Things

Outcomes

Students will be expected to

- identify different ways to classify living things in their local habitat (204-6)
- classify living things in the local habitat and create a chart or diagram that shows the method of classifying (206-1)
- present a selected classification scheme to others (207-2)
- describe how classifications may vary and suggest possible explanations for variations (104-5)
- identify communication problems that arise from the differences in classification schemes for living things, and describe the role of a common classification system (206-9, 300-15)

Elaborations–Strategies for Learning and Teaching

Students should start this unit by going out to a local habitat (forest, seashore, pond, meadow, park, wooded area), and observe and record the wide variety of species that they see. Using other sources, such as magazines, videos, field guides and other media, they can appreciate the greater diversity of life. From their observations and research, students can classify their organisms into groups based on characteristics they select. They may use fairly specific characteristics or more general groupings related to insects, plants, fungi, trees, animals or combinations of each. Students can then attempt to sort them using different characteristics, and come up with a totally different classification scheme. As they compare their schemes with others in the class, they will see that their classification schemes will not be the only way to classify organisms.

Teachers could initiate a discussion around the necessity for a common classification scheme in order for scientists to communicate using the same language and terminology. There are more than one million species of living things, with the possibility of millions more yet to be discovered. This raises questions about how we can simplify the presentation of information about so many different species. Discussion should lead to the advantages of grouping or classification of organisms on the basis of common characteristics, and the necessity of a common classification scheme.

Background: Classification schemes have changed over the years as new information has accumulated. An early classification scheme had all organisms divided into two kingdoms: plants and animals. A more recent classification scheme divides all organisms into five kingdoms (monerans, protists, fungi, plants and animals). At this level, students should be able to identify three of the five kingdoms: animals, plants, and fungi. The other two kingdoms can be grouped together as being microorganisms. These will be further distinguished in high school biology.

See the introductory page for the extent to which organisms will be classified in this unit. The use of the terms kingdom, phylum, and species may be used, but it is not necessary to go into the full formal classification scheme for individual species. It is enough to show the common characteristics of some phyla, and look at some examples of species that belong to them.

The Role of a Common Classification Scheme for Living Things

Tasks for Instruction and/or Assessment

Performance

- Collect leaves in your neighbourhood. After careful observation, decide on a way to group the leaves you have collected. In your note book, write or chart the characteristics that you decided on to group the leaves, and then draw pictures of the leaves in each group, or paste the leaves into your book in the appropriate place. Students might be challenged to identify the plant to which they belong. (Classification should be done with a variety of living things, such as insects and flowers). (204-6, 206-1)
- Share your classification scheme with other groups, and compare and contrast the schemes. (207-2)

Journal

- On my trip to the farm (seashore, park, garden centre), I saw many types of organisms ... (Students can continue to write about their experience, recording their point of interest during the trip. Encourage them to organize their journal entry into sections: one for animals, plants, fungi (if appropriate)). (206-9, 300-15)

Paper and Pencil

- Here is an example of what could happen if scientists did not group and name organisms the same way: Fred, a scientist, is studying living things in Africa, and he sorts all the frogs, toads, and lizards (cold-blooded creatures) into a group called “grogs”. Marie, another scientist doing a similar study, groups frogs, fish, and whales (water creatures) together and calls them “moists”.
    a. Are Fred and Marie grouping their living things the same way? Is one better than the other? Explain. Could they compare their results of their investigations?
    b. If every scientist grouped living things the way they wanted, and called their groups by different names, what problems would it cause when they talked to each other about their ideas? (206-9, 300-15)

Interview

- Did your group classify things the same way other groups did? Why or why not? Is there more than one way we can classify organisms? (104-5)

Resources/Notes

Science and Technology 6

Teacher’s Guide:
Diversity of Living Things

Launch: Diversity at the Zoo, p. 8

1. Methods of Classifying, p. 10
2. Classifying Living Things, p. 13
3. Classifying Trees, p. 16
10. The Key to Classifying, p. 38

Design Project: Classifying Living Things Around Us, p. 46

Project Wild Activity Guide

Wild Words...A Journal-Making Activity, p. 82

Fashion a Fish, p. 197

The Animal Kingdom: Vertebrates and Invertebrates

Outcomes

Students will be expected to

- classify animals as vertebrates or invertebrates (104-8, 300-16)
- compare the characteristics of mammals, birds, reptiles, amphibians, and fish (300-17)
- record observations while investigating common arthropods (205-7)
- compare characteristics of common arthropods (300-18)
- classify invertebrates as arthropods or "other invertebrates" (206-1)

Elaborations–Strategies for Learning and Teaching

In this section, students are introduced to classifying animals as vertebrates (animals with a backbone) or invertebrates (animals without backbones).

Students can attempt to classify the animals from their list of organisms as vertebrates or invertebrates (most of the organisms from the habitat study will probably be invertebrates—invertebrates outnumber vertebrates in diversity and number, and most of the vertebrates will have, in all probability, remained well hidden). They can also classify other animals that they have seen in a variety of print and electronic resrouces or on field trips to zoos, natural history museums and aquaria. Students should have opportunities to see reconstructed backbones or models of backbones, and compare and contrast them with exoskeletons of lobsters or crabs.

From their list of vertebrates, students, individually or in groups, can classify the organisms further. Challenge the students to find a variety of ways to group their vertebrates. The students can report their schemes to the class, and why they choose them. As long as their schemes are based on set characteristics, they are valid classifications. However, for global communication, a common classification scheme has to be agreed on, and at some point, the common groups of vertebrates (fish, amphibians, reptiles, birds and mammals) should be introduced, and their common characteristics identified. As much as possible, students should be given opportunities to study live and preserved organisms or view videos of animals that are representative of these groups.

The invertebrates will not be completely classified in this unit. Of approximately thirty invertebrate phyla, this unit will only distinguish the arthropods (many jointed legs). Students could collect real specimens and/or pictures of common arthropods, and bring them to class where they could observe and record characteristics of this group. Insects make up a large portion of arthropods, and provide interesting and motivating specimens for investigations. Students can investigate these organisms outdoors, or set up artificial indoor habitats for them, such as ant farms or jars with dirt, leaves and food or wood scraps. Other arthropods that can be explored are lobsters and crabs, centipedes and millipedes, and spiders.

The Animal Kingdom: Vertebrates and Invertebrates

Tasks for Instruction and/or Assessment

Performance

- From drawings, specimens, pictures, or a list of animals, classify each organism as a vertebrate or invertebrate, and then further classify them as mammals, birds, reptiles, amphibians, fish, arthropods, or other invertebrates. (Provide drawings, pictures, or list of animals) (104-8, 206-1, 300-16, 300-17)
- Examine pictures or specimens of arthropods. Investigate the relationship between arthropod's mouth parts and feeding behaviour. How does the arthropod's mouth parts help it feed? Draw and label sketches and record your observations and findings in sentences. (205-7)

Journal

- In your journal, draw pictures and describe some of the arthropods that you have investigated. Did you find it easy to see the similarities in these different organisms? What similarities did you find first? Were there any features that you thought all arthropods had, but then found out that they didn't? (205-7, 300-18)

Paper and Pencil

- What questions would you ask to determine if an animal is a mammal, bird, reptile, fish or amphibian. (300-17)

Interview

- Students are shown pictures or specimens of skeletons of various vertebrates, including some fish, birds and mammals. How are these skeletons alike? How are they different? Note whether students indicate that animals that can look very different on the outside can have very similar skeletons. (300-17)

Portfolio

- Select one of your best pieces of work on invertebrates or vertebrates. Evaluate this work on the Portfolios assessment sheet.

Resources/Notes

Science and Technology 6

**Teacher's Guide:
Diversity of Living Things**

4. Classifying Animals - The Invertebrates, p. 19
5. Classifying Arthropods, p. 23
6. Observing an Arthropod - The Mealworm, p. 26
7. Classifying Animals - The Vertebrates, p. 29

Project Wild Activity Guide

Microtrek Scavenger Hunt, p. 20

Microorganisms

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • identify and use appropriate equipment to examine and describe a variety of mircroorganisms (204-8, 300-19)	When using microscopes, students should be taught the proper way to use and care for a microscope. Microscope video cams can be connected to a large screen television, computer monitor, or projection unit to show the whole class the features of microorganisms. Hand lenses and mini microscopes can be used to view microscopic characteristics. A magnifying learning centre that also includes illustrations of other magnifying devices, such as electron microscopes, would be ideally suited for this purpose. A field trip to a local university or research facility might be arranged so that students can see some of the more advanced devices used in the study of the microscopic world.
• describe how microorganisms meet their basic needs, including obtaining food, water, and air, and moving around (302-12)	Students should describe how microorganisms meet their basic needs such as obtaining nutrients, water and oxygen. Samples of pond water, compost material, aquarium glass scrapings or prepared slides can provide specimens for study. Physical features such as flagella or cilia, that help microorganisms meet their needs, should be highlighted. The use of commercially prepared slides and videos that illustrate the various features of microorganisms is recommended.
• provide examples of how science and technology have been involved in identifying and controlling the growth of microorganisms (107-6)	Students should understand that microorganisms can be both beneficial. (e.g., food digestion in the bowel, composting sanitation, food preservation, and disease control) and harmful to humans (e.g., spreading many germs and diseases). Guest speakers, students' interviews with grocers, food processors, fish plant workers, sanitation workers, health inspectors and public health officials in the community are good exercises.
• describe products and techniques that can be used at home to protect against unwanted microorganism growth (107-1)	Students could discuss examples of technological innovations that have been developed to protect against unwanted microorganisms (such as cleaning solutions, processed lunch packages, canned goods, preserving jars, and antibacterial hygienic products like toothpaste, creams, and soaps.)

Microorganisms

Tasks for Instruction and/or Assessment

Performance

- Use a microscope or micro-viewer to correctly focus a prepared slide. Draw a sketch of what you see. (204-8, 300-19)

Journal

- Write a paragraph about two microorganisms: one that can be harmful to humans and one that can be beneficial to humans. Collect or draw pictures of these microorganisms, and research the features that enable them to move and obtain food. (302-12)

Paper and Pencil

- Research Assignment: Using a specific example, (e.g., strep throat, e-coli in food products) describe the roles of both science and technology in controlling harmful bacteria in one of the following: sanitation, food preservation and disease control. (Students should differentiate between scientific study of the organisms, and technological products and techniques that have been developed to control the organisms). (107-6)

Presentation

- Prepare a display of images viewed through magnifying glasses, microscopes, and electron microscopes. Under each image, identify the object that was magnified, the instrument that magnified it, and the extent to which it was magnified (for example (40x). (204-8, 300-19)
- Collect the labels and brochures of disinfectants and antibacterial hygienic products. Make a poster displaying product labels which are used to protect against microorganism growth. (107-1)
- A short skit could be developed on good and bad bacteria. This could be video recorded or presented live. (107-1)

Portfolio

- Select one of your best pieces of work on microorganisms for your portfolio. (302-12, 107-6, 107-1)

Resources/Notes

Science and Technology 6

Teacher's Guide:
Diversity of Living Things

11. The Microscopic World, p. 41

Project Wild Activity Guide

Interview a Spider, p. 13

Water Canaries, p. 109

Micro Odyssey, p. 165

Something's Fishy Here! p. 311

SPECIAL PLACES: Eco-Lessons from the National Parks in Atlantic Canada

Conservation 'Ad'vice for National Parks, p. 3.1

Adaptations and Natural Selection

Outcomes

Students will be expected to

- propose questions about the relationship between the structural features of organisms and their environment, and use a variety of sources to gather information about this relationship (204-1, 205-8)
- compare the adaptations of closely related animals living in different parts of the world and discuss reasons for any differences (301-15)
- describe reasons why various animals are endangered, and describe efforts to study their population size and ensure their continued existence (105-1, 107-6)
- identify changes in animals over time, using fossils (301-16)
- identify the theory of natural selection as one that has developed based on the gradual accumulation of evidence (105-5)
- identify palaeontologists as people who study fossils, and describe examples of improvements to some of their techniques and tools that have resulted in a better understanding of fossil discoveries (106-3, 107-11)

Elaborations–Strategies for Learning and Teaching

In classroom discussion, teachers can encourage students to ask questions about the adaptations and structural features of organisms. For example, students could ask, "Why does this frog have such a long tongue?" Questions like these should be rephrased to "What does the frog use his long tongue for?" and used as the basis of an investigation. Students can study the organisms they found in their field study to identify the features that have enabled them to live in their particular habitat.

They should explore similar organisms that live in different parts of the world (e.g., arctic hare and snowshoe hare), and inquire about the structural differences in these organisms, and how these structural differences help them in their environment.

Students can inquire into the conditions that have led to the endangerment of various species. Students can investigate local and global examples to see how information about population size is determined, and what efforts are being made to ensure the survival of these species. This will encourage students to be aware of and develop a sense or responsibility for the welfare of living things.

Students should explore what types of fossils have been found and theories that exist about what caused particular organisms (e.g., dinosaurs) to become extinct. Field trips to fossil exhibits or local sites are encouraged. The use of software, the Internet, print resources and audiovisual resources would also be good sources of information about fossils.

Students should explore evidence of natural selection from studies of bacterial strains that are resistant to antibiotics. Superbugs have developed due to the overuse of antibacterials creams. Students can explore genetic research on genetically modified organisms such as tomatos, potatos, corn, and fish.

Students should also investigate the tools and techniques, past and present, that paleontologists use to acquire knowledge about fossils (finding and cleaning fossils, trying to piece together skeletal remains, estimating the age of fossils using computer generated diagrams, carbon-dating, etc.) The emphasis should be on helping students to see that improvements in scientific techniques and technological tools can lead to better scientific knowledge. The emphasis should not be on explaining how these new techniques and technological tools actually work.

This section provides an excellent opportunity for students to explore a variety of science-related careers related to the diversity of life.

Adaptations and Natural Selection

Tasks for Instruction and/or Assessment

Journal

- Write about your personal feelings regarding endangerment of local species. (105-1, 107-6)

Paper and Pencil

- Choose a pair of similar animals and research their different habitats. Identify one major difference between them and describe how that difference helps that animal survive in its habitat. Examples of similar aminals that might be researched include:
  a. brown bear and polar bear
  b. red fox and arctic fox
  c. red-eyed tree walker frog and poison dart frog
  d. Beluga whale and Orca whale (301-15)
- Write a report about palaeontologists. Include a description of what they study, some of the techniques they use in their work, and how their work has contributed to our understanding of life on Earth. (106-3, 107-11)

Presentation

- Choose an organism and describe the structural features that enable it to survive in its environment. Focus on the structural features that the organism has for moving, obtaining food, and protecting itself. Describe how these help it to survive in its environment. Present your findings to the class using drawings, pictures, video or skit. (204-1, 205-8)
- From a list of endangered species, choose one and research it. Why is it endangered? What is being done to protect it? Work in pairs and present your findings to the class. (105-1, 107-6)
- Create a poster showing extinct organisms that lived on Earth long ago and similar organisms that live on Earth today. (204-1,301-16)

Resources/Notes

Science and Technology 6

**Teacher's Guide:
Diversity of Living Things**

6. Observing an Arthropod - The Mealworm, p. 26
7. Classifying Animals - The Vertebrates, p. 29
8. All About Fish, p. 32
9. A Prehistoric Vertebrate, p. 35

Project Wild Activity Guide

Water Canaries, p. 109

Hook and Ladders, p. 184

Fashion a Fish, p. 197

Here Today, Gone Tomorrow, p. 216

Too Close For Comfort, p. 286

SPECIAL PLACES: Eco-Lessons from the National Parks in Atlantic Canada

The News Knows! p. 4.1

Species at Risk, p. 5.1

Physical Science: Electricity

Introduction

Students encounter electricity every day of their lives. A basic understanding of how electricity works can help students recognize the need for safe practices when around electricity, begin to realize that they have control over how much electricity they use in the home and at school, and begin to understand the impact energy consumption has on resources used to generate electricity.

Focus and Context

There is a dual focus in this unit, inquiry and problem solving. Students should be encouraged to investigate which materials conduct electricity, and compare a variety of circuit pathways. From this, they should be able to design solutions to electrical problems by completing various circuit pathways.

The context for this topic should be on electrical systems. Our society's reliance on electricity is pervasive; one need only think about the implications of an extended blackout to realize the extent to which our society depends on electricity. Electrical appliances, houses, small towns, and large cities use and depend on electricity to function.

Science Curriculum Links

This unit follows from a grade 3 unit, Invisible Forces, in which students explore static electricity. Students will explore electricity again in grade 9.

pan-Canadian Science Learning Outcomes

N.B. The fololowing pan-Canadian Science Learning Outcomes were used as the framework in the development of the Atlantic Canada Science Curriculum at this grade level. They are included here to illustrate the three types of science outcomes at the Elementary level: i.e., *STSE*, *Knowledge* and *Skills*. **For planning, instructional, and assessment purposes, teachers should refer to the PEI/APEF Specific Curriculum Outcomes found on the next page.**

STSE

Students will be expected to

Nature of Science and Technology

104-5 describe how results of similar and repeated investigations may vary and suggest possible explanations for variations

105-3 describe examples of scientific questions and technological problems that have been addressed differently at different times

Relationships Between Science and Technology

106-3 describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries

106-4 describe instances where scientific ideas and discoveries have led to new inventions and applications

Social and Environmental Contexts of Science and Technology

107-9 compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment

108-5 describe how personal actions help conserve natural resources and protect the environment in their region

108-8 describe the potential impact of the use by humans of regional natural resources

Skills

Students will be expected to

Initiating and Planning

204-1 propose questions to investigate and practical problems to solve

204-3 state a prediction and a hypothesis based on an observed pattern of events

204-4 define objects and events in their investigations

204-7 plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea

204-8 identify appropriate tools, instruments, and materials to complete their investigations

Performing and Recording

205-1 carry out procedures to explore a given problem and to ensure a fair test of a proposed idea, controlling major variable

205-3 follow a given set of procedures

205-7 record observations using a single word, notes in point form, sentences, and simple diagrams and charts

205-9 use tools and apparatus in a manner that ensures personal safety and the safety of others

Analysing and Interpreting

206-3 identify and suggest explanations for patterns and discrepancies in data

Communication and Teamwork

207-2 communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language

Knowledge

Students will be expected to

303-31 identify and explain the dangers of electricity at work or at play

303-23 compare a variety of electrical pathways by constructing simple circuits

300-20 compare the conductivity of a variety of solids and liquids

303-24 describe the role of switches in electrical circuits

303-25 compare characteristics of series and parallel circuits

303-22 compare the characteristics of static and current electricity

303-27 describe the relationship between electricity and magnetism when using an electromagnet

303-26 demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects

303-28 identify various methods by which electricity can be generated

303-29 identify and explain sources of electricity as renewable or nonrenewable

303-30 identify and explain different factors that could lead to a decrease in electrical energy consumption in the home and at school

PEI/APEF Specific Curriculum Outcomes

Electrical Safety

Students will be expected to

- use tools and apparatus such as batteries, bulbs, and wires in a manner that ensure personal safety and the safety of others (205-9)
- identify and explain the dangers of electricity at work or at play (303-31)
- describe examples of how our knowledge of the hazards of electrical shock has led to the development of electrical safety features (106-4)

Investigating Static Electricity

Students will be expected to

- record observationsa while exploring and solving static electricity challenges (205-7)
- suggest possible explanations for variations in the results of investigations involving static electricity (104-5, 206-3)
- use the terms *attraction*, *repulsion*, *electrons*, *positive charg*e and *negative charge* in meaningful contexts while exploring static electricty (204-4)

Circuit Pathways

Students will be expected to

- compare a variety of electrical pathways by constructing simple circuits, and illustrate the electrical circuits with drawings and apropriate symbols (303-23, 207-2)
- test the conductivity of different solids and liquids, and draw conclusions as to which materials tested were insulators or conductors (205-3, 300-20)
- describe the role of switches in electrical circuits, and identify materials that can be used to make a switch (303-24, 204-8)
- compare characteristics of series and parallel circuits (303-25)
- compare the characteristics of static and current electricity (303-22)

Electromagnets and their Applications

Students will be expected to

- describe the relationship between electricity and magnetism when using an electromagnet (303-27)
- propose questions about the factors that affect the strength of electromagnets, state predictions and hypotheses related to these factors, and carry out a fair test of these factors (204-1, 204-3, 205-1)
- describe how knowledge of electronmagnets has led to the development of many electrical devices that use them (106-3)

Uses for Electricity

Students will be expected to

- demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects (303-26)
- propose electrical circuitry problems to investigate, and plan a set of steps to solve them (204-1, 204-7)
- describe how knowledge of electricity has led to many new inventions that have changed the way we live, and describe ways in which we have become increasingly dependent on electricity over the years (107-9, 106-4)

Sources of Electricity

Students will be expected to

- describe how knowledge that magnets can produce electric current led to the invention of electrical generators (106-4)
- identify and investigate various methods of generating electricity (past, present and future), and describe some ways in which these methods affect the environment (303-28, 105-3, 108-8)
- identify and explain sources of electricity as renewable or nonrenewable (303-29)

Electrical Energy Consumption and Conservation

Students will be expected to

- identify and explain different factors that could lead to a decrease in electrical energy consumption in the home and at school and how will this help protect the environment (108-5, 303-30)

Electrical Safety

Outcomes

Students will be expected to

- use tools and apparatus such as batteries, bulbs, and wires in a manner that ensures personal safety and the safety of others (205-9)
- identify and explain the dangers of electricity at work or at play (303-31)
- describe examples of how our knowledge of the hazards of electrical shock has led to the development of electrical safety features (106-4)

Elaborations–Strategies for Learning and Teaching

Since students will be working with various electrical devices safety outcomes should be reinforced throughout this unit.

Students should be made aware of the dangers of shock related to electrical sockets, especially when it comes to inserting metallic objects in them. This could be addressed with outcomes related to insulators and conductors.

Project work, safety videos, classroom discussions, or class presentations by electricians or the fire department are recommended. Students should be made aware of dangerous situations involving electricity:

- taking electrical devices such as radios or hair dryers into the bathroom where water could cause electric shock
- fallen power lines
- climbing transmission towers
- climbing trees or flying kites near power lines
- frayed insulation on electrical wires
- pulling out plugs by the cord
- taking apart electrical appliances (some contain capacitors which store electrical charge even if unplugged)

Students can identify safety features such as the three prong plug, circuit breakers, grounding wires and fuses that have been developed to reduce the chance of electrical shock. Guest speakers, such as utility company personnel could be invited to the class.

Students can create charts, collages, videos or other displays that illustrate electrical safety.

Electrical Safety

Tasks for Instruction and/or Assessment

Presentation

- Create a poster or web page, that illustrates: (106-4, 303-31)
  a. electrical dangers at work and play
  b. electrical safety devices/procedures which protect us from these dangers.
- Make a public service advertisement which provides safety information about electricity. (106-4, 303-31)

Informal/Formal Observation

- As students work through the activities in this unit, teachers should ensure that safety considerations are addressed and that students follow established procedures. (205-9)

Resources

Science and Technology 6

Teacher's Guide: Electricity

2. Characteristics of Electricity, p. 13
4. Light Up the Classroom, p. 21
6. Different Needs, Different Circuits, p. 28
9. Learning About Magnets, p. 38
10. Electrical Picker Uppers, p. 41

Design Project: Secret Talk, p. 53

Investigating Static Electricity

Outcomes

Students will be expected to

- record observations while exploring and solving static electricity challenges (205-7)
- suggest possible explanations for variations in the results of investigations involving static electricity (104-5, 206-3)
- use the terms *attraction*, *repulsion*, *electrons*, *positive charge* and *negative charge* in meaningful contexts while exploring static electricity (204-4)

Elaborations–Strategies for Learning and Teaching

Matter is defined as anything that has mass and occupies space and an ***atom*** is the smallest unit of matter.

At the centre of each atom is a nucleus which contains two kinds of tiny particles, ***protons*** and ***neutrons*** and orbiting around the nucleus are even smaller particles called ***electrons***. Protons, neutrons and electrons are very different from each other. They have their own properties or characteristics and one of these properties is called an ***electrical charge***. While neutrons have no charge at all (they are neutral), a proton has a positive charge (+), and an electron has a negative charge (-) and they are both equal in strength. If the number of protons in an atom is the same as the number of electrons then the electrical charges balance each other and the atom is said to be neutral.

Normally the nucleus does not change. Its protons and neutrons are held together very tightly and cannot be altered by usual everyday methods. It would require some form of high-energy nuclear occurence to distrub the nucleus and subsequently dislodge its positively-charged protons.

Electrons occupy the region of space outside the nucleus in specific, predictable ways. Some electrons may be removed or added to the outer regions of the atoms depending on the type of atom it is. A neutral atom that loses electrons has more positive particles (protons) than negative particles (electrons) and is now *positively charged*. An atom that gains electrons has more negative than positive particles and is said to be *negatively charged*. **Static electricity is the imbalance of positive and negative charges.**

Positive and negative charges behave in interesting ways. Two things with opposite charges (a positive vs. a negative) will attract each other. Things with the same charge (two positives or two negatives) will repel, or push away from each other. For example, when you take off your wool hat, it rubs against your hair causing electrons to move from your hair to the hat leaving many positively charged hairs on your head. Since things with the same charge repel each other the hairs try to get as far from each other as possible and the farthest they can get is by standing up and away from the others.

Some materials impede the free flow of electrons from atom to atom. These things are called *insulators*. Plastics, cloth, glass and rubber are good insulators. Other materials permit the free flow of electrons and make it easier for a charge to be transferred. These are called *conductors*; most metals are good conductors. For example, if you were to walk across the carpeting of a room, electrons would likely be scuffed off the carpet and on to you. Now you have extra electrons and if you come near to a good conductor such as a metal door knob, these electrons will jump from you to the knob giving you a shock.

Scientists have ranked materials in order of their ability to hold or give up electrons. A list of common materials follows. Under ideal conditions, if two materials come in contact with each other, the higher one on the list should give up electrons and become positively charged. Students could experiment with these items.

1. your hand
2. glass
3. your hair
4. nylon
5. wool
6. fur
7. silk
8. paper
9. cotton
10. hard rubber
11. polyester
12. polyvinylchloride plastic (PVC)

When we charge something with static electricity, no electrons are made or destroyed. No new protons appear or disappear. Electrons are just moved from one place to another. The total electric charge stays the same. This is called the *Principle of Conservation of Charge*.

Investigating Static Electricity

Tasks for Instruction and/or Assessment

Performance

Students will have already investigated static electricity in Grade 3. Brainstorm with students about their previous experiences and allow them to further explore static electricity with a variety of materials, such as balloons, fur, fabrics, rubber rods, styrofoam balls, bits of paper or confetti, and plastic combs. Challenge students with a combination of materials which, when rubbed, will attract or repel small pieces of paper confetti or rice. Which combination of materials, when rubbed, will attract a hanging piece of yarn? Can they get two identical or two different objects to attract or repel each other? Students should record their observations, measurements, and the procedures.

- Select from the materials provided and solve the static electricity challenge. Record each strategey that you tried in solving the challenge, and your observations. Identify the strategy that gave you the best results. (205-7, 204-4)

Electricity Observations

Activity	Observations	Inferences

Journal

- Students should realize that very often in science, identical results are not always achieved. In their investigations of static electricity students can compare their results with those of others and attempt to explain any differences. They might speculate about experimental error or differences in materials or procedures.

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Electricity

8. A Special Kind of Electricity - Static Electricity, p. 35

Circuit Pathways

Outcomes

Students will be expected to

- compare a variety of electrical pathways by constructing simple circuits, and illustrating the circuits with drawings and appropriate symbols (303-23, 207-2)
- follow instructions for testing the conductivity of different solids and liquids, and draw conclusions as to which materials were insulators or conductors (205-3, 300-20)
- describe the role of switches in electrical circuits, and identify materials that can be used to make a switch (303-24, 204-8)
- compare characteristics of series and parallel circuits (303-25)
- compare the characteristics of static and current electricity (303-22)

Elaborations–Strategies for Learning and Teaching

After reviewing *static* (stationary) electricity, students then move on to an exploration of *current* (moving) electricity. They can experiment with batteries, wires and light bulbs to determine which *circuits* allow electricity to flow and which ones do not. They should then draw diagrams to illustrate both types. Teachers can introduce the proper symbols for representing cells, batteries, light bulbs, switches, and other components that may be added later in the unit.

Using copper wire, batteries, bulbs and other materials students should test such items as paper clips, tin foil, fresh water, salt, or sugar water, plastic spoons, and coins to discover which ones conduct electricity (conductors) and which do not (insulators).

The role of switches should now be investigated. In simple circuits, such as those students made earlier in the unit, electricity is flowing constantly in a complete path and there is no way to control it other than by disconnecting the power source. A switch is inserted somewhere along the path to allow you to interrupt the flow of electricity. Students should relate what they learned about insulators to identify materials that might be used to make a switch. Provide students with switches to incorporate into their simple circuits and diagrams.

Students should observe and compare how lights in *series* and *parallel* circuits are connected. Christmas lights are good examples. In strands of Christmas lights that are connected in parallel a burned out bulb has no impact on the rest of the bulbs. Older sets of lights that used bulbs about the size of a night light were connected in parallel. However, they used a lot of energy (about 5 watts per bulb) and generated enough heat to melt things.

The more recent mini-lights are about 2.5 volts each and they are connected in series. In the earlier sets of mini-lights, if one bulb burned out the whole set went out. This problem was fixed by placing a *shunt wire* in each bulb just below the filament. If the filament burns out, the shunt keeps the current running through the bulb so the rest of the strand stays lit.

Students should construct both types of circuits and investigate the properties of each by breaking the circuit at various points. Since students have gained an understanding of the importance of a complete circuit they can now apply their problem-solving skills in situations where cicuits do not work as aniticipated: *Is the battery dead? Are the connections tight? Is there a break in the wire? Is there a systematic way to test all the possibilities until a solution is found?*

Students can take apart and examine a variety of simple electrical devices, like flashlights, or a plug and wire, to try to explain how the circuit is completed. Circuit testers and simple voltmeters can be used to accurately measure changes in electrical characteristics.

Probe their conceptions of electricity by asking questions like, “How is the static electricity on our clothes or in our hair different from the electricity that runs this clock (or some other appliance)?

Lead the discussion so that students understand that in static electricity the charge is localized on an object; that is, it stays on the object. In current electricity, the charge consists of electrons that move along a closed path. How is the static electricity in our hair or on our clothes different from the elecrricty that runs on a television?

Circuit Pathways

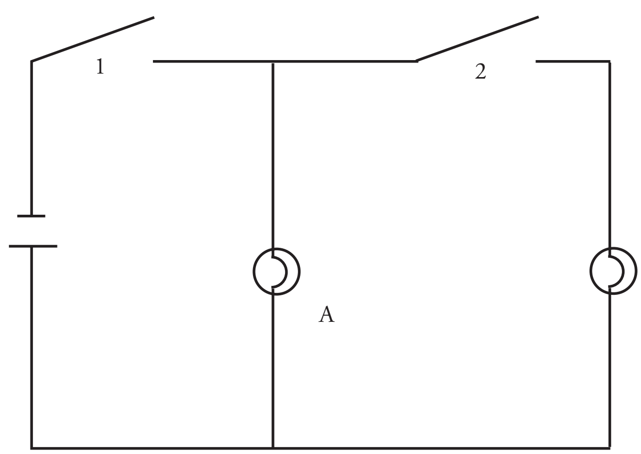
Tasks for Instruction and/or Assessment

Performance

- Determine which of the materials (e.g., paper clips, erasers, aluminium foil, salt water, cotton) are insulators or conductors. Create a wall chart of conductors/insulators from students' collected results. From the diagram of the simple circuit, construct a working model with the materials provided. (Provide students with a diagram of a series or parallel circuit with one or two batteries, light sources, or other electrical devices.) (303-23, 207-2, 303-24, 204-8, 205-3, 300-20)
- Construct electrical circuits using a variety of electrical equipment. Draw and chart their results using appropriate symbols. (204-8, 207-2, 303-23, 303-24, 303-25)

Paper and Pencil

- What light bulbs (A, B, both, or neither) will be "on" if
  a. Switch 1 is open and Switch 2 is closed
  b. Switch 1 is closed and switch 2 is open (303-24, 204-8)
- If a second bulb is added to a series circuit: (303-25)
  a. the light gets brighter
  b. the light gets duller
  c. the light goes out
  d. the brightness stays the same



Interview

- What is the difference between insulators and conductors? Give examples of each. (205-3, 300-20)

Journal

- From home and school experiences, write about two examples each of static and current electricity, and how each affects your daily life. (303-22)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Electricity

2. Characteristics of Electricity, p. 13
4. Light Up the Classroom, p. 21
5. Key Features of Electrical Circuits, p. 25
6. Different Needs, Different Circuits, p. 28
7. Fixing Electrical Problems, p. 32
8. A Special Kind of Electricity - Static Electricity, p. 35

Electromagnets and their Applications

Outcomes

Students will be expected to

- describe the relationship between electricity and magnetism when using an electromagnet (303-27)
- propose questions about the factors that affect the strength of electromagnets, state predictions and hypotheses related to these factors, and carry out a fair test of these factors (204-1, 204-3, 205-1)
- describe how knowledge of electromagnets has led to the development of many electrical devices that use them (106-3)

Elaborations–Strategies for Learning and Teaching

A simple electromagnet can be constructed by using a length of insulated wire, a battery, and a long iron nail or spike to wrap the wire around. A compass needle or paper clips, staples, and other small magnetic objects can be used to detect the magnetism.

Caution: Do not test electromagnets or magnets near computers, computer diskettes, or CD-Roms.

Once students make an electromagnet they can experiment with ways to increase its strength. They can then state their ideas in the form of a testable question, and propose a hypothesis and make predictions. Some variables they might like to investigate could be the voltage of the batteries, the number of wraps of wire around the nail, the type and size of nail, and the type of wire being used. They can test the electromagnet by seeing how much a compass needle is deflected by the electromagnet, or by counting the number of staples or paper clips the electromagnet attracts.

Caution: Students should not use battery sources of any more than 3 volts. The electromagnets they make have circuits with very little resistance, only very conductive wires. The current that flows in the electromagnets will be relatively large compared to the other circuits they have constructed, and the wires get hot quite quickly. If they wish to test the effect of increased voltage, get them to use one 1.5 V battery, then repeat with two 1.5 V batteries connected in series. **Caution: students are not to try house current coming from the wall in their house, and not to try a car battery.**

Many devices that use electromagnets (telephones, televisions, radios, and microphones) can be displayed in the classroom. Pictures of heavy objects that are being lifted using electromagnets can be used to illustrate the power that they have. Students can investigate simple devices, like doorbells, to see how the electromagnets cause the bell to work. These activities will encourage students to appreciate the role and contribution of technology in their understanding of the world.

Electromagnets and their Applications

Tasks for Instruction and/or Assessment

Performance

- Carry out procedures to test a variable that could affect the strength of an electromagnet. The plan should include clear statements of the problem, hypothesis, materials, procedure, controlled, manipulated, and responding variables, as well as observations, and results. (303-27, 204-1, 204-3, 205-1)

  Note: (Variables could include the size, shape and type of the core, or the type, size and length of wire wrapped around the core.)

Journal

- What did you learn about electromagnets? What else would you like to know? (204-1, 204-3, 204-7)

Interview

- What is an electromagnet? What do you need to make an electromagnet? What makes an electromagnet stronger? (204-1, 204-3, 204-7)

Presentation

- Collect or draw pictures of devices which use electromagnets. For each, state the role of the electromagnet in the device. (106-3)

Resources

Science and Technology 6

Teacher's Guide: Electricity

9. Learning About Magnets, p. 38
10. Electrical Picker Uppers, p. 41

Uses for Electricity

Outcomes

Students will be expected to

- demonstrate how electricity in circuits can produce light, heat, sound, motion, and magnetic effects (303-26)
- propose electrical circuitry problems to investigate, and plan a set of steps to solve them (204-1, 204-7)
- describe how knowledge of electricity has led to many new inventions that have changed the way we live, and describe ways in which we have become increasingly dependent on electricity over the years (107-9, 106-4)

Elaborations–Strategies for Learning and Teaching

Bring on the gadgets! All kinds of buzzers, lights, solar cells, motors, and electromagnets can be used. Heat can be demonstrated by feeling the light bulb warm up, or by displaying electrical devices that convert electrical energy into heat (toasters, curling irons, kettles). **Caution: Check the voltage rating on the gadget—some of them need a power supply with greater than three volts.** You must make sure the minimum voltage required for the device is between one–three volts, or else you will be using too many batteries to get it to work. Students can make circuits using these devices to see how they work.

Students should design a circuit. Challenge students to think of an electrical task. For example, design circuits that won't shut off if one light bulb is removed, or one that will; design a circuit with switches that activate the circuit on contact, or one with switches that turn off the circuit on contact; circuits that have two places to turn off or on a circuit; or circuits with buzzers that are activated by touching something. Give them a wide variety of electrical apparatus (such as wires, buzzers, light bulbs) to try to design solutions.

Students should identify and describe the uses of electricity in everyday life. One activity that can get students thinking about the many electrical inventions they use and how they depend on electricity is to describe their experiences when the power goes out. How did they cope without electricity?

Students could interview parents, grandparents, or older people in the community about electrical devices that have been developed in their lifetimes, and how these devices have changed their lives. This connects with the English Language Arts Curriculum Outcome: *Students will be expected to use writing and other forms of representation to explore, clarify, and reflect on their thoughts, feelings, experiences, and learnings; and to use their imagination.*

Uses for Electricity

Tasks for Instruction and/or Assessment

Performance

- Use the design process to solve a problem such as: (204-1, 204-7)
  - turn on/off a light from either end of a corridor
  - create an alarm for a toy box

Note: There are five steps to the *design process* in technology that parallel the *inquiry process* in science.

1. Identify a task or problem
2. Plan your design
3. Build your design
4. Test your design
5. Communicate

In technology, we design solutions to problems of human needs and we build something to see if it works. We may find many different solutions and designs that solve the same problems.

Paper and Pencil

- complete the chart to indicate the types of effects which an electrical device might create. Test your predictions.

Effects Created by Electrical Devices

Device	Heat	Motion	Sound	Magnetic	Light
buzzer					
speaker					
: :					

Journal

- Pretend you live in the days before electricity. In your journal, write about your activities. Be sure to refer to activities for which we would use electricity today. (107-9, 106-4)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Electricity

Launch:

1. The Shocking Background of Electricty, p. 10
2. Characteristics of Electricity, p. 13
4. Light Up the Classroom, p. 21
6. Different Needs, Different Circuits, p. 28
7. Fixing Electrical Problems, p. 32
11. Talking Around the World - Thanks to Canadians, p. 44
12. Electricity - Use It Carefully, p. 47

Sources of Electricity

Outcomes

Students will be expected to

- describe how knowledge that magnets can produce electric current led to the invention of electrical generators (106-4)
- identify and investigate various methods of generating electricity (past, present and future), and describe some ways in which these methods affect the environment (303-28, 105-3, 108-8)

Elaborations–Strategies for Learning and Teaching

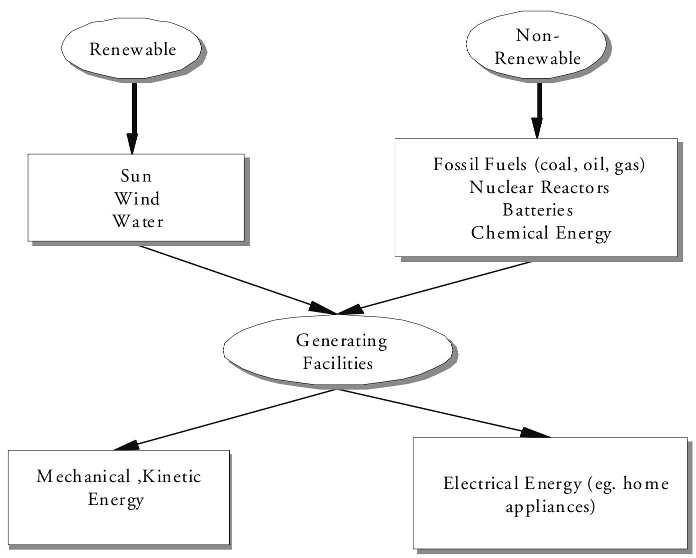
Students should understand that the production of electricity by wrapping a magnet in a wire has lead to the development of electrical generators. Students have already investigated how electricity can generate magnetism (electromagnets). A good way to lead into this section is to investigate the reverse of this (generating electricity from magnets). Students will need a fairly sensitive way to detect electricity (galvanometer, compass). Using a wire coiled around a tube and connected to a galvanometer, students can move a magnet in various directions around the coil and watch the way the needle on the galvanometer deflects. If they insert the bar magnet in and out of the tube, they should also detect a current in the wire. Alternatively, generators can be purchased from science supplies catalogues. Students could look carefully at these to see the components (coils of wire, rotating magnet) of the generator. By turning the crank at sufficient speed, students can get light bulbs and buzzers to work.

Brainstorm with students and record their ideas on how electricity is produced.

Students should identify chemical (batteries), mechanical (wind, falling water, steam) and solar energy as forms of energy that can be converted into electrical energy. Energy can be converted from chemical, mechanical, solar and nuclear to electrical energy. Some forms of chemical energy would be batteries and fossil fuel combustion. Sources of energy would be wind, water, tidal, solar, and nuclear.

Renewable forms of energy include wind, solar, and hydro energy. Examples of non renewable forms of energy are fossil fuels and nuclear energy.

Sources of Energy



Sources of Electricity

Tasks for Instruction and/or Assessment

Paper and Pencil

- Compare and contrast electromagnets and generators in terms of: (106-4, 303-27)
  a. what they are made from
  b. their source of energy
  c. what they do

Interview

- What invention came from the discovery that magnets can produce an electric current? How is this invention useful to us? (106-4)

Resources

<u>**Science and Technology 6**</u>

Teacher's Guide: Electricity

3. Where Does Electricity Come From? p. 18
10. Electrical Picker Uppers, p. 41

Sources of Electricity (continued)

Outcomes

Students will be expected to

- identify and explain sources of electricity as renewable or nonrenewable (303-29)

Elaborations–Strategies for Learning and Teaching

Students can generate their own electricity from chemical energy by making some simple electrochemical cells using copper and zinc strips or nails that are embedded in fruit. Teachers can demonstrate a more traditional electrochemical cell by resting a copper strip in a beaker containing a solution of copper (II) sulphate or some other salt of copper, and a zinc strip in a solution of zinc (II). Connect the two metal strips with a wire that is hooked up to something that shows that electricity is flowing (bulb or multi-meter), and connect the two beakers by soaking a paper towel in a salt (NaCl) solution. This completes the circuit pathway.

Students can connect solar cells in circuits to see solar energy being converted into electrical energy. Solar energy kits are available from scientific suppliers.

Students can do a research project using print and electronic sources on the environmental effects of various methods of producing electricity.

Sources of Electricity (continued)

Tasks for Instruction and/or Assessment

- Create a pictorial concept map showing energy conversions.
- Choose either chemical, mechanical, or solar energy, and research:
  - a. how electrical energy is produced from the source
  - b. whether the source is renewable or non-renewable
  - c. positive and negative impacts on the environment of using this source to create electricity
- Report your findings (web page, report, oral presentation with visual aids). (303-28, 105-3, 108-8, 303-29)
- Do a video or skit on the impacts on the environment in using a source of energy (renewable or non- renewable) to create electricity. (303-29)

Resources

Science and Technology 6

Teacher's Guide: Electricity

3. Where Does Electricity Come From? p. 18

Electrical Energy Consumption and Conservation

Outcomes

Students will be expected to

- identify and explain different factors that could lead to a decrease in electrical energy consumption in the home and at school and how will this help protect the environment (108-5, 303-30)

Elaborations–Strategies for Learning and Teaching

Students should see the effects of their effort to conserve energy by collecting data about the consumption before and after they try to reduce electrical usage.

Students could keep an "electrical use" journal, noting the various electrical devices/systems they encounter over the course of a period of time.

Students can be introduced to some of the units that are used to quantify electrical energy, such as watts and kilowatt hour. (The depth of teeatment should be quite minimal. It is enough that they understand that the watt is a unit of measuring how much electrical energy a device uses, and that a kilowatt hour is the amount of energy being consumed if the device is used for one hour. They should understand that the more watts or kilowatt hours a device is rated for, then the more electrical energy is being used.) A guest speaker from a power company could be invited to speak to the class about electrical power usage, conservation of electricity, and peak power usage times, and how to read an electrical meter.

Students could categorize devices according to whether they are high-medium-, or how-consumption devices (some discussion of kilowatt hours will be needed). Students could carry out a household inventory of electrical appliances, and light bulbs, noting the wattage of bulbs, and describing use patterns.

Students could propose ways that consumption can be decreased. Students should discuss the advantages to the environment of using less energy. Students could investigate how the damming of a river affects a local environment, or how fossil fuel energy sources contribute to greenhouse gases.

Electrical Energy Consumption and Conservation

Tasks for Instruction and/or Assessment

Journal

- How can you conserve electricity and what affect will this have on the home and family budget. (108-5, 303-30)
- Reflect on how wasting energy may affect the environment (108-5, 303-30)

Paper and Pencil

- Develop strategies to conserve energy in the school. Present your report to the administration (303-30)

Presentation

- Do a skit/video on how energy conservation benefits the environment. (108-5)

Portfolio

- Choose some of your a piece of work from this unit to include on your portfolio.

Resources

Science and Technology 6

Teacher's Guide: Electricity

12. Electricity - Use It Carefully, p. 47
13. Conserving Electricity, p. 50

Physical Science: Flight

Introduction

The capability of flight is shared by a variety of living things and human inventions. For many centuries, humans have marvelled at the ability of living things to attain flight, and they have developed a variety of devices to recreate that ability. Students learn to appreciate the science and technology involved as they investigate how things fly and develop and test a variety of prototype devices. Through their investigations they learn that many different approaches are used, and that each provides a means to achieve varying amounts of lift, movement, and control.

Focus and Context

The emphasis in this unit is on how things fly or stay afloat in air, and the variables that affect flight. This focus of this unit is, for the most part, problem solving. Students should be immersed in rich experiences with many aspects of air/aerodynamics and flight. Activities related to solving problems, like "How can I get the airplane to stay in the air longer?", require that the students design, test, and then modify their designs and retest their models. Students should use their imagination, creativity, and research skills in designing model planes, various wing shapes, and in devising methods to test their designs. After much classroom experimentation, design and testing, steams of students should have the opportunity to investigate an aspect of flight that interests them most, and present their findings. By providing opportunities to re-examine and retest, research and rebuild, and share, students will grow in the four broad areas of skills: initiating and planning, performing and recording, analysing and interpreting, and communications and teamwork.

Science Curriculum Links

Students are introduced to the concept of air taking up space and being able to be felt as wind in grade 2.

Student will use many of the concepts in this unit in the grade 8 unit Fluids, and in high school Physics.

pan-Canadian Science Learning Outcomes

N.B. The fololowing pan-Canadian Science Learning Outcomes were used as the framework in the development of the Atlantic Canada Science Curriculum at this grade level. They are included here to illustrate the three types of science outcomes at the Elementary level: i.e., *STSE*, *Knowledge* and *Skills*. **For planning, instructional, and assessment purposes, teachers should refer to the PEI/APEF Specific Curriculum Outcomes found on the next page.**

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **104-3** demonstrate and explain the importance of selecting appropriate processes for investigating scientific questions and solving technological problems **104-5** describe how results of similar and repeated investigations may vary and suggest possible explanations for variations **105-3** describe examples of scientific questions and technological problems that have been addressed differently at different times **Relationships Between Science and Technology** **106-3** describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries **106-4** describe instances where scientific ideas and discoveries have led to new inventions and applications **Social and Environmental Contexts of Science and Technology** **107-6** provide examples of how science and technology have been used to solve problems around the world **107-9** compare past and current needs, and describe some ways in which science and technology have changed the way people work, live, and interact with the environment **107-12** provide examples of Canadians who have contributed to science and technology	Students will be expected to **Initiating and Planning** **204-2** rephrase questions in a testable form **204-7** plan a set of steps to solve a practical problem and to carry out a fair test of a science-related idea **Performing and Recording** **205-1** carry out procedures to explore a given problem and to ensure a fair test of a proposed idea, controlling major variables **205-2** select and use tools in manipulating materials and in building models **205-5** make observations and collect information that is relevant to a given question or problem **205-8** identify and use a variety of sources and technologies to gather pertinent information **Analysing and Interpreting** **206-6** suggest improvements to a design or constructed object **Communication and Teamwork** **207-2** communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language	Students will be expected to **301-18** describe and demonstrate methods for altering drag in flying devices **303-32** describe the role of lift in overcoming gravity and enabling devices or living things to fly **301-17** describe and demonstrate how lift is affected by the shape of a surface **300-21** identify characteristics and adaptations that enable birds and insects to fly **303-33** identify situations which involve Bernoulli's principle **303-34** describe the means of propulsion for flying devices **300-22** describe and justify the differences in design between aircraft and spacecraft

PEI/APEF Specific Curriculum Outcomes

Drag

Students will be expected to

- rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device (204-2, 205-5, 207-2)
- describe and demonstrate mehtods for altering drag in flying devices (301-18)
- describe how the results of similar and repeated investigations resting drag may vary and suggest possible explanations for variations (104-5)
- suggest improvements to the design of a flying device to improve its performance (206-6)
- provide examples of how technological research and design has resulted in many product designs that have reduced the amount of drag experienced (107-6)

Lift and Wing Shape

Students will be expected to

- describe the role of lift in overcoming gravity and enabling devices or living things to fly (303-32)
- plan and carry out a set of steps to investigate the effect of wing shape on lift, and select and use tools in building models of various wing shapes (204-7, 205-1, 205-2)
- demonstrate and describe how lift is affected by the shape of a surface (301-17)
- identify characteristics and adaptations that enable birds and inserts to fly (300-21)
- describe how knowledge of wing shape affects lift has led to the development of aerodynamically designed wings, and features on planes that allow wing shape to be altered during the flight (106-4)

Life and Bernoulli's Principle

Students will be expected to

- identify situations which involve Bernoulli's principle (303-33)
- describe how aerodynamic research using wind tunnels and/or computers can contribute to new airplane designs (106-3)
- explain why using computer simulations and/or wind tunnels are appropriate processes for investigating wing and airplane designs (104-3)
- identify and use a variety of sources to investigate the use of wind tunnels in testing aircraft shapes (205-8)

Thrust and Propulsion

Students will be expected to

- describe and demonstrate the means of propulsion for flying devices (303-34)
- describe and justify the differences in design between aircraft and spacecraft (300-22)
- compare current and past air and space craft (105-3)
- describe some ways that flying devices have changed the way people work and live (107-9)
- provide examples of Canadians who have contributed to the science and technology aircraft (107-12)

Drag

Outcomes

Students will be expected to

- rephrase questions about drag in a testable form and then carry out procedures, make and record observations, to test the performance of a flying device (204-2, 205-5, 207-2)
- describe and demonstrate methods for altering drag in flying devices (301-18)

Elaboration–Strategies for Learning and Teaching

The unit could start with a Know-Want to Learn-Learned (K-W-L) activity that focuses on flight and aerodynamics. Students could brainstorm what they know and have experienced with respect to wind, air resistance, flying, bird and insect flight and leaves falling. They could also raise questions that they have and would like to investigate. This activity will help the teacher gauge students' conceptions, and help focus the investigations in the unit.

There are four forces acting on flying objects: drag is the force that slows the flying device, gravity is the force that pulls it towards earth, thrust is the force that propels, and lift is the force that keeps it up in the air.

In classroom discussion, teachers can introduce the concept of drag, and encourage students to ask questions about drag that could be investigated. As students pose questions, the teacher can model for students how to change the question to a testable form (such as, "How can I reduce the drag in my glider?" to "Will folding the wings in half reduce the drag?"). Students should be able to see the difference between these two questions, and write similar types of questions.

Drag is the force caused by air resistance. Air is invisible, so students need to be reminded that air has real substance, and can affect things in many ways. They can feel moving air, or wind, simply by standing outside on a windy day. Even on a still day, when a person or object is moving, the effect of air resistance can be felt. Students can brainstorm techniques and products used to reduce drag while walking (bending into the wind) or taking part in sports (streamlined helmets, bathing suits, haircuts, for example). Small windmill toys and pollen blowing around can be used to show how air can be used to move things. Students can time each other as they run the length of they gymnasium—the first time holding a large piece of Bristol board in front of them, and the second time without to see the effect of wind resistance. Students are so used to experiencing life with air that they have to stretch their imaginations to think of how things would be affected without it. Students can explore this idea by dropping sheets of paper, and taking part in discussion with questions such as: Why does the paper flutter to the ground? What is holding it up? What would happen to the sheet if there was no air? They could time how long papers folded in different ways take to reach the ground, graph their results, and propose explanations for any trends they may see.

Drag

Tasks for Instruction and/or Assessment

Performance

- Construct a paper glider. Test, modify and retest your design to reduce drag as much as possible. Record evidence (flight time, flight distance) which demonstrates that drag has been reduced. Be prepared to discuss your modifications with your teacher.
- Construct a paper glider which will turn left, turn right, gain altitude, or make a loop as it flies. (204-2, 205-5, 207-2)

Journal

- Modify the question "How can I reduce the drag in my glider?" into testable hypotheses. (204-2, 205-5, 207-2)

Informal/Formal Observation

- Observation checklist (possible criteria) (204-2, 205-5, 207-2, 301-18)
  - student revises design
  - student is recording distance and length of time
  - student analyses the design with respect to distance travelled, time in the air, and other factors that they want to test
- As the students move from trying to figure out the factors that affect drag (science) to designing stable, long-flying aircraft (technology), creativity should be encouraged. There is no fixed "right" design. Students should be encouraged to try a variety of designs, and as they test them out, analyse their effectiveness. (204-2, 205-5, 207-2, 206-6)
- Possible Criteria:
  - student attempts to improve the glider's performance
  - student tries a wide variety of designs and is creative in approach to design
  - student attempts to control the performance of the glider by making it turn, loop or gain altitude

Paper and Pencil

- Suggest improvements to the design of this plane (truck, car, boat) that would decrease the amount of drag that it experiences. (Provide students with a picture of an older model airplane, truck, car, or boat). (107-6, 206-6)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Air and Flight

7. Take Off, p. 30
8. Moving Faster, Slower, Up and Down, p. 33
9. The Four Forces of Flight, p. 36
10. Payload Lift Off, p. 39

Design Project: Make It Go, p. 50

Drag (continued)

Outcomes

Students will be expected to

- describe how the results of similar and repeated investigations testing drag may vary and suggest possible explanations for variations (104-5)
- suggest improvements to the design of a flying device to improve its performance (206-6)
- provide examples of how technological research and design has resulted in many product designs that have reduced the amount of drag experienced (107-6)

Elaboration–Strategies for Learning and Teaching

The two main factors that affect the amount of drag are shape and texture. Students should compare the drag in various flying devices. They can make gliders using various shapes and textures of papers, and see which ones travel the fastest (and therefore has the least drag) when released or launched (same student throwing glider with same force). This can be done by seeing which glider passes by a certain point first. Note that the one that stays in the air the longest does not necessarily have the least drag. Since air and water are both fluids, they could even try to show how shape affects drag by dragging objects with various shapes and textures under water, and using a spring scale to measure the drag. Students could also design parachutes, and see which ones stay aloft the longest.

Students should identify some variables and determine why variations in flight path and time exist. They can work on redesigning their flying devices to improve performance. There are many variables in these types of activities (such as force that the students use, air currents).

Students can also investigate methods for altering drag by examining various highspeed transportation devices, such as trucks or cars. They can also look at how airplane designs have become more streamlined over the years, and examine designs like the space shuttle, or high speed planes, and compare them with other commercial airliners. This will encourage students to appreciate the role and contribution of technology in their understanding of the world.

Drag (continued)

Tasks for Instruction and/or Assessment

Interview

- Why do you think your plane does not travel the same distance each time? (104-5)

Presentation

- Prepare a poster of cars, planes, motorcycles, and the like which have an aerodynamic shape. For comparison, include similar machines which are not as aerodynamic. (107-6)
- Present a paper glider show to demonstrate the various aircraft and performance abilities. Have students describe or show how they refined their paper gliders to improve its performance. (206-6, 301-18)
- Research and display shapes of cars and trucks historically to show improvements in aerodynamic design. (107-6)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Air and Flight

1. Lift Off! p. 10
7. Take Off, p. 30
8. Moving Faster, Slower, Up, and Down, p. 33
9. The Four Faces of Flight, p. 36
10. Payload Lift Off, p. 39
12. Flight Just Above the Ground: The Hovercraft, p. 47

Lift and Wing Shape

Outcomes

Students will be expected to

- describe the role of lift in overcoming gravity and enabling devices or living things to fly (303-32)
- plan and carry out a set of steps to investigate the effect of wing shape on lift, and select and use tools in building models of various wing shapes, (204-7, 205-1, 205-2)
- demonstrate and describe how lift is affected by the shape of a surface (301-17)
- identify characteristics and adaptations that enable birds and insects to fly (300-21)
- describe how knowledge of how wing shape affects lift has led to the development of aerodynamically designed wings, and features on planes that allow wing shape to be altered during the flight (106-4)

Elaboration–Strategies for Learning and Teaching

Heavy, solid objects do not normally stay aloft. Discussions held throughout this unit will undoubtedly raise the question, "How do heavy flying devices, like commercial planes, lift off the ground and fly?".

Students can design various wing shapes using materials such as cardboard, paper, tape, and something to attach strings onto (like a pencil) and blow on these shapes using a straw held at varying angles, and see how far the various shapes rise. Students should investigate both the factors of wing shape and angle of attack (angle that the air is blown at the wing, or the orientation of the wing with respect to the air blowing on it) in their investigations.

Lift can be also be achieved through temperature differences in air, since warm air is less dense than cold air. Hot air balloons are examples of how warm air rises to float on the denser cold air. Students can investigate this by inflating garbage bags inflated with the warm air from a hair dryer. Students can investigate the uses of solar balloons, which are made from material that warms the air in the balloon when exposed to the sun, and gives the balloon its lift.

Part of their designing process should involve an investigation into the shapes of the various insects and birds that fly. By noting shapes that make them more aerodynamic, they can try to incorporate similar shapes in their design.

They can also investigate wing designs on aircraft, and look at features that planes have that can increase or decrease the angle of attack during the flight. If possible, a field trip to an airport or a flight museum would provide students with the experience of seeing the wing flaps move first-hand. Students could prepare a list of questions they wish to investigate as they examine a real plane, and talk to informed personnel at the airport. Students can design paper airplanes that incorporate different types of flaps to see the effect that they have on the flight path of the flying device. Encourage students to work collaboratively while designing their flying devices.

That different car designs also utilize the principle of aerodynamics may be an interesting concept to students. Spoilers, for example, are designed so that cars hug the road.

Lift and Wing Shape

Tasks for Instruction and/or Assessment

Performance

- Design, test, evaluate, and modify a wing shape to achieve the best lift. Use questions such as "What worked?, What didn't and why?". Suggest changes you might make to help focus student attention. (301-17)
- Using illustrations, animations, personally narrated video clips, poetry or dance, compare the movements of two things that naturally fly or glide. Include the unique structures or characteristics that enable this creature to fly. (205-5, 300-21)

Paper and Pencil

- Research "birds" and "insects". Write four jot notes which identify characteristics and adaptations that enable birds and insects to fly. Try to provide examples or pictures of aircraft that use similar features. (300-21)
- Draw and label diagrams of the profiles of at least two of your wings, indicating areas where improvements were made. As part of your completed diagram, answer the question, "Why is lift important to flight?" (204-7, 205-2, 205-2, 301-17, 303-32)
- Do the necessary research and draw a labelled diagram to illustrate how the shape of wings on a plane can be changed during flight. (106-4)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Air and Flight

4. Gravity Versus Lift: Forces Against Each Other, p. 21
5. Air in Motion, p. 24
6. Learning About Flight, p. 27
7. Take Off, p. 30
8. Moving Faster, Slower, Up, and Down, p. 33
9. The Four Forces of Flight, p. 36
10. Payload Lift Off, p. 39
12. Flight Just Above the Ground: The Hovercraft, p. 47

Design Project: Make It Go, p. 50

Lift and Bernoulli's Principle

Outcomes

Students will be expected to

- identify situations which involve Bernoulli's principle (303-33)
- describe how aerodynamic research using wind tunnels and/or computers can contribute to new airplane designs (106-3)
- explain why using computer simulations and/or wind tunnels are appropriate processes for investigating wing and airplane designs (104-3)
- identify and use a variety of sources to investigate the use of wind tunnels in testing aircraft shapes (205-8)

Elaboration–Strategies for Learning and Teaching

Once students have seen the effect that different wing shapes have on the amount of lift, they can be introduced to explanations involving Bernoulli's principle: fast moving air exerts less pressure than slow moving air. Students should explore many situations involving Bernoulli's principle, and give explanations as to why objects move as they do using this principle:

- Suspend two ping pong balls from a metre stick across two chairs at the same level, about 6–10 cm apart, and predict how the balls will move when the students blow between them. Test their prediction.
- Baseball curve balls also work using Bernoulli's Principle. Students can conduct research to find out why throwing the baseball with a spin results in a curve ball.
- With the fingers of both hands, students can hold a single sheet of paper just below their lower lip. Allow the paper to bend and hang downward, then blow across the top surface of the paper. The strip of paper should rise.
- Identify everyday situations which illustrate Bernoulli's Principle, for example, the movement of the shower curtain after the shower is turned on, or the way long hair will fly out an open window of a moving car.

Investigations in wind tunnels show streams of air moving faster over the top of a wing illustrating how wings get their lift. As air moves around the wing, there is a net force pushing the plane up (lift).

Students should demonstrate an understanding that wind tunnels and/or computers are appropriate for testing and designing aircraft. Students could use print, Internet, and other media to research the use of wind tunnels and computer simulations, in designing wing shapes and airplane designs both of which allow wings and airplanes to be tested safely.

Lift and Bernoulli's Principle

Tasks for Instruction and/or Assessment

Performance

- Set up an activity, or create a visual or multimedia presentation, that illustrates Bernoulli's principle. (Groups of students can set up stations around the class with their activity or presentation, and the class can circulate around the classroom to try out the various activities at each station) (303-33)

Journal

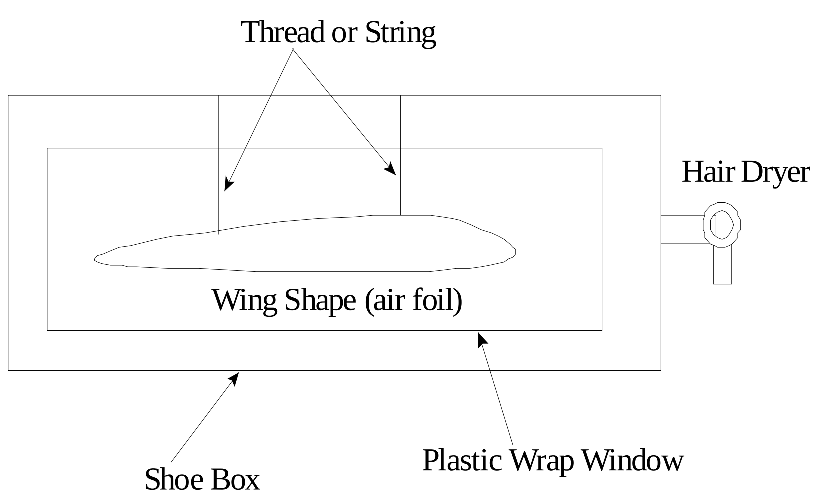
- Illustrate and label a situation that involves Bernoulli's principle ... (303-33)

Paper and Pencil

- Using point form, write brief answers to the following questions:
    a. What is a wind tunnel?
    b. How are wind tunnels used in aircraft design?
    c. Why are wind tunnels appropriate methods of testing and designing aircraft? (106-3, 104-3, 205-8)

Presentation

- Create a presentation that shows pictures of wind tunnels and the investigations that are performed in them. (205-8)



- Make your own wind tunnel using a hair dryer, and a shoe box with windows cut out on the side so you can see what is happening inside the box. Attach different shaped wings, and see how they are affected by the wind. (205-8)

Resources

<u>**Science and Technology 6**</u>

Teacher's Guide: Air and Flight

6. Learning About Flight, p. 27

Thrust and Propulsion

Outcomes

Students will be expected to

- describe and demonstrate the means of propulsion for flying devices (303-34)
- describe and justify the differences in design between aircraft and spacecraft (300-22)
- compare current and past air and space craft (105-3)
- describe some ways that flying devices have changed the way people work and live (107-9)
- provide examples of Canadians who have contributed to the science and technology of aircraft (107-12)

Elaboration–Strategies for Learning and Teaching

Students should investigate propellers. The third force that acts upon flying devices is thrust, the force that propels the flying device forward. There are two main types of propulsion: propulsion based on gases being projected away from the plane (pushing the plane through the air), and propulsion pulling the plane through the air.

Some early and present-day aircraft use propellers for thrust. Propellers turn in a way that pulls the air in front to the back, similar to a screw being twisted into wood. Propellers must have an atmosphere to work, since they rely on the resistance of air to provide the thrust. Students could make propellers or propellers can be purchased from electronic or hobby stores. They may also use a propeller under water.

All of the flying objects explored in this unit so far have depended on air to fly. Space craft cannot use propellers, since there is very little air in space for it to catch in its blades. They must make their own gas to shoot out to propel the plane forward. This is illustrated by blowing up a balloon, and then letting it go. It will zoom around the room because it is being propelled by the escaping gas. Alternatively, straws could be attached to the balloon, with a thread or string threaded through the straws and attached to a far wall, and the balloons could be propelled along the string track. Teachers could challenge a class to identify craft that work by jet propulsion (such as rocket ships, jet, and space shuttles).

Students should examine designs for spacecraft and airplanes, and note features that rely on an atmosphere (large wings, engines, propellers) and those that indicate the craft will be flying in space (small wings or rudders, large booster containers for fuel as these are needed).

In the past, there were large differences between air and space craft, but increasingly, more flying devices (like space shuttles) are being developed that have the ability to fly both in space and in air, and thus have features of both. Examples of Canadians who have contributed to flight are Wallace R. Turnbull from New Brunswick, who invented the variable speed propeller, and Robert Noorduyn from Québec who designed the bush plane. J. D. McCurdy—built and flew first aircraft in British Commonwealth. Alexander Bell—built Silver Dart and several kites. Additional Canadian achievements in flight and space research could be researched (examples Bombardier, Canadian Aerospace Agency, Avro Arrow).

Thrust and Propulsion

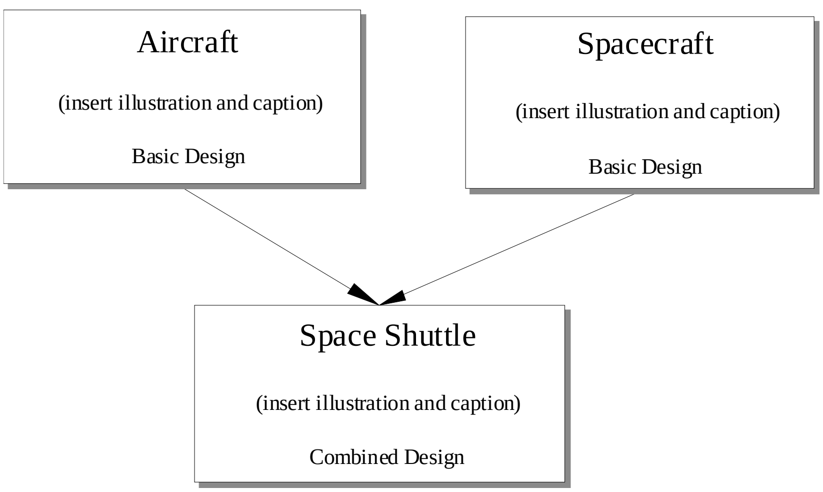
Tasks for Instruction and/or Assessment

Paper and Pencil

- Write a paragraph which compares and contrasts thrust and propulsion. (303-34)

Presentation

- Create a display that illustrates a variety of aircraft showing developments from past to present day. Be sure your work has Canadian content! (105-3, 107-9, 107-12)
- In a group, design a poster that illustrates the difference between aircraft and space craft, and how the space shuttle has features of both. Follow the outline shown below: (300-22)



Portfolio

- Select pieces of work for your portfolio.

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Air and Flight

8. Moving Faster, Slower, Up, and Down, p. 33
9. The Four Forces of Flight, p. 36
10. Payload Lift Off, p. 39
11. Flying Canadians: Building a Wall of Fame, p. 43
12. Flight Just Above the Ground: The Hovercraft, p. 47

Design Project: Make It Go, p. 50

Earth and Space Science: Space

Introduction

Space science involves learning about objects in the sky to discover their form, their movements, and their interactions. For students, developing a concept of Earth and space presents a new challenge. It requires extensive experience with models to explore relationships of size, position, and motion of different bodies. In learning about space, students come to appreciate that human ability to observe and study objects in space is now greatly enhanced by technology. Students learn that screwed and unscrewed probes and earth-based devices are contributing to our knowledge of space, and that new capabilities are being developed for monitoring the Earth, for communications, and for the further exploration of space.

As the various components of the solar system are discussed and researched, students can learn about technologies (such as telescopes, satellites, and space probes) that have been developed to explore the solar system, the experiences that astronauts have as they live in space, and how space exploration has been undertaken as a largely international affair.

Focus and Context

The focus in this unit is inquiry. Students can create and use models to simulate and explore the interactions within the major components of the solar system and universe. By constructing models, the students can investigate, for example, the causes for the seasons. A second focus is on the giving students opportunities to find up-to-date information about space exploration, and about the various components of the solar system and constellations. Students will be exposed to electronic and print resources that can illustrate the wealth of knowledge that has accumulated about space, and learn skills for searching out and personalizing this knowledge.

Science Curriculum Links

From the unit, *Daily and Seasonal Changes* in grade 1, students have been introduced to the concept of daily and seasonal cycles. In this unit on space, students will account for these cycles, and expand their knowledge of space by studying the components of space. This topic will be studied in more depth in a grade 9 unit, *Space Exploration*.

pan-Canadian Science Learning Outcomes

N.B. The fololowing pan-Canadian Science Learning Outcomes were used as the framework in the development of the Atlantic Canada Science Curriculum at this grade level. They are included here to illustrate the three types of science outcomes at the Elementary level: i.e., *STSE*, *Knowledge* and *Skills*. **For planning, instructional, and assessment purposes, teachers should refer to the PEI/APEF Specific Curriculum Outcomes found on the next page.**

STSE	Skills	Knowledge
Students will be expected to **Nature of Science and Technology** **104-8** demonstrate the importance of using the languages of science and technology to compare and communicate ideas, processes, and results **105-1** identify examples of scientific questions and technological problems that are currently being studied **105-6** describe how evidence must be continually questioned in order to validate scientific knowledge **Relationships Between Science and Technology** **106-3** describe examples of improvements to the tools and techniques of scientific investigation that have led to new discoveries **Social and Environmental Contexts of Science and Technology** **107-3** compare tools, techniques, and scientific ideas used by different people around the world to interpret natural phenomena and meet their needs **107-12** provide examples of Canadians who have contributed to science and technology **107-15** describe scientific and technological achievements that are the result of contributions by people from around the world	Students will be expected to **Initiating and Planning** **204-6** identify various methods for finding answers to given questions and solutions to given problems, and select one that is appropriate **Performing and Recording** **205-2** select and use tools in manipulating materials and in building models **205-8** identify and use a variety of sources and technologies to gather pertinent information **Analysing and Interpreting** **206-4** evaluate the usefulness of different information sources in answering a given question **Communication and Teamwork** **207-2** communicate procedures and results, using lists, notes in point form, sentences, charts, graphs, drawings, and oral language	Students will be expected to **301-21** describe how astronauts are able to meet their basic needs in space **301-19** demonstrate how Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons **301-20** observe and explain how the relative positions of Earth, the moon, and the sun are responsible for the moon phases, eclipses, and tides **300-23** describe the physical characteristics of components of the solar system—specifically, the sun, planets, moons, comets, asteroids, and meteors **302-13** identify constellations in the night sky

PEI/APEF Specific Curriculum Outcomes

Space Exploration

Students will be expected to

- describe how astronauts are able to meet their basic needs in space (301-21)
- provide examples of Canadians who have contributed to the science and technology of space exploration (107-12)
- describe examples of improvements to the tools and techniques of exploring the solar system that have led to discoveries and scientific information (106-3)
- describe scientific/technological achievements in space science that are the result of contributions by people from around the world (107-15)
- identify examples of scientific questions and technological problems about space and space exploration that are currently being studied (105-1)

Relative Position and Motion of the Earth, Moon, and Sun

Students will be expected to

- describe how peoples' conceptions of the Earth and its position in the solar system have been continually questioned and changed over time (105-6)
- demonstrate how Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons (301-19)
- observe and explain how the relative positions of Earth, the moon, and the sun are responsible for the moon phases, eclipses, and tides (301-20)

The Solar System

Students will be expected to

- select and use tools in building models of the solar system that show approximate relative size of the planets and sun, and the approximate relative orbits of the planets around the sun (205-2)
- describe the physical characteristics of components of the solar system (104-8, 300-23)
- identify and use a variety of sources and technologies to gather pertinent information about a planet, moon, asteroid, or comet, and display their findings using diagrams, pictures and/or descriptions from recent explorations (105-1, 205-8, 207-2)
- evaluate the usefulness of different information sources when getting information about the components of the solar system (206-4, 204-6)

Stars and Constellation

Students will be expected to

- identify constellations from diagrams, pictures and/or representations of the night sky (302-13)
- use electronic print resources and/or visit a planletarium to gather information on the visual characteristics and mythodlogy of constellations (205-8)
- compare how different cultures have used the positions of stars for such things as the appropriate time to plant and harvest crops, navigate the oceans, and/or foretell significant events (107-3)

Space Exploration

Outcomes

Students will be expected to

- describe how astronauts are able to meet their basic needs in space (301-21)
- provide examples of Canadians who have contributed to the science and technology of space exploration (107-12)
- describe examples of improvements to the tools and techniques of exploring the solar system that have led to discoveries and scientific information (106-3)
- describe scientific/ technological achievements in space science that are the result of contributions by people from around the world (107-15)
- identify examples of scientific questions and technological problems about space and space exploration that are currently being studied (105-1)

Elaborations–Strategies for Learning and Teaching

Students should speculate, discuss, and gather information about how astronauts meet their basic needs. One way to approach this is to ask students to describe their day, and then, bit by bit, try to figure out how they would do the same things in space. What challenges would they face?

Students could research Canadian scientist and engineers who have contributed to the space program such as astronauts Marc Garneau, Roberta Bondar, Julie Payette, Chris Hadfield, Bob Trisk, Steve MacLEan, Dave Williams, Bjarnie Trygvasson, and George J. Klein.

Students should describe examples of tools the development of which has improved our ability to explore the universe such as binoculars, telescopes, the lunar buggy, the Canadarm™, the Hubble telescope, space probes, and the space station. Students could also learn about products that were developed for space travel and have been applied to everyday use, such as Tang™, freeze-dried food, and velcro™.

Many countries are involved in space exploration, and often teams are put together for various projects. Students could note the construction of the space station, and investigations on space shuttle missions as examples of these types of international collaborative efforts.

Students could explore current investigations/observations in space: such as the movements of comets, space exploration missions, the origin of the solar system and universe, and the movement of asteroids.

Two excellent sources of information on current space initiatives are NASA's home page on the Internet, and the Canadian Space Agency. Students can get daily reports of space shuttle missions, see pictures from various space probes and ask questions to astronauts, as well as many other educational features.

Space Exploration

Tasks for Instruction and/or Assessment

Journal

- Imagine you are a Canadian Astronaut. Over a one week period, compose a daily journal entry as if you were on a space shuttle mission. Write about your personal observations while living and working in space. (105-1, 106-3, 107-15, 301-21)

Paper and Pencil

- Research an Astronaut you admire or would like to learn more about. If you had a chance to write/meet him/her, what questions would you ask? (107-12)

Interview

- Do you think the space shuttle is an improvement over earlier rockets? Explain why or why not. (106-3)

Presentation

- As a starting point to the unit, a class chart will be created as a wall chart. This chart will be a reference for the unit and may be added to as the unit progresses. (205-2, 104-8, 300-23, 105-1, 205-8, 207-2)

Our Solar System

Name	Relative size to Earth	Length of Orbit	Make-up: Solid, liquid, and/or gas	. . .
Sun				
Moon				
Mars				
○ ○				

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Space

9. Tides: The Mystery of the Moon, p. 38
10. Blackout! p. 41
11. Out Solar System, p. 45
13. What's Happening in Space? p. 52
14. Living in Space, the New Frontier, p. 55

Relative Position and Motion of the Earth, Moon, and Sun

Outcomes

Students will be expected to

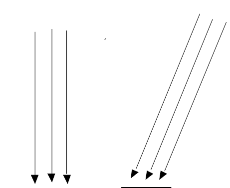
- describe how peoples' conceptions of the Earth and its position in the solar system have been continually questioned and changed over time (105-6)
- demonstrate how Earth's rotation causes the day and night cycle and how Earth's revolution causes the yearly cycle of seasons (301-19)
- observe and explain how the relative positions of Earth, the moon, and the sun are responsible for the moon phases, eclipses, and tides (301-20)

Elaborations–Strategies for Learning and Teaching

This unit could start with an open discussion with students about their conceptions of the Earth and its place in the solar system: What is the shape of the Earth, the motion of the Earth relative to the sun, the moon, and the planets? Throughout this discussion, teachers should probe where the students got their information, and intersperse early conceptions of the Earth and its place in the solar system. These early conceptions (flat Earth, the sun rotating around the Earth) seem quite common sense in the absence of contrary evidence, and in fact, the idea that the Earth actually revolved around the Sun was met with considerable resistance when first proposed. What today's students may take for granted and not question, was very controversial in its time.

Students can use models to show the effects of moving celestial bodies (use balls, globes, flashlights, or lamps to show how day and night occur, for example).

Before students can understand the causes of the seasons, they need to investigate the effect of the angle of the Sun's rays on temperature. If possible, light meters can be used to investigate the difference in light intensity at various points on a globe or circular object when light from a lamp or flashlight is shone it. Diagrams can also be drawn to show the angle will cause the light to be spread out over a larger area, and therefore the light is not as concentrated, and it will not be as warm.



Students can note the differences in temperature at various times of the day and relate these differences to the angle of the sun. (This may replace the model activity above.)

Once students understand the effect the angle of the sun has, they can investigate the causes of the seasons by using four globes tilted on the axes and positioned so that the same geographic feature faces the lamp. The centre and the axis of each globe must be parallel to each other for this to work.

Relative Position and Motion of the Earth, Moon and the Sun

Tasks for Instruction and/or Assessment

Performance

- Put a light in the middle of the room to represent the sun. A basketball (mark or paste something on it to represent Atlantic provinces) or globe can represent the Earth, and a tennis ball can represent the moon. Ask student to position or move the Earth and/or the moon to simulate the following situations: (105-6), (301-19)
  - Position the Earth so that it is night in the Atlantic provinces.
  - Position the Earth so it is summer in the Atlantic provinces.
  - Move the Earth to show its path for one year (no rotation, just revolution).
  - Move the Earth to show its motion for one day.

Paper and Pencil

- In the past, many people believed that the Earth was the centre of the solar system. What information has caused people to change their belief? (105-6)

Resources

<u>**Science and Technology 6**</u>

Teacher's Guide: Space

4. Patterns of Light and Darkness, p. 20
5. And the Seasons Go Round and Round, p. 24
6. The Moon's Changing Face, p. 28
7. The Moon on the Move, p. 31
9. Tides: The Mystery of the Moon, p. 38
10. Blackout! p. 41

Relative Position and Motion of the Earth, Moon, and Sun (continued)

Outcomes

Students will be expected to

- observe and explain how the relative positions of Earth, the moon, and the sun are responsible for the moon phases, eclipses, and tides (301-20)

Elaborations–Strategies for Learning and Teaching

Models using globes, balls, and lamps or flashlights could also be used to illustrate the phases of the moon and eclipses. Students should be able to demonstrate an understanding of the relative positions of the Earth, moon, and Sun to show how the various phases of the moon occur, and how a solar and lunar eclipse occur.

Tides are the periodic rise and fall of the sea level that results from the gravitational interactions and motions of the sun, moon and Earth. The influence of the moon on tides is greater than that of the sun because the moon is much closer to the Earth. The Bay of Fundy and its component parts experience some of the highest tides in the world and could be a focus of study when learning about this natural phenomenon.

Students could look for evidence of tides (for example, How high do you think the tides go? What signs do you see as evidence?) on a field trip to a tidal zone. Explanations of tides should be limited to simple models or diagrams that involve the Earth and the moon. Other factors affect tides, such as the gravitational pull of the Sun on the Earth and the oceans, but these factors should be ignored for now, or explored as an enrichment activity (neap tides, spring tides).

Students can observe the phases of the moon, the rise and fall of tides and Sun's position over a period of time. Students are able to relate this to their models of earth, moon and sun.

Relative Position and Motion of the Earth, Moon, and Sun (continued)

Tasks for Instruction and/or Assessment

Performance

- Using a model, ask students to position and/or move the Earth and moon to show:
  - when the people of the Atlantic provinces would see a full, half, or new moon
  - high tide and low tide in the Atlantic provinces
  - a solar and lunar eclipse in the Atlantic provinces (301-20)
- Check your local newspaper (or Internet site) for tide times and heights (search key words: "tide table"). Keep track of high and low tide times, and the tide heights for one week. E-mail a student in another community or Atlantic province, and compare your tide data. Propose explanations for why there are differences in the times and heights. (301-20)
- Examine next month's calendar page showing phases of the moon. Draw your predictions of the interim position/images of the moon between each phase shown. Check your predictions with actual observations or use an Astronomy Software program for similar results. (301-20)

Journal

- Every night for one month, draw a picture of the moon if it is visible, and date it. Identify the date of a full moon, a half moon, new moon, and quarter moon. (301-20)

Resources

Science and Technology 6

Teacher's Guide: Space

6. The Moon's Changing Face, p. 28
7. The Moon on the Move, p. 31
9. Tides: One Mystery of the Moon, p. 38
10. Blackout! p. 41

The Solar System

Outcomes

Students will be expected to

- select and use tools in building models of the solar system that show approximate relative size of the planets and sun, and the approximate relative orbits of the planets around the sun (205-2)
- describe the physical characteristics of components of the solar system (104-8, 300-23)

Elaborations–Strategies for Learning and Teaching

Students should construct models that give them a concrete picture of the scale of the solar system and the interactions between the planets. Depending on the scales chosen, this model may be constructed in a classroom, or in the gym, or outside in the school yard. A useful model uses various lengths of string to show the distance of a planet from a sun, and different sized balls or balloons to represent different planets. If students are given a ball (planet) and the string attached to the sun to hold on to, they can simultaneously revolve around the sun to simulate the planets in their orbits. Other students may be given other props to signify what they are, for example, a small ping-pong ball or a pea could signify an asteroid, and then move throughout this model to show the path they might follow.

Students should be able to distinguish between the identified components in terms of the paths they follow (for example, Do they orbit the sun? Do they orbit a planet?) , and their general make-up (solid, liquid and/or gas), and ability to radiate light. Students should also be expected to know the names of the planets, and be able to identify the closest planets to Earth. They should not be required to know the order of all nine planets, but could perhaps name the planets closest and furthest from the sun. The focus should be on introducing them to the concept of a solar system, and then teaching them the skills to seek out specific information instead of memorizing it.

Students should

- describe the sun as the centre of the solar system, and the main source of energy for everything in the solar system
- describe planets as bodies that move around the sun, and do not give off their own radiation
- state the names of all the planets, and name the planets on either side of the Earth
- identify examples of planets that are made from rocky materials, and those that are made up of gases
- describe moons as bodies that move around the planets, and do not give off their own radiation
- describe the general composition, relative size, appearance, and paths of asteroids, comets, and meteors

The Solar System

Tasks for Instruction and/or Assessment

Performance

- In a group of two or three, construct a model from the suggested list below:
  - model of the moon rotating and revolving around the Earth
  - model of another planet and its moon(s), illustrating the paths and relative size
  - model of the planets of the solar system and sun, showing relative size or distance from the sun
  - model that illustrates the difference between a rocky planet, and one composed mostly of gases.
  - model that illustrates the relative size, path and composition of a comet, meteor, or asteroid

  (205-2, 104-8, 300-23, 105-1, 205-8, 207-2)

Journal

- Describe how the sun is very important to me. Describe why. (104-8, 300-23)

Paper and Pencil

- What is the difference between the orbit of a planet and the orbit of a moon? (104-8, 300-23)

Interview

- Do all the planets have the same type of composition? What types of planets are there? (104-8, 300-23)

Resources

<u>Science and Technology 6</u>

Teacher's Guide: Space

2. Tracking Out Nearest Star, p. 14
3. That Glorious Old Sun, p. 17
7. The Moon on the Move, p. 31
8. Earth's Companion, p. 34
11. Out Solar System, p. 45
12. Sky Pictures, p. 49

Design Project: Planetarium, p. 59

The Solar System (continued)

Outcomes

Students will be expected to

- identify and use a variety of sources and technologies to gather pertinent information about a planet, moon, asteroid, or comet, and display their findings using diagrams, pictures and/or descriptions from recent explorations (105-1, 205-8, 207-2)
- evaluate the usefulness of different information sources when getting information about the components of the solar system (206-4, 204-6)

Elaborations–Strategies for Learning and Teaching

Students will select one of the components of the solar system to research using the Internet, software, videos, or other sources. If they research a planet, they can collect information on moons, planets surface temperature or the amount of gravity. The focus should be on developing the skills to seek out the information and trying to make the facts they collect as relevant and real to them as possible. They can display their findings in project form. Alternatively, students could write a letter home describing their holiday on a planet, moon, or asteroid other than the Earth and include in the description the key characteristics, drawings or pictures of the planet. Students can participate in an "Invent an Alien" contest where students can use recyclable material to construct an alien that could survive on a planet other than Earth, or write a story about this alien, its experiences, and its adaptive features. Students can draft a travel brochure to a planet.

Software and Internet sites are available that can provide an excellent, motivating source of information about the components of the solar system.

Students should examine, critically, a variety of information sources on the solar system. Sources include science fiction books, television programs, Internet sites, and scientific books and magazines. There are a wide variety of science fiction shows on television. Students could evaluate these shows to try to pick out fact from fiction in some of these episodes. This can connect to language arts outcomes related to critical literacy. An interesting project is to show old science fiction shows, and discuss how some of technologies used in those shows were not even invented at that time, but are now common place. Another source of fact versus fiction can be explored by students or teachers reading science fiction and factual accounts of phenomena (such as the apparent canals on Mars). Discussions can ensue on the merits and purpose (entertainment versus information) of each account. It can also help to highlight the concept that as technology improves, ideas in science constantly evolve. Hubble, who first used his telescope to look at Mars, concluded that it was crisscrossed with canals, which led him to conclude that it had intelligent life forms that used advanced technologies. This spurred on scientific investigation to determine the nature of these canals, which led in turn to a better theory as to the origin of the canals.

The Solar System (continued)

Tasks for Instruction and/or Assessment

Paper and Pencil

- Select a component of the solar system, a current event in space travel or exploration, or a technology used to explore space, and using a variety of sources to obtain information, write a report on this topic. (105-1, 205-8, 207-2, 107-12, 106-3, 107-3)
- How are planets different from stars? (105-1, 205-8, 207-2)

Interview

- When you watch science fiction shows, how much of it do you think is based on fact? How much of it is fiction? Select one for discussion. (206-4, 204-6)

Presentation

- Create a model of a component of the solar system that you are researching and present your project to the class. (105-1, 205-8, 207-2)
- Write a short story about space travel incorporating the component of the solar system you are researching. How long would it take you to get there? What would you see when you arrived? Could you walk on the planet? What kinds of things would you experience? (105-1, 205-8, 207-2)

Resources

Science and Technology 6

Teacher's Guide: Space

11. Out Solar System, p. 45
13. What's Happening in Space? p. 53

Stars and Constellations

Outcomes

Students will be expected to

- identify constellations from diagrams, pictures and/or representations of the night sky (302-13)
- use electronic, print resources and/or visit a planetarium to gather information on the visual characteristics and mythology of constellations (205-8)
- compare how different cultures have used the positions of stars for such things as the appropriate time to plant and harvest crops, navigate the oceans, and/or foretell significant events (107-3)

Elaborations–Strategies for Learning and Teaching

Obviously, viewing the night sky is not going to be possible during school hours. Depending on weather conditions, the stars may not be visible for long periods of time. Whenever possible though, students should be involved in observing the night sky and identifying patterns and differences over the evening, and from night to night. As a home activity, students should pick out one star/constellation and note its position at the same time each night. Students should not be asked to memorize large numbers of constellations. Teachers may want to focus on one or two that are visible at that time of the year, so that students can recognize them and show them to others in their household. Given a picture of the night sky, students can invent their own constellations and name them. This will emphasize to them that constellations are human inventions, and different places around the world have defined different constellations with a variety of names.

Students can try to identify constellations using pictures of the night sky, or viewing the constellations using a portable planetarium, or visiting a planetarium. Students can make their own planetarium by selecting a constellation, and using construction paper, poking holes and shining light through them to project a constellation on a screen.

Students should investigate how different stars to plant and harvest crops, foretell significant events.

Students can investigate, using electronic and print resources, how the stars have been used by different cultures (e.g., Celts, Aztecs, and Egyptians) and how various constellations got their names. Fishers, explorers, and astrologers have used the position of the stars to help them. Students can investigate some of the ways that stars have been used in the past, and, if possible, try using the same techniques to see if they have merit.

Stars and Constellations

Tasks for Instruction and/or Assessment

Performance

- Using dark construction paper, draw a constellation, and mark the stars that define it. **Caution: Using a pin or sharp point of a pencil or pen put holes in the paper where the stars appear.** Using an overhead projector, show your class your constellation. (205-8)

Journal

- Three times this month, on clear nights, record your observations of the night sky. Create your own constellation, name it, and draw it in your journal. (205-7, 302-13)

Paper and Pencil

- Research and write a brief report on a constellation. Refer to the origin of its name, and its importance to ancient and/or modern culture. (205-8)
- Research how the Egyptians, Aztecs, and other cultures used the Sun and stars to explain natural phenomena. (107-3)

Interview

- Do we always see the same stars when we look out at night? Do the patterns of stars change over the year? (205-7, 302-13)

Portfolio

- Select pieces of your work to include in your portfolio.

Resources

Science and Technology 6

Teacher's Guide: Space

12. Sky Pictures, p. 49

Elementary Science Safety

Although experimentation in the elementary years may not be in as much depth as in secondary school, and the equipment and chemicals may not be as sophisticated, the attention to safety is just as important. Safety is an important concern in the elementary science classroom because students are learning new skills and working with unfamiliar equipment and materials that can pose some degree of hazard. Safety in the elementary school science classroom depends upon the wise selection of experiments, materials, resources and field experiences as well as consistent adherence to correct and safe techniques. Some work procedures require thorough planning, careful management and constant monitoring of students' activities. Teachers should be knowledgeable of the properties, possible hazards, and proper use and disposal of all materials used in the classroom.

The Safe Classroom

Some general principles of safe science classroom management may be identified:

- Prepare, maintain, and prominently display a list of emergency telephone numbers.
- Identify people within the school who are qualified to administer first aid.
- Annually review and complete the safety checklists relevant to your situation.
- Familiarize yourself with the relevant medical histories of individual students.
- Review basic first aid procedures regularly.
- Formulate, in consultant with administration and other teachers, an action plan to deal with accidents in the classroom and also on extracurricular activities such as field trips.

Non-Hazardous Chemicals

The following chemicals can be used safely by students (but remember that any substance, even salt, can be harmful if taken in sufficient quantity). Be aware that any substance in a fine powder or dust form can be inhaled and thus harm health.

Aluminum foil	Detergents, hand-washing types (but not dishwashing)	Soap
Baking powder (sodium bicarbonate and tartaric acid)	Food colouring	Starch
Baking soda (sodium bicarbonate)	Glycerine (glycerol)	Steel wool
Bath salts/Epsom salts (magnesium sulfate)	Iron filings	Sugar
Borax (sodium borate)	Lemon juice (contains citric acid)	Tea (contains tannic acid)
Carbonated (fizzy) drinks	Marble chips (calcium carbonate)	Universal (pH) indicator paper or solution
Chalk (calcium carbonate)	Litmus paper or solution	'Vaseline'
Charcoal (carbon)	Milk	Vinegar (dilute acetic acid)
Citric acid crystals	Oils, vegetable and mineral (but not motor oil)	Vitamin C (ascorbic acid)
Clay (moist)	Plaster of Paris or cellulose fillers ('Polyfilla')	Washing powder, hand-washing types
Copper foil	Salt (sodium chloride)	Zinc foil
Cream of tartar (tartaric acid and potassium hydrogen tartrate)	Sand	

Dangerous Household Chemicals

Some common products are potentially hazardous and should not be used in the elementary classroom. Consider warning the students about the dangers in their homes.

Bleach	Fine powdered substances	Paint strippers
Caustic coda (sodium hydroxide)	Fireworks, sparklers and party poppers	Pesticides, fungicides, and insecticides
Rust-removal solution	Gasoline and other fuels	Some plant growth substances
Dishwasher detergents	Hydrogen peroxide	(e.g. rooting powders)
Drain cleaner	(more than a 3% solution)	Scale removers
Dry cleaning fluids	Laundry detergents	Toilet cleansers
Some fertilizers	Oven cleaners	Weed killers

Disposing of Chemicals

- The disposal of non-hazardous, water-soluble liquid wastes (e.g. liquid handsoap, vinegar) should involve diluting the liquid waste before pouring it down the drain, then running tap water down the drain to further dilute the liquid.
- Non-hazardous solid wastes (e.g. iron filings, table salt) should be disposed of in a waste container.
- Hazardous wastes should be placed in specially marked waste containers and disposed of in an appropriate manner.

Science Safety Rules and Procedures for Elementary Science Students (not a conclusive list)

1. Never do any experiment without the approval and direct supervision of your teacher.
2. Read all written instructions before doing an activity.
3. Listen to all instructions and follow them carefully.
4. Make sure you understand all the safety labels.
5. Always ask your teacher if you do not understand.
6. Wear proper safety protection as instructed by teacher.
7. Never remove your goggles during an activity.
8. Tie back long hair and avoid wearing loose clothing such as scarves, ties or long necklaces.
9. Know the location of safety and first aid equipment.
10. Work carefully and make sure that your work area is not cluttered.
11. Always cut away from yourself and others when using a knife.
12. Always keep the pointed end of scissors or any other sharp object facing away from yourself and others if you have to walk with it.
13. Dispose of broken glass as your teacher directs.
14. Do not smell a substance directly. Fan the smell toward you with your hand.

Science Safety Rules and Procedures for Elementary Science Students (not a conclusive list) (continued)

15. Never eat or drink in the laboratory.
16. Never drink or taste any substances.
17. Never use cracked or broken glassware.
18. Make sure that your hands are dry when touching electrical cords, plugs, or sockets.
19. Handle hot objects carefully.
20. Tell your teacher immediately if an accident or spill occurs, no matter how minor.
21. Clean equipment before you put it away.
22. Dispose of materials as directed by your teacher.
23. Clean up your work area upon completion of your activity.
24. Wash hands carefully with soap and water after handling chemicals, after all spills and at the end of each activity.

Plant and Animal Care in the Classroom

(http://www.sasked.gov.sk.ca/docs/elemsci/corgesc.html)

Teachers should familiarize themselves with any local, provincial, or federal statutes pertaining to the care of plants or animals. If in doubt, inquire. Pet shops may have useful information. Remember that there are regulations preventing the picking of some wild flowers, or the captive use of migratory birds or endangered species. The following are some guidelines for the care of plants and animals in the classroom:

- Be wary of any possible signs of allergic reactions among students to any plants or animals.
- Inform the administration before bringing any animals into the school.
- Inquire about specific feeding and facility requirements for classroom pets.
- Be wary of possible diseases that may be spread by animals, or by people to animals.
- Poisonous animals and plants, or other potentially dangerous animals such as venomous snakes and spiders should not be kept in the classroom.
- Wear gloves when handling animals in the classroom. Over-handling can put the animals under excessive stress.
- Involve students in helping to care for plants and animals.
- Make arrangements to have the plants and animals looked after over holidays and on weekends.

(Adapted and used with permission from the Ministry of Education, British Columbia)

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

For grades 6 - 9, it is expected that students will be encouraged to ...

Appreciation of science

422 appreciate the role and contribution of science and technology in our understanding of the world

423 appreciate that the applications of science and technology can have advantages and disadvantages

424 appreciate and respect that science has evolved from different views held by women and men from a variety of societies and cultural back grounds

Evident when students, for example,

- recognize the potential conflicts of differing points of view on specific science-related issues
- consider more than one factor or perspective when formulating conclusions, solving problems, or making decisions on STSE issues
- recognize the importance of drawing a parallel between social progress and the contibutions of science and technology
- establish the relevance of the development of information technologies and science to human needs
- recognize that science cannot answer all questions
- consider scientific and technological perspectives on an issue
- identify advantages and disadvantages of technology
- seek information from a variety of disciplines in their study
- show an interest in the contributions women and men from many cultural backgrounds have made to the development of science and technology

Interest in science

425 show a continuing curiousity and interest in a broad scope of science-related fields and issues

426 confidently pursue further investigations and readings

427 consider many career possibilities in science- and technology-related fields

Evident when students, for example,

- attempt at home to repeat or extend a science activity done at school
- actively participate in co-curriculum and extra-curricular activities such as science fairs, science clubs, or science and technology challenges
- choose to study topics that draw on research from different science and technology fields
- pursue a science-related hobby
- discuss with others the information presented in a science show or on the Internet
- attempt to obtain information from a variety of sources
- express a degree of satisfaction at understanding science concepts or resources that are challenges
- express interest in conducting science investigations of their own design
- choose to investigate situations or topics that they find challenging
- express interest in science- and technology-related careers
- discuss the benefits of science and technology studies

Scientific inquiry

428 consider observations and ideas from a variety of sources during investigations and before drawing conclusions

429 value accuracy, precision, and honesty

430 persist in seeking answers to difficult questions and solutions to difficult problems

Evident when students, for example,

- ask questions to clarify meaning or confirm their understanding
- strive to assess a problem or situation accurately by careful analysis of evidence gathered
- propose options and compare them before making decisions or taking action
- honestly evaluate a complete set of data based on direct observation
- critically evaluate inferences and conclusions, basing their arguments on fact rather than opinion
- critically consider ideas and perceptions, recognizing that the obvious is not always right
- honestly report and record all observations, even when the evidence is unexpected and will affect the interpretation of results
- take the time to gather evidence accurately and use instruments carefully
- willingly repeat measurements or observations to increase the precision of evidence
- choose to consider a situation from different perspectives
- identify biassed or inaccurate interpretations
- report the limitations of their designs
- respond sceptically to a proposal until evidence is offered to support it
- seek a second opinion before making a decision
- continue working on a problem or research project until the best possible solutions or answers are identified

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

For grades 6 - 9, it is expected that students will be encouraged to ...

Collaboration

431 work collaboratively in carrying out investigations, as well as in generating and evaluating ideas

Evident when students, for example,
- assume responsibility for their share of the work to be done
- willingly work with new individuals, regardless of their age, their gender, or their physical or cultural characteristics
- accept various roles within a group, including that of leadership
- help motivate others
- consider alternative ideas and interpretations suggested by members of the group
- listen to the points of view of others
- recognize that others have a right to their points of view
- choose a variety of strategies, such as active listening, paraphrasing, and questioning, in order to understand others' points of view
- seek consensus before making decisions
- advocate the peaceful resolution of disagreements
- can disagree with others and still work in a collaborative manner
- are interested and involved in decision making that requires full-group participation
- share the responsibility for carrying out decisions
- share the responsibility for difficulties encountered during an activity

Stewardship

432 be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment

433 project, beyond the personal, consequences of proposed actions

Evident when students, for example,
- show respect for all forms of life
- consider both the immediate and long-term effects of their actions
- assume personal responsibility for their impact on the environment
- modify their behaviour in light of an issue related to conservation and protection of the environment
- consider the cause-and-effect relationships of personal actions and decisions
- objectively identify potential conflicts between responding to human wants and needs and protecting the environment
- consider the points of view of others on a science-related environmental issue
- consider the needs of other peoples and the precariousness of the environment when making decisions and taking action
- insist that issues be discussed using a bias-balanced approach
- participate in school or community projects that address STSE issues

Safety in science

434 show concern for safety in planning, carrying out, and reviewing activities

435 become aware of the consequences of their actions

Evident when students, for example,
- read the labels on materials before using them, and ask for help if safety symbols are not clear or understood
- readily alter a procedure to ensure the safety of members of the group
- select safe methods and tools for collecting evidence and solving problems
- listen attentively to and follow safety procedures explained by the teacher or other leader
- carefully manipulate materials, using skills learned in class or elsewhere
- ensure the proper disposal of materials
- immediately respond to reminders about the use of safety precautions
- willingly wear proper safety attire without having to be reminded
- assume responsibility for their involvement in a breach of safety or waste disposal procedures
- stay within their own work area during an activity, respecting others' space, materials, and work
- take the time to organize their work area so that accidents can be prevented
- immediately advise the teacher of spills, breaks, and unusual occurrences, and use appropriate techniques, procedures, and materials to clean up
- clean their work area during and after an activity
- seek assistance immediately for any first aid concerns such as burns, cuts, or unusual reactions
- keep the work area uncluttered, with only appropriate materials present