Science 9

Guide

NOVA SCOTIA
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Science 9

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Atlantic Canada Science Curriculum
Grade 9

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.

Contents

Introduction

Background

The curriculum described in *Foundation for the Atlantic Canada Science Curriculum* was planned and developed collaboratively by regional committees. The process for developing the common science curriculum for Atlantic Canada involved regional consultation with the stakeholders in the education system in each Atlantic province. The Atlantic Canada science curriculum is consistent with the framework described in the pan-Canadian *Common Framework of Science Learning Outcomes K to 12*.

Aim

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

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

Program Design and Components

Learning and Teaching Science

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

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

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

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

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

Writing in Science

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

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

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

The Three Processes of Scientific Literacy

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

Inquiry

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

Problem Solving

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

Decision Making

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

Meeting the Needs of All Learners

Foundation for the Atlantic Canada Science Curriculum stresses the need to design and implement a science curriculum that provides equitable opportunities for all students according to their abilities, needs, and interests. Teachers must be aware of, and make adaptations to accommodate, the diverse range of learners in their classes. To adapt instructional strategies, assessment practices, and learning resources to the needs of all learners, teachers must create opportunities that will permit students 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 achieving designated outcomes. Teachers should adapt classroom organization, teaching strategies, assessment practices, time, and learning resources to address students' needs and build on their strengths. The variety of learning experiences described in this guide provide access for a wide range of learners. Similarly, the suggestions for a variety of assessment practices provide multiple ways for learners to demonstrate their achievements.

Assessment and Evaluation

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

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

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

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

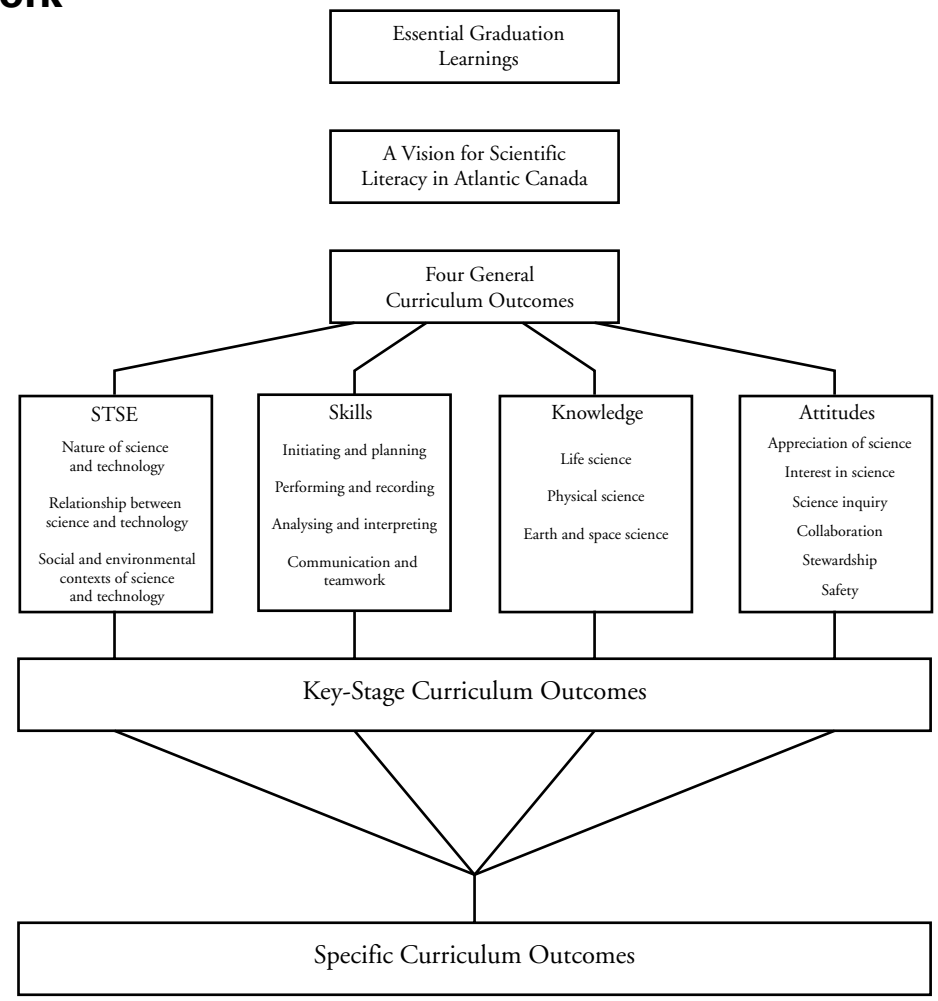
The Atlantic Canada science curriculum reflects the three major processes of science learning: inquiry, problem solving, and decision making. When a teacher assesses student progress, it is helpful to know some activities/skills/actions that are associated with each process of science learning. Student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

Curriculum Outcomes Framework

Overview

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

Outcomes Framework



Essential Graduation Learnings

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

Aesthetic Expression

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

Citizenship

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

Communication

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

Personal Development

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

Problem Solving

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

Technological Competence

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

General Curriculum Outcomes

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

Science, Technology, Society, and the Environment

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

Skills

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

Knowledge

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

Attitudes

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

Key-Stage Curriculum Outcomes

Key-stage curriculum outcomes are statements that identify what students are expected to know, be able to do, and value by the end of grades 3, 6, 9, and 12 as a result of their cumulative learning experiences in science. The key-stage curriculum outcomes are from the *Common Framework for Science Learning Outcomes K to12*.

Specific Curriculum Outcomes

This curriculum guide outlines specific curriculum outcomes for Grade 9 and provides suggestions for learning, teaching, assessment, and resources to support students' achievement of these outcomes. Teachers should consult *Foundation for the Atlantic Canada Science Curriculum* for descriptions of the essential graduation learnings, vision for scientific literacy, general curriculum outcomes, and key-stage curriculum outcomes.

Specific curriculum 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 four units. Each unit is organized by topic as follows:

Reproduction

- Cellular Processes (X hours)
- Asexual and Sexual Reproduction (X hours)
- Genetic Changes (X hours)

Atoms and Elements

- Safety Consideration and Physical Properties (X hours)
- Chemical Changes/Reactions (X hours)
- Atomic Theory (X hours)
- Periodic Law (X hours)

Characteristics of Electricity

- Static Electricity (X hours)
- Static Electricity and Electric Current (X hours)
- Series and Parallel Circuits (X hours)
- Use of Electrical Energy (X hours)
- Electricity and the Environment (X hours)

Space Exploration

- The Beginnings of the Solar System (X hours)
- Composition and Characteristics of the Solar System (X hours)
- Composition and Characteristics of the Universe (X hours)

The following pages outline Grade 9 specific curriculum outcomes grouped by units and topics.

Reproduction

Students will be expected to

Cellular Processes

- recognize that the nucleus of a cell contains genetic information and determines cellular processes (305-1)
- explain the importance of using the terms gene and chromosome properly (109-14)
- identify major shifts in scientific understanding of genetics (110-3)
- illustrate and describe the basic processes of mitosis and meiosis (304-11)
- determine and graph the theoretical growth rate of a cell, and interpolate and extrapolate the cell population from the graph (210-2, 210-4, 210-9)

Asexual and Sexual Reproduction

- distinguish between sexual and asexual reproduction in representative organisms (305-2)
- compare sexual and asexual reproduction in terms of their advantages and disadvantages (305-3)
- identify questions to investigate about sexual reproduction in plants (208-2)
- use tools and apparatus safely to investigate the structure of flowers (209-6)
- communicate the results of an investigation into the structure of flowers (211-2)

Genetic Changes

- provide examples of genetic conditions that cannot be cured using scientific and technological knowledge at the present time (113-10)
- discuss factors that may lead to changes in a cell's genetic information (305-5)
- evaluate information and evidence gathered on the topic of genetics and genetic engineering (209-5, 210-8)
- provide examples of how the knowledge of cellular functions has resulted in the development of technologies (111-1)
- provide examples of Canadian contributions to science and technology related to heredity and genetic engineering (112-12)

Atoms and Elements

Students will be expected to

Safety Consideration and Physical Properties

- compare earlier conceptions of the structure of matter with their conceptions (110-1)
- demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials (209-7)
- investigate materials and describe them in terms of their physical properties (307-12)
- compile and display data collected during an investigation of the physical properties of materials (210-2)

Chemical Changes/Reactions

- describe changes that result from some common chemical reactions (307-13)
- determine, where possible, if the change in a material or object is physical or chemical on the basis of experimental data (210-11)
- identify new questions about physical and chemical changes that arise from investigations (210-16)

Atomic Theory

- identify major changes in atomic theory up to and including the Bohr model (110-3)

- use models in describing the structure and the components of atoms and molecules, and explain the importance of choosing words that are scientifically or technologically appropriate (109-13, 307-14)
- provide examples of technologies that have enhanced, promoted, or made possible scientific research in chemistry (111-4)
- provide examples to illustrate that scientific and technological activities related to atomic structure take place in a variety of individual and group settings (112-8)
- explain the importance of using the terms law and theory in science (109-14)

Periodic Law

- identify examples of common elements, and compare their characteristics and atomic structure (307-15)
- describe and explain the role of collecting evidence, finding relationships, and proposing explanations in the development of the periodic table (109-2)
- use or construct a classification key (210-1)
- identify the elements and number of atoms, given a chemical formula (307-16)
- provide examples where knowledge of chemistry has resulted in the development of commercial materials (111-1)
- give and explain examples illustrating how limited resources have forced scientists and technologists to develop more efficient ways to extract elements and compounds from nature, or to find or develop appropriate substitutes (112-3)

Characteristics of Electricity

Students will be expected to

Static Electricity

- identify properties of static electrical charges (308-14)
- explain the production of static electrical charges in some common materials (308-13)
- provide examples of how knowledge of static electricity has resulted in the development of technologies (111-1, 112-7)
- provide examples of careers related to electricity in their community and province (112-10)

Static Electricity and Electric Current

- describe the flow of charge in an electrical circuit and describe the factors affecting the amount of resistance in a wire (length, diameter, type) (109-14, 308-16)
- compare qualitatively static electricity and electric current (308-15)

Series and Parallel Circuits

- rephrase questions in a testable form related to series and parallel circuits (208-1)
- use an ammeter and a voltmeter to measure current and voltage in series and parallel circuits (209-3)

- identify potential sources of error in ammeter and voltmeter readings (210-10)
- identify and suggest explanations for discrepancies in data collected using an ammeter and a voltmeter (210-7)
- present graphically the data from investigation of voltage, current, and resistance in series and parallel circuits (210-5, 211-2)
- describe series and parallel (maximum two resistors) circuits involving varying resistance, voltage, and current, using Ohms' Law (308-17)

Use of Electrical Energy

- relate electrical energy to domestic power consumption costs (308-18)
- explain that precise language is required to properly interpret Energuide labels and to understand a utility bill (109-14)
- compare examples of past and current technologies that used current electricity to meet similar needs (110-9)
- determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy (308-19)

Electricity and the Environment

- describe the transfer and conversion of energy from a generating station to the home (308-20)
- evaluate evidence and sources of information when conducting research on electrical energy production and its impact on the environment (210-8)
- select recent data while conducting research on the environmental problems associated with various types of electrical energy production (113-6, 210-8)
- propose a course of action that reduces the consumption of electrical energy (113-9, 113-13)
- give examples of the development of alternative sources of energy (such as wind generators and solar energy) that are a result of cost and the availability and properties of materials (109-6)

Space Exploration

Students will be expected to

The Beginnings of the Solar System

- describe and explain the apparent motion of celestial bodies (312-4)
- describe theories on the formation of the solar system (312-1)

Composition and Characteristics of the Solar System

- describe the composition and characteristics of the components of the solar system (312-5)
- explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies (110-6, 210-3)
- provide examples of how the Canadian Government and/or Canadian Space Agency is involved in research projects about space (112-6)

- defend their position regarding societal support for space exploration (211-5)
- describe the effects of solar phenomena on Earth (312-6)
- design and describe a model space station on the basis of what they have learned about the sun's influences on Earth (208-4, 211-1)

Composition and Characteristics of the Universe

- describe theories on the origin and evolution of the universe (312-3)
- describe and classify the major components of the universe (312-2)
- calculate the travel time to a distant star at a given speed (210-9)
- explain how data provided by technologies contribute to our knowledge of the universe (109-3)
- working collaboratively with group members, prepare a comparative data table on various stars, and design a model to represent some of these stars relative to our solar system (209-4, 211-1, 211-3)
- describe examples of science- and technology-based careers in Canada that are associated with space exploration (112-11)
- identify new questions and problems that arise from the study of space exploration (210-16)
- describe the science underlying three technologies designed to explore space (109-11, 111-5)

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.

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

Key-Stage Curriculum Outcomes: Attitudes

For grade 7–9, students will be expected to

Appreciation of Science	Interest in Science	Scientific Inquiry
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 backgrounds *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 usefulness of mathematical and problem-solving skills in the development of a new technology • recognize the importance of drawing a parallel between social progress and the contributions 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 • avoid stereotyping scientists • show an interest in the contributions women and men from many cultural backgrounds have made to the development of science and technology	**425** show a continuing curiosity 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-curricular 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 challenging • 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	**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 biased or inaccurate interpretations • report the limitations of their designs • respond skeptically 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

Key-Stage Curriculum Outcomes: Attitudes *(continued)*

For grades 7–9, students will be expected to

Collaboration	Stewardship	Safety in Science
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	**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	**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 like burns, cuts, or unusual reactions • keep the work area uncluttered, with only appropriate materials present

Curriculum Guide Organization

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

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

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

Unit Organization

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

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

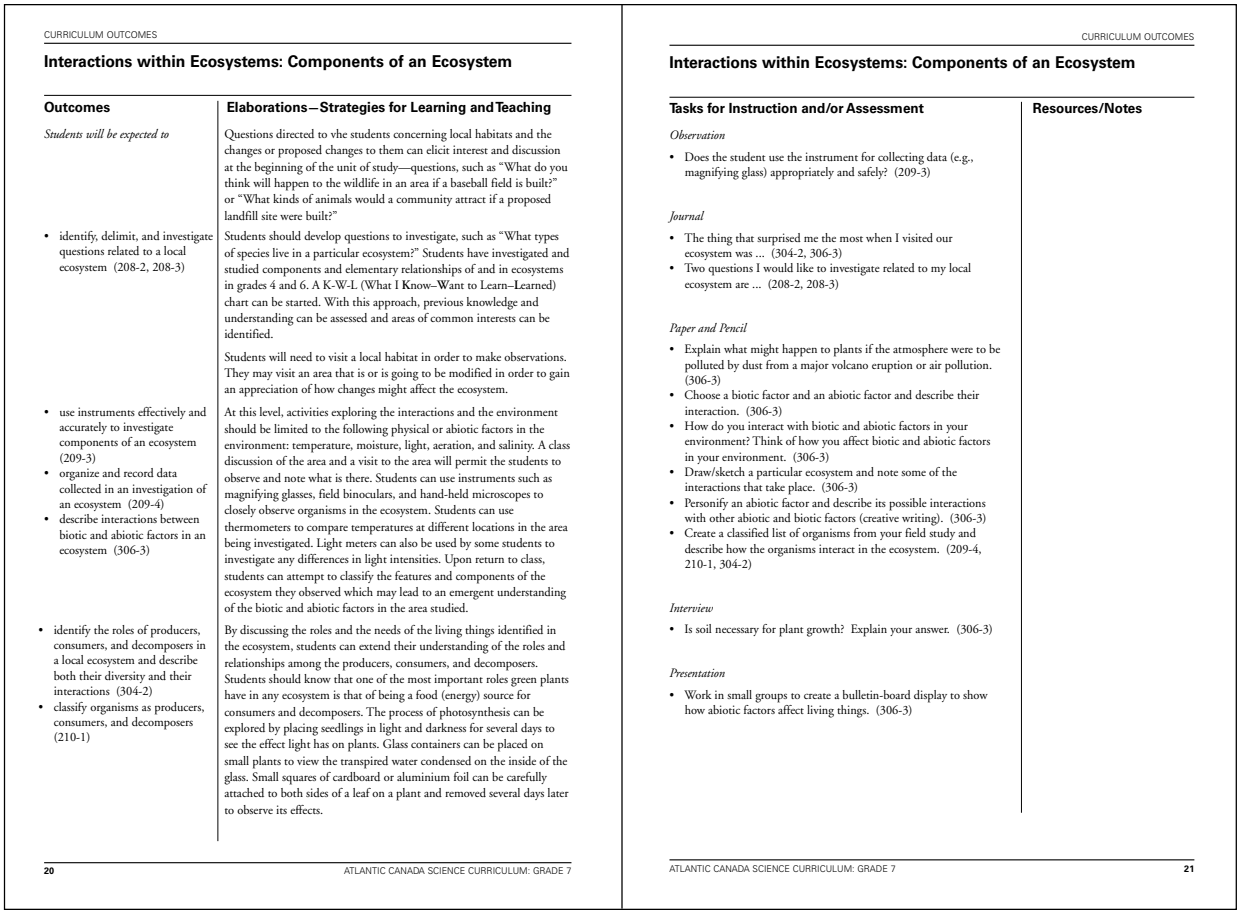
- 100s—Science-Technology-Society-Environment (STSE) outcomes
- 200s—Skills outcomes
- 300s—Knowledge outcomes
- 400s—Attitude outcomes (see pages 16–18)

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

The Four-Column Spread

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

Two-Page, Four-Column Spread



CURRICULUM OUTCOMES

Interactions within Ecosystems: Components of an Ecosystem

Outcomes	Elaborations—Strategies for Learning and Teaching
Students will be expected to	Questions directed to vhe students concerning local habitats and the changes or proposed changes to them can elicit interest and discussion at the beginning of the unit of study—questions, such as "What do you think will happen to the wildlife in an area if a baseball field is built?" or "What kinds of animals would a community attract if a proposed landfill site were built?"
• identify, delimit, and investigate questions related to a local ecosystem (208-2, 208-3)	Students should develop questions to investigate, such as "What types of species live in a particular ecosystem?" Students have investigated and studied components and elementary relationships of and in ecosystems in grades 4 and 6. A K-W-L (What I **K**now–**W**ant to Learn–**L**earned) chart can be started. With this approach, previous knowledge and understanding can be assessed and areas of common interests can be identified. Students will need to visit a local habitat in order to make observations. They may visit an area that is or is going to be modified in order to gain an appreciation of how changes might affect the ecosystem.
• use instruments effectively and accurately to investigate components of an ecosystem (209-3) • organize and record data collected in an investigation of an ecosystem (209-4) • describe interactions between biotic and abiotic factors in an ecosystem (306-3)	At this level, activities exploring the interactions and the environment should be limited to the following physical or abiotic factors in the environment: temperature, moisture, light, aeration, and salinity. A class discussion of the area and a visit to the area will permit the students to observe and note what is there. Students can use instruments such as magnifying glasses, field binoculars, and hand-held microscopes to closely observe organisms in the ecosystem. Students can use thermometers to compare temperatures at different locations in the area being investigated. Light meters can also be used by some students to investigate any differences in light intensities. Upon return to class, students can attempt to classify the features and components of the ecosystem they observed which may lead to an emergent understanding of the biotic and abiotic factors in the area studied.
• identify the roles of producers, consumers, and decomposers in a local ecosystem and describe both their diversity and their interactions (304-2) • classify organisms as producers, consumers, and decomposers (210-1)	By discussing the roles and the needs of the living things identified in the ecosystem, students can extend their understanding of the roles and relationships among the producers, consumers, and decomposers. Students should know that one of the most important roles green plants have in any ecosystem is that of being a food (energy) source for consumers and decomposers. The process of photosynthesis can be explored by placing seedlings in light and darkness for several days to see the effect light has on plants. Glass containers can be placed on small plants to view the transpired water condensed on the inside of the glass. Small squares of cardboard or aluminium foil can be carefully attached to both sides of a leaf on a plant and removed several days later to observe its effects.

20 ATLANTIC CANADA SCIENCE CURRICULUM: GRADE 7

CURRICULUM OUTCOMES

Interactions within Ecosystems: Components of an Ecosystem

Tasks for Instruction and/or Assessment	Resources/Notes
Observation • Does the student use the instrument for collecting data (e.g., magnifying glass) appropriately and safely? (209-3)	
Journal • The thing that surprised me the most when I visited our ecosystem was ... (304-2, 306-3) • Two questions I would like to investigate related to my local ecosystem are ... (208-2, 208-3)	
Paper and Pencil • Explain what might happen to plants if the atmosphere were to be polluted by dust from a major volcano eruption or air pollution. (306-3) • Choose a biotic factor and an abiotic factor and describe their interaction. (306-3) • How do you interact with biotic and abiotic factors in your environment? Think of how you affect biotic and abiotic factors in your environment. (306-3) • Draw/sketch a particular ecosystem and note some of the interactions that take place. (306-3) • Personify an abiotic factor and describe its possible interactions with other abiotic and biotic factors (creative writing). (306-3) • Create a classified list of organisms from your field study and describe how the organisms interact in the ecosystem. (209-4, 210-1, 304-2)	
Interview • Is soil necessary for plant growth? Explain your answer. (306-3)	
Presentation • Work in small groups to create a bulletin-board display to show how abiotic factors affect living things. (306-3)	

ATLANTIC CANADA SCIENCE CURRICULUM: GRADE 7 21

Column One: Outcomes

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

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

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

Column Two: Elaborations—Strategies for Learning and Teaching

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

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

Column Three: Tasks for Instruction and/or Assessment

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

Column Four: Resources/Notes

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

Reproduction

Introduction

Reproduction is an essential biological mechanism for the continuity and diversity of species. Students should be provided with opportunities to explore the fundamental processes of reproduction. As well, heredity and the transmission of traits from one living generation to the next will be examined.

The ability of scientists and technologists to manipulate, alter, and substitute genetic material in a variety of cells has increased greatly in recent years. Students will have the opportunity to investigate and debate the current developments and uses of gene manipulation and therapy. An STSE "Science-Technology-Society-Environment" approach to this unit should provide the framework around which an investigation into the ever-expanding world of genetics and gene manipulation can develop. At this level, an elementary introduction to the science of genetics is expected.

Focus and Context

The focus of this unit is inquiry. The unit is subdivided into three sections: cellular processes, asexual and sexual reproduction, and genetic changes. In the first section, students will investigate and study the role of the nucleus in determining mitosis or meiosis. Students will have an introduction to these two processes of cell division. In the second section, students will explore the processes of asexual and sexual reproduction in representative organisms and compare the two processes. Finally, the current topics of cloning, gene therapy, and genetic manipulation will be investigated in the context of genetic changes and the debates and discussions that accompany these topics and issues.

Science Curriculum Links

By the end of **grade three**, students have explored the life cycles of several common animals and plants. At the end of **grade six**, students should be able to describe the role played by body systems in helping humans and other animals to grow and reproduce. Last year, students were formally introduced to the cell as a living system that exhibits all the characteristics of life. Students also investigated the structural and funtional relationships between and among cells, tissues, organs, and systems in the human body.

In **high school**, students will have the opportunity to study a unit in biology called "Genetic Continuity." Meiosis and mitosis will be explored in detail at this level. As well, students will have the opportunity to develop an understanding of Mendelian genetics, including the concepts of dominance, co-dominance, recessiveness, and independent assortment. Much of the foundation for that unit of study is found in this unit.

Curriculum Outcomes

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**	**305-1** recognize that the nucleus of a cell contains genetic information and determines cellular processes
109-14 explain the importance of using precise language in science and technology	**208-2** identify questions to investigate arising from practical problems and issues	**304-11** illustrate and describe the basic process of cell division, including what happens to the cell membrane and the contents of the nucleus
110-3 identify major shifts in scientific world views	**Performing and Recording**	**305-2** distinguish between sexual and asexual reproduction in representative organisms
Relationships Between Science and Technology	**209-5** select and integrate information from various print and electronic sources or from several parts of the same source	**305-3** compare sexual and asexual reproduction in terms of their advantages and disadvantages
111-1 provide examples of scientific knowledge that have resulted in the development of technologies	**209-6** use tools and apparatus safely	**305-5** discuss factors that may lead to changes in a cell's genetic information
Social and Environmental Contexts of Science and Technology	**Analysing and Interpreting**	
112-12 provide examples of Canadian contributions to science and technology	**210-2** compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots	
113-10 provide examples of problems that arise at home, in an industrial setting, or in the environment that cannot be solved using scientific and technological knowledge	**210-4** predict the value of a variable by interpolating or extrapolating from graphical data	
	210-8 apply given criteria for evaluating evidence and sources of information	
	210-9 calculate theoretical values of a variable	
	Communication and Teamwork	
	211-2 communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means	

Cellular Processes
X hours

Outcomes

Students will be expected to

- recognize that the nucleus of a cell contains genetic information and determines cellular processes (305-1)
- explain the importance of using the terms gene and chromosome properly (109-14)
- identify major shifts in scientific understanding of genetics (110-3)

Elaborations–Strategies for Learning and Teaching

In grade 8, students explored and learned about the basic concept of the cell. They investigated the similarities and differences between animal and plant cells. Students were also involved in activities that led them to understand and explain that growth and reproduction depend on cell division. In order to be prepared for an investigation of sexual reproduction in plants, a flowering plant such as a lily should be started before the unit begins. Students may be motivated to investigate cellular processes and genetic changes if they are involved in initial discussions or questions centred around topics such as cloning, genetically modified organisms/food, or gene therapy. Students should gain an appreciation of the major shifts in scientific understanding of genetics over the course of their investigation into this topic. The development of breeds of animals with desired traits, identification of the nucleus of the cell as the location of genetic material and the contributions of Watson and Crick can be explored and discussed.

A possible opening to this unit is to call upon students to observe, note, and report differences and similarities among members of their class or families. This activity can compare and contrast genetically determined physical traits such as hair and eye colour, attached/detached ear lobes, and tongue-rollers/non-tongue-rollers. Students can collect data to determine the frequency of these traits in class or within their families. This research can provide the opportunity for students to ask questions about why we are unique yet similar to classmates or other family members. This approach can lead to questions such as "What causes people to be the same and yet different?" and "Are there similar similarities and differences in other species?" Another possible context for investigation is a study of diseases, their causes, and controls.

In grade 8, students compared and contrasted typical animal and plant cells. They investigated and learned about the main components of cells: nucleus, cell membrane/wall, cytoplasm, and chloroplasts. At this level, students should begin their investigation into the role of the nucleus of a cell. In the course of the investigations and activities, students should come to understand the basic functions of chromosomes and genes, and how genetic information is propagated within an organism and passed on to any offspring.

Chromosomes are not normally visible under a light microscope unless the cell being observed is in the process of dividing. Students can observe prepared slides of cells undergoing division in order to view the chromosomes in the nucleus. Students can view slides of onion root tips, for example, in order to see chromosomes in cells that are in the process of dividing. Appropriate videos and computer software can supplement microscope investigations of cellular activity with regard to mitosis and meiosis.

Cellular Processes

X hours

Tasks for Instruction and/or Assessment

Performance

- Do a survey of the people in your family or class in order to collect data on the following:
  - smooth hair line versus widow's peak
  - can roll tongue versus cannot roll tongue
  - hair on little finger versus no hair on little finger

  Create a data display of your findings. (109-14, 305-1)

Journal

- Explain the difference between gene and chromosome and why they cannot be used interchangeably. (109-14, 305-1)

Paper and Pencil

- Research and report on the process of healing wounds. (304-11, 305-1)
- Investigate what Watson and Crick discovered that improved our understanding of genetics. (110-3)
- Use a sketch or drawing to illustrate the difference between a gene and a chromosome. (109-14, 305-1)

Presentation

- Create a 3-dimensional model of a simplified nucleus containing chromosomes and explain why this term is used and not "genes." (109-14)
- Draw and label a typical animal cell in which the nucleus and nuclear material is indicated. (305-1)

Resources/Notes

Activities from Teacher's Resource

- Around the World
- Modeling a Cell

Software

- HIP Biology 1, "Plants: The Inside Story"
- HIP Biology 2, "The Cell Factory"

Videos

- *DNA: Molecule of Heredity* (V9459)
- *Cells and Systems* (V0832, 20954)
- *Biotechnology* (21638)
- *Mitosis and Meiosis* (V2145)

Cellular Processes *(continued)*

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • illustrate and describe the basic processes of mitosis and meiosis (304-11)	Students should come to understand that mitosis is the process of cell division that results in growth and/or cell replacement. Students should come to understand that not all cells have the same rate of cell reproduction. It is not necessary that the students learn the phase names at this stage. Students can be challenged to create simple models of the various stages of mitosis. The terms gene and chromosome should be carefully distinguished as they are, at times, used interchangeably. Students should come to appreciate that our understanding of the roles of these cellular components has grown tremendously since they were first identified. **Teacher Note:** *Genes are specific parts or location on chromosomes and one or more genes determine the traits that a person exhibits.* The topic of DNA (deoxyribonucleic acid) is not core at this grade level but may be addressed as an extension or enrichment if time permits or if there is student interest. Students should investigate the general stages of meiosis in order to compare and contrast this process with mitosis. Emphasis should not be placed on the rote memorization of these two processes, but rather on understanding the results of these two different forms of cell reproduction. Students are not required to learn the names of the phases of mitosis or meiosis at this level. Some commercial resources may contain the phase names for mitosis and meiosis as well as detailed descriptions of each phase. At the grade 9 level, an introductory treatment of these processes is expected. Students should realize that meiosis results in the production of sex cells of most plants and animals. Students can model or act out the process of mitosis and meiosis by pairing up and simulating the process. Students can use different coloured pinnies or labels that indicate the chromosome or chromosome pairs in the process.
• determine and graph the theoretical growth rate of a cell, and interpolate and extrapolate the cell population from the graph (210-2, 210-4, 210-9)	Students can do the following activity to experience and appreciate the theoretical exponential growth rate of cells due to mitosis. Ask students if they would prefer to have a million dollars or the total value of pennies on a checkerboard if one penny were placed on the first square and then doubled its value for every subsequent square. Students can do this exercise with a calculator. Students should realize that cells die and are replaced at about the same rate in most cases of cell division. Students can begin a yeast population and study the population growth rate over a short period of time. This activity can also be used to investigate budding.

Cellular Processes *(continued)*

Tasks for Instruction and/or Assessment

Performance

- Search for pictures of cells in various stages of mitosis and/or meiosis on the Internet and describe their similarities and differences. (304-11)

Paper and Pencil

- Produce a line graph that communicates the exponential growth rate of theoretical cellular reproduction and a line graph of what one would predict as a better representation of real growth. Explain what each line represents. (210-2, 210-4, 210-9)
- In a series of drawings, illustrate/demonstrate the basic processes of mitosis and meiosis. (304-11)
- Construct a concept map for the processes of meiosis and mitosis. (304-11)
- Research and report on the process of healing wounds. (304-11)

Presentation

- Plan and perform a skit or play that demonstrates the processes of mitosis and meiosis. (304-11)
- Write and perform a play-by-play radio broadcast that demonstrates the four stages of mitosis. (304-11)
- Produce a graph of theoretical cell growth rates and superimpose a graph that would represent a realistic representation of growth rate. (209-9, 210-2, 210-4)

Portfolio

- Develop a concept map to link terms that have been introduced in this unit (chromosome, gene, asexual, sexual, mitosis, meiosis). (109-14, 304-11)

Resources/Notes

Activities from Teacher's Resource

- A Budding Problem
- A Growing Problem
- A Puzzle of a Task

Software

- HIP Biology 1, "The Cell Cycle"
- HIP Biology 2, "Anaphase Animation"
- HIP Biology 2, "Mitosis Movie"

Videos

- *DNA: Molecule of Heredity* (V9459)
- *Cells and Systems* (V0832, 20954)
- *Biotechnology* (21638)
- *Mitosis and Meiosis* (V2145)

Asexual and Sexual Reproduction

X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • distinguish between sexual and asexual reproduction in representative organisms (305-2)	Students should investigate the various processes of asexual reproduction. Students can observe slides or videos in which the following types of asexual reproduction take place: fission—algae and protozoa; spore production—moulds (on old bread or rotting fruit), budding-yeast or hydra. Students should be able to illustrate various types of asexual and sexual reproduction. For example, students can compare and contrast, using diagrams or sketches, reproduction in yeasts and roses. Sexual reproduction involves two parents in the majority of cases. Students should come to understand that organisms that reproduce sexually generally show a wider variety of differences in traits within a given species than those organisms that reproduce asexually. Plants such as roses can be investigated and studied to highlight this point. Students should be given the opportunity to communicate the results of this type of research by using such media as posters, multi-media presentations, and drawings.
• compare sexual and asexual reproduction in terms of their advantages and disadvantages (305-3)	Students can be challenged to think of the advantages and disadvantages of asexual and sexual reproduction. In asexual reproduction organisms can reproduce alone. However, these organisms must generally rely on a mutation in order to have offspring that are significantly different from the parent cell. Organisms that reproduce sexually generally must have two parents in order to reproduce. Exceptions are found in some organisms that have both male and female parts. A greater variety of traits are possible in species that reproduce sexually. Students can investigate and discuss, for example, the variety of dogs, cats, and roses that exist.
• identify questions to investigate about sexual reproduction in plants (208-2) • use tools and apparatus safely to investigate the structure of flowers (209-6) • communicate the results of an investigation into the structure of flowers (211-2)	By observing a variety of plants or pictures of plants, students can be challenged to explain their understanding of how plants reproduce. Have students propose questions about plant reproduction to investigate, such as “How do some flowers differ from each other?” and “What are the basic parts of flowers?” Flowering plants should be started early enough to be used for this activity if flowering plants are not obtained by other means. The lily is a good plant to use as the flowers are large and the flower parts are easily distinguished. Using basic tools such as scissors, forceps, hand lenses, and probes, students can investigate flowers in order to study the different parts. Students can sketch the various parts of the flower in order to communicate the results of their investigations.

Asexual and Sexual Reproduction
X hours

Tasks for Instruction and/or Assessment

Observation

- **Self-Assessment** (208-2, 209-6, 211-2)

Self-Assessment of Plant Reproduction

Tasks	Rarely			Always
I develop procedures in logical sequence.	1	2	3	4
I use tools carefully and effectively.	1	2	3	4
I keep accurate notes of my observations.	1	2	3	4
I communicate the results of my investigations accurately.	1	2	3	4

Performance

- What feature of the stigma makes it well suited for receiving pollen grains? (211-2, 305-3)

Paper and Pencil

- Why would the offspring of organisms that reproduce asexually resemble very closely the parent organism? (303-3)
- Bees gather a sweet fluid called nectar from flowers. In the process, they do something to help fertilize flowers. Research what they inadvertantly do when gathering nectar. (305-3)

Presentation

- Research and report upon the similarities and differences between organisms that reproduce asexually and sexually. (305-2)
- Research cloning techniques in animals and plants. How does cloning resemble asexual reproduction? (305-3)
- Create a poster or mural of organisms that reproduce asexually. (305-2)
- Produce a series of sketches or computer drawings of organisms that reproduce sexually and asexually. (305-3)
- Create a display that illustrates the variety that can occur in a species that reproduces sexually. (305-3)

Resources/Notes

Activities from Teacher's Resource

- A Changing Problem

Videos

- *Sexual Reproduction* (20962)
- *Flowering Plants: From Seed to Seed* (21932)
- *Kingdom of Plants* (V2147)
- *Seeds in Motion* (V1825)
- *Anatomy of a Flowering Plant* (V1616)
- *Moss and Fern Life Cycles* (V1614)

Genetic Changes
X hours

Outcomes

Students will be expected to

- provide examples of genetic conditions that cannot be cured using scientific and technological knowledge at the present time (113-10)
- compare factors that may lead to changes in a cell's genetic information:
  - mutations caused by nature
  - mutations caused by human activities (305-5)
- evaluate information and evidence gathered on the topic of genetics and genetic engineering (209-5, 210-8)
- provide examples of how the knowledge of cellular functions has resulted in the development of technologies (111-1)
- provide examples of Canadian contributions to science and technology related to heredity and genetic engineering (112-12)

Elaborations–Strategies for Learning and Teaching

A general survey of some genetic conditions that are presently not curable can set the stage for this section. Students should investigate situations in which science and technology have yet to solve problems associated with reproduction and genes such as certain causes of cancer and certain conditions, cystic fibrosis, for example.

Students may be aware of some of the work being done by researchers around the world on genetic manipulation. This is a topic which lends itself easily to the introduction and study of differing opinions regarding a particular topic in science and technology.

Students should investigate the "environment versus genetic" debate with regard to genetic changes within populations. Natural (solar radiation and radioactive gases) and human-made factors (chemicals and nuclear radiation) can be investigated in order to understand the ways in which genetic information can be altered within an individual and between generations. Students should be encouraged to identify current questions being debated with regard to this topic as well as their own. Some topics and/or issues that may be investigated and discussed or debated are drugs that affect genetic processes, such as thalidomide, mercury pollution, the use of X rays, and various types of radiation (nuclear and electromagnetic).

The topic of gene manipulation and engineering lends itself well to the critical investigation of a particular process or technology. Students should have opportunities to investigate and discuss the positions of various scientists, researchers, and organizations that work in or study the field of gene manipulation and/or gene technologies. Students should also have the opportunity to critically examine and evaluate sources of information by keeping in mind such things as the date of the publication, the type of audience for which the material was intended, and the author's intent. Students can explore and investigate the information from various groups and their positions regarding topics such as cloning, gene manipulation/therapy in people, and genetically modified foods.

Students can role-play or use debates to highlight the issues inherent in genetic manipulation. Recent events involving the cloning of various animals such as sheep, and the genetic research and technologies associated with foods and food quality can be used to help students appreciate the complex nature of the debate.

Development of wheat and potato varieties, cloning, and an investigation of companies that work in genetic engineering such as Aqua Bounty Farms in Newfoundland can provide contexts for these investigations. Breeding programs in the livestock industry as well as the development of the Macintosh apple, can be topics to be investigated.

Genetic Changes
X hours

Tasks for Instruction and/or Assessment

Observation

- Research various positions of scientists and others with regard to cloning of animals. Participate in a role play or debate on the subject. (210-8, 305-5)

Paper and Pencil

- Investigate and report on a company in your region or province that works within the field of genetic manipulation/selection. (112-12, 305-5)
- In an essay, outline two positions on the cloning of plants and animals. (209-5, 210-8)
- Research the positive and negative effects of mutations or changes in the genetic code; for example, curing/treating diseases (positive); organisms such as bacteria and some mosquitos developing resistance to pesticide. (305-5)

Presentation

- Prepare an oral report on gene therapy. (111-1, 113-10, 305-5)
- Investigate a factor that causes genetic changes, such as nuclear radiation or thalidomide, and prepare a report to present to the class. (209-5, 210-8, 305-5)
- Create a multimedia presentation on the work done to find a cure or treatment for genetically related conditions in humans. (111-1, 113-10)
- Prepare a visual representation of genetic technologies. (210-8)

Resources/Notes

Activities from Teacher's Resource

- Critical Thinking
- Where Have all the Birds Gone?
- Monocots and Dicots
- An Investigation in Genetic Engineering

Software

- HIP Biology1, "Biology Bottlenecks"
- HIP Biology 1, "Gel Electrophoresis"
- HIP Biology 1, "Harris' Hawks"
- HIP Biology 2, "Karyotypes"

Videos

- *Germ Wars* (22281)
- *Immune System: Your Magic Doctor* (21944)
- *Our Genetic Heritage* (20152)
- *Gene Therapy* (21459, V1893)
- *Fighting Diseases* (V1891, 21543)
- *Biotechnology* (21638)
- *Mutation and All That* (V9493)
- *Genetic Fingerprinting* (22225)
- *Genetics: The Amish* (22404)
- *Genetics and Heredity* (V2166)
- *Canadian Farming on the Go* (V9967)
- *Canola Council of Canada: An Industry's Success* (V1598, 21190)
- *News in Review: Genetics in Food—Changing Mother Nature* (22830)
- *Biotechnology*–National Film Board (22463)

Atoms and Elements

Introduction

Modern chemistry is founded on atomic theory and its associated findings. Building on past explorations using various substances and the particle model of matter, students should become familiar with the basic constituents of atoms and molecules, with chemical symbols themselves, and with common elements and compounds. A strong connection should develop between students' basic ideas about chemistry and related examples in their own lives.

Focus and Context

This unit is primarily focussed on inquiry. Students should be exposed to activities that illustrate how knowledge and theories related to atoms and elements have been developed. This unit provides an excellent opportunity to distinguish between laws and theories in science.

Science Curriculum Links

In entry to grade 3, students begin a cursory look at properties of objects and materials (physical properties). Also, a preliminary look at static electricity and magnetism occurs. By the end of grade 6, students have encountered and studied properties and changes in materials (properties of physical changes and chemical changes).

Students in high school will be involved with a unit of work entitled "Chemical Reactions" in which they will learn to name and write formulas for some common ionic and molecular compounds, using the periodic table and a list of ions. In addition, students will classify substances such as acids, bases, or salts according to their characteristics, name, and formula. Students will learn to represent chemical reactions and the conservation of mass, using molecular models and balanced symbolic equations. Students will investigate how neutralization involves tempering the effects of an acid with a base, or vice versa. Finally, students will illustrate how factors such as heat, concentration, light, and surface area can affect chemical reactions.

In high school, students will have the opportunity to further their studies in chemistry in which topics such as organic chemistry, acids and bases, bonding, electrochemistry, solutions, and stoichiometry and thermochemistry are addressed.

Curriculum Outcomes

STSE

Students will be expected to

Nature of Science and Technology

109-2 describe and explain the role of collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge

109-13 explain the importance of choosing words that are scientifically or technologically appropriate

109-14 explain the importance of using precise language in science and technology

110-1 provide examples of ideas and theories used in the past to explain natural phenomena

110-3 identify major shifts in scientific world views

Relationships Between Science and Technology

111-1 provide examples of scientific knowledge that have resulted in the development of technologies

111-4 provide examples of technologies that have enhanced, promoted, or made possible scientific research

Social and Environmental Contexts of Science and Technology

112-3 explain how society's needs can lead to developments in science and technology

112-8 provide examples to illustrate that scientific and technological activities take place in a variety of individual or group settings

Skills

Students will be expected to

Performing and Recording

209-7 demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials

Analysing and Interpreting

210-1 use or construct a classification key

210-2 compile and display data, by hand or computer, in a variety of formats, including diagrams, flow charts, tables, bar graphs, line graphs, and scatter plots

210-11 state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea

210-16 identify new questions and problems that arise from what was learned

Knowledge

Students will be expected to

307-12 investigate materials and describe them in terms of their physical properties

307-13 describe changes in the properties of materials that result from some common chemical reactions

307-14 use models in describing the structure and components of atoms and molecules

307-15 identify examples of common elements, and compare their characteristics and atomic structure

307-16 identify and write chemical symbol or molecular formula of common elements or compounds

Safety Consideration and Physical Properties

X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	This unit can begin with a What I Know-Want to Know-Learned (K-W-L) activity centred around the topic of matter. Questions such as "What is matter?," "What do you think matter is made up of?" and "How small can matter be divided?" will allow for an assessment of students' prior understanding and knowledge of matter. Students should explore earlier concepts of the nature of matter, such as those of Aristotle and the ancient Greeks, who believed matter to be composed of air, fire, and/or water. This investigation will illustrate that understanding of scientific ideas and phenomena evolve and change over time.
• compare earlier conceptions of the structure of matter with their conceptions (110-1)	
• demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials (209-7)	It is important that the teacher and students, collectively and collaboratively, develop a set of lab safety rules based on provincial safety guidelines. Rules should be discussed, agreed upon, and posted. Students may want to use a variety of media to communicate these rules. Art and creativity can be easily focussed upon here. Safety posters made by students can be displayed to illustrate these rules and remind students of their importance. Students should be introduced to the existence and use of WHMIS data sheets. Students will not be expected to understand all of the information presented in chemical data sheets but they should understand that these data sheets provide valuable information regarding the safe handling and disposal of the chemicals involved. Examples of these data sheets can be posted in the classroom or laboratory for students to read and examine.
• investigate materials and describe them in terms of their physical properties (307-12)	To gain an appreciation of how physical properties can be used to identify materials, students may be asked to describe everyday objects in terms of their physical characteristics. Students can identify objects based on descriptions provided by other students, for example. If the list of objects is long enough, students may create and use a database to assist them in this activity. Physical properties are properties that do not involve the formation or creation of a new substance. Examples of physical properties include odour, colour, melting point, boiling point, solubility, malleability, and density.
• compile and display data collected during an investigation of the physical properties of materials (210-2)	The students can be supplied with a variety of materials of the same dimensions in order to test their strength, malleability, flexibility, and density. Some examples of materials to test are copper, aluminum, iron, plastic, and wooden strips. Other physical properties that may be investigated are texture and colour. Testing and/or observations can be done on materials such as baking soda, salt, sugar, iron filings, and flour. Students should be encouraged to devise an efficient way to compile and display the data that they have collected from their investigations.

Safety Consideration and Physical Properties

X hours

Tasks for Instruction and/or Assessment

Observation

- **Self-Assessment** (210-2, 307-12)

My Physical Properties' Checklist	Yes	No
Did I understand the task? Have I developed a clear set of procedures to follow? Have I followed the procedures in my plan? Did I use the equipment safely and accurately? Have I recorded my observations in an organized way?		

Journal

- What do you think matter is composed of? How small can it be broken up? (110-1)
- Create an advertisement for a fictional substance that has just been created or discovered and highlight its physical properties. (307-12)

Paper and Pencil

- Write a story in which the characters are described with physical properties. (307-12)
- Research a particular substance to find out its physical properties. (307-12)
- Interview a member of a Waste Watch program to learn how WHMIS standards are used in the disposal of some dangerous or hazardous wastes. (209-7)

Presentation

- Prepare a poem or cartoon illustrating a safety feature or procedure in the laboratory. (209-7)
- Design and contribute to a bulletin-board display of physical properties of a variety of materials that display various aspects of the physical properties (for example, gold-malleable, diamond-not malleable). (307-12)
- Make a poster showing the relationship between a material (physical properties) and its uses. (307-12)
- Create a database file of physical properties of some common materials. (210-2)

Resources/Notes

Activities from Teacher's Resource

- Making Rocky Candy
- Safety Plates
- Physical and Chemical Changes
- Bucky Balls
- Mystery Element

Videos

- *Atomic Structure: Mapping the Invisible World* (V2206)
- *Lab Sense* (V1714, 21793)
- *Matter: Form and Substance in the Universe* (V2205)

Chemical Changes/Reactions

X hours

Outcomes

Students will be expected to

- describe changes that result from common chemical reactions:
  - energy change
  - change in colour
  - precipitate formed
  - gas formed
  - new chemical substance formed (307-13)
- determine, where possible, if the change in a material or object is physical or chemical on the basis of experimental data (210-11)
- identify new questions about physical and chemical changes that arise from investigations (210-16)

Elaborations–Strategies for Learning and Teaching

Common substances should be exposed to changes such as dissolving and burning in order to investigate to see if a new substance has been created. A variety of activities and reactions will allow for classification of chemical and physical changes. At this point, discussion should focus on evidence which indicates physical versus chemical change. Students should understand that a chemical change involves the production of new substances with new properties. While there are particular types of evidence which can be used to support the inference of a chemical change (for example, bubbles being formed, change of colour, odour, temperature change), it is important that students understand that this is not conclusive evidence, since many physical changes may also fit these categorizations. Some changes, such as those in which a precipitate is formed, indicate a chemical change. Some changes such as dissolving are more difficult to classify. Dissolving is usually classified as physical, but many chemical interactions occur. Many chemical reactions are easily reversible (equilibrium reactions), while many physical changes are not easily reversible (shredding paper, sanding down wood).

Students can try to identify physical changes which involve evidence that may suggest chemical changes. For example, when a bottle of pop is opened, gas appears. This is a physical and not a chemical change. If an ice sculpture melts, the change is not easily reversible, yet it is a physical change. In the case of pH indicators, the colour change may be easily reversible, yet it is a chemical change. Some possible leading questions to initiate classroom discussion follow: “Are there examples of changes that are not easily identified as chemical or physical?,” “What does it mean when you say a new substance is formed?,” and “Can you always tell when a substance is different from the starting material?” Students should be aware that the theoretical definitions are more clear-cut than operational definitions in this case.

Chemical Changes/Reactions

X hours

Tasks for Instruction and/or Assessment

Observation

- Use a checklist to assess safety precautions and basic lab skills during chemical-change activity. (209-7, 210-11)
- Give the students the opportunity to investigate a number of safe, common chemical and physical changes. Use a scoring rubric to assess their ability to recognize and provide proof for the various changes. (210-11, 307-12, 307-13)

Journal

- When can the appearance of gas bubbles in a liquid be problematic when trying to determine if their appearance is due to a physical or a chemical change? (307-13)

Interview

- Describe a situation in which it would be difficult to ascertain if the change is physical or chemical and explain why. (210-16, 307-13)

Paper and Pencil

- Classify the following changes as chemical or physical: making of toothpicks, making pancakes, and so on. (307-12, 307-13)
- Interview a plumber or other tradesperson to find out which chemical or physical changes occur regularly in the course of the job. Make a list of these changes. (307-13)

Presentation

- Prepare a display containing possible indicators of a chemical change. (307-13)
- Prepare a brochure or bulletin-board display containing physical and chemical changes. Include pictures from everyday life. (210-11, 307-13)

Portfolio

- Note and record typical "changes" in your home and note whether they are physical or chemical changes. Give reasons for your choices. (307-12, 307-13)

Resources/Notes

Software

- Interactive Chemistry Journey
- PASCO Science Workshop with Temperature and/or pH Probes

Videos

- *Reactions: The Chemistry of Change* (V2203)
- *Compounds: Electromagnetic Attraction in Molecules* (V2208)
- *Physical Science: Bill Nye* (21650)
- *Energy and the Chemistry of Life* (22017)

Atomic Theory
X hours

Outcomes

Students will be expected to

- identify major changes in atomic theory up to and including the Bohr model (110-3)

- use models in describing the structure and the components of atoms and molecules, and explain the importance of choosing words that are scientifically appropriate:
  - determine the number of protons and electrons in the atom of an element, given its atomic number
  - determine the number of protons, electrons, and neutrons, given the mass number and atomic number
  - be able to write the appropriate symbol for an isotope, given the number of protons and neutrons (109-13, 307-14)

Elaborations–Strategies for Learning and Teaching

Do research or view an appropriate video to learn more about the construction of atomic theory. A time line may be created and placed in class illustrating the names of people and the atomic theories associated with them. This type of activity provides an opportunity for students to see how scientific theories are constructed, modified, and at times discarded as new data and evidence are collected. Students can create models of atoms (mobiles, posters, for example), using historical atomic model conventions (for example, Dalton's "billiard ball" model, Thomson's "raisin bun" model, Bohr's "planet" model). Students can correlate the time line on the discovery of elements with the development of atomic models from Dalton to Bohr. Some students may show an interest in other women and men, such as Robert Boyle, Joseph Priestley, Marie Curie, and Ernest Rutherford, who have made contributions to our knowledge and understanding of the atom.

The development of the atomic model is an important and worthwhile lesson in one aspect of the nature of science. Models form conceptual frameworks to organize complex phenomena into understandable forms. Even though it is now possible to view individual atoms of some elements, scientists still cannot see the structure of the atom itself, so they build useful models to explain observed behaviour.

Students will learn about the major component parts of atoms, including their basic characteristics. Students should be exposed to our current cloud theory or energy-level theory of atoms. Students should explore and be able to represent the different arrangements of electrons in the energy levels around the nucleus of the atom of the first eighteen elements of the period tables.

The use of videos and other visuals about atomic structure and theory appropriate to this grade level are highly recommended as the ideas and structures being investigated are fairly abstract.

Students can use charts to arrange the atomic number, mass number, number of protons, neutrons, and electrons of various elements.

Students can be assigned an element to research (abundance, extractions, forms, for example). They may then present their findings to the class in the form of an oral presentation, a poster display, or multi-media presentation.

Atomic Theory
X hours

Tasks for Instruction and/or Assessment

Interview

- What is the essential difference between an element and a compound? (307-14)

Paper and Pencil

- Represent the element sodium in a diagram which shows the arrangement of its electrons in energy levels. (109-13, 307-14)
- How is the atomic number of an element related to the mass number of the same element? (109-13, 307-14)
- Oxygen has the atomic number 8. How many protons and electrons would an atom of this element have? (109-13, 307-14)
- The atomic number of carbon is 6. The mass number of its most common form is 12. Determine the number of protons, neutrons, and electrons in the atom. (109-13, 307-14)
- There are three isotopes of hydrogen: hydrogen, deuterium, and tritium. Research how many protons and neutrons each isotope has. (109-13, 307-14)
- Given the mass number and atomic number of an element, determine the number of neutrons it has. (307-14)

Presentation

- Using coloured clothing or pinnies, devise a way to represent elements (like colours) or compounds (unlike colours). (109-13, 307-14)
- Create a bulletin-board display highlighting the evolution of our understanding of atomic structure and theory. (110-3)
- Create a model, using a variety of media and materials, of our present understanding of atomic structure. (307-14)
- Create a visual and animated representation of our present concept of atoms, using people to represent the components of an atom. (110-3, 307-14)
- Research and play the role of Rutherford to explain his contribution to our present atomic theory. (109-13, 110-3, 307-14)
- Create art displays of atomic models that illustrate how our conception of atomic structure has changed over the years. (110-3)

Resources/Notes

Activities from Teacher's Resource

- What's in the Box?
- Theories of the Atom: Research and Presentation

Software

- Discover the Elements
- Interactive Chemistry Journey

Videos

- *Structures of the Atom Series* (V9446, V9451)
- *Introducing the Players* (V9440)
- *Energy and the Chemistry of Life* (22017)
- *Atomic Structure: Mapping an Invisible World* (V2206)
- *Eureka: Energy and Control* (V2387)

Atomic Theory *(continued)*

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	Students should be aware that our understanding of atoms and atomic structure is largely based on evidence gathered from many physical and chemical explorations and activities. The individual components of atoms are too small to be viewed, but the atomic theory is based on evidence of their activities or relationships with matter and energy.
• provide examples of technologies that have enhanced, promoted, or made possible scientific research in chemistry (111-4)	Students should be made aware of and note some technologies that have helped scientists explore and gain a better understanding of the atom and its composite parts. From the vacuum tube used by Crookes in the 19th century to atomic cyclotrons of today, technologies have helped further our understanding of the atomic world.
• provide examples to illustrate that scientific and technological activities related to atomic structure take place in a variety of individual and group settings (112-8)	It is important that students appreciate that some activities related to chemistry take place in a variety of settings. The fact is that many of the scientists who helped to develop the various atomic models, such as Crookes, Thomson, and Rutherford, worked with others in university settings. They used the discoveries of others to help them in their experiments to develop their own theories. When examples such as cooking (individual) and the development of better metallic alloys (groups of chemical engineers) are used, students can better appreciate the variety of activities in which chemistry is involved. Students can investigate how scientists, working together, have used knowledge of atomic structure to build new technologies such as atomic micro-engines and investigate the atom even further.
• explain the importance of using the terms law and theory in science (109-14)	This is an opportune time to introduce and formally discuss the difference between a law and a theory in science. Very often, students use the terms interchangeably. Sometimes students use the term "theory" to denote a hypothesis in an experiment. Students should understand that, in science, a law simply describes or summarizes what happens or is observed. The Periodic Law, for example, describes the periodic nature of elements with regard to how they behave chemically. A theory, on the other hand, is an imaginative way of explaining why something happens. The Atomic Theory, for example, is a creative way scientists have to try to explain structure and function at the atomic and sub-atomic level. Theories often change or are modified on the basis of new or conflicting evidence from experimental data or observations.

Atomic Theory *(continued)*

Tasks for Instruction and/or Assessment

Journal

- Keep a record of the individuals or groups you encounter in the study of this topic who work with chemical changes or chemistry-related activities. (112-8)
- What is the essential difference between a law and a theory in science? Give examples to illustratPM65.EXE`14)

Presentation

- Prepare a multimedia presentation illustrating theories and understandings of atomic theory over the ages (for example, from Democrites to Bohr). (110-3, 111-4, 307-14)

Resources/Notes

Software

- Discover the Elements
- Interactive Chemistry Journey

Videos

- *Organic Chemistry: The Carbon Connection* (V0436, 20969)
- *Organic Chemistry 2: Industrial Application* (V0437, 20970)
- *Chemistry in Action: Aluminum* (21268)
- *Chemistry in Action: Iron and Steel* (21269)

Periodic Law
X hours

Outcomes

Students will be expected to

- identify examples of common elements, and compare their characteristics and atomic structure (307-15)

- describe and explain the role of collecting evidence, finding relationships, and proposing explanations in the development of the periodic table (109-2)

- use a periodic table to predict properties of a family of elements:
  - period
  - family
  - metals
  - metalloids
  - nonmetals (210-1)

Elaborations–Strategies for Learning and Teaching

Students should be exposed to and observe appropriate non-toxic, non-corrosive safe elements such as C, Cu, Al, Fe, and Zn in order to compare and contrast some of the physical characteristics of these elements. Pictures, pictorial periodic tables, and videos of a variety of the common elements will provide students with the knowledge that individual elements exhibit physical properties that can be unique and yet similar in some cases to other elements.

Students should investigate how Dmitri Mendeleev found a pattern when he arranged the known elements of his day in order of increasing mass. He came to realize that there was a repeating pattern of the elements with regard to differences and similarities in their chemical characteristics. Students can develop a time line of the discovery of the elements that were found after Mendeleev and show how they fit into the proposed periodic table.

The introductory investigation of the periodic table and its uses should focus on the periodic nature of elements and the main organization of groups or elements owing to their similarities because of the periodicity of elements. Students should not memorize components of the periodic table. The focus should be on the use of the periodic table.

Students should be given the opportunity to research the physical and perhaps even some of the chemical properties of one or several common elements, using a variety of resources. The results of this research should be shared with the other students. Posters, oral presentations, and multimedia presentations can be used to communicate their findings. Students can be involved with activities involving a blank Periodic Table or early attempts to organize the elements according to their properties. Students can also develop a time line of discovery of the elements.

Students should use the Periodic table to derive information about the number of protons, neutrons, and electrons in the atoms of common elements. Activities should define the relationship between atomic number and mass number, and students should apply it for identifying isotopes. Learning activities designed to introduce and explore the Periodic Law should be developed. Students can make predictions about a certain element of a particular family of elements based on the characteristics of that family, and verify their predictions. Students can be asked to make inferences about the relationships between and among the various families of elements.

Periodic Law

X hours

Tasks for Instruction and/or Assessment

Journal

- Explain how the use of patterns helped in the development of the periodic table. (109-2)

Interview

- What would you predict about the chemical properties of potassium, given the fact that sodium is a very explosive/reactive element? (210-1)

Paper and Pencil

- Write an article on a particular element for the school paper. Note its date of discovery, symbol, and usage. (307-15)
- Given an incomplete Periodic Table, predict the atomic structure of missing elements in the first eighteen places. (210-1)
- Compare and contrast a helium atom with a sodium atom with regard to their numbers of protons, neutrons, and electrons. (307-15)
- Research the five most abundant components of air and earth, and create a circle graph to communicate their percentage distributions. (307-15)
- What physical properties would you predict the element chromium to have? (210-1)

Resources/Notes

Activities from Teacher's Resource

- Exploring the Elements

Software

- Discover the Elements
- Interactive Chemistry Journey

Video

- *Periodic Table: Reactions and Relationships* (V2207)

Periodic Law *(continued)*

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • identify the elements and number of atoms, given a chemical formula (307-16)	Students should learn what the component parts of relatively simply chemical formulas are. Students should come to understand that the molecules or compounds are represented in ratio form. For example, in one molecule of water (H_2O) there are two atoms of hydrogen and one atom of oxygen. Other examples of appropriate chemical formulas to explore would be methane (CH_4), carbon dioxide (CO_2), calcium carbonate ($CaCO_3$), propane (C_3H_8), and sodium chloride (NaCl). Students are not expected to learn how molecular and ionic compounds are formed. This will be addressed in grade 10.
• provide examples where knowledge of chemistry has resulted in the development of commercial materials (111-1)	Students should become aware of the ways in which our knowledge of chemistry has resulted in the development of the great variety of technologies that affect nearly every aspect of everyday life. Medicines, clothing and building materials, fertilizers and petrochemicals and their derivatives can be explored to see how we have been able to use our knowledge of elements and how they react with other elements and compounds to create a wide variety of chemical compounds.
• give and explain examples illustrating how limited resources have forced scientists and technologists to develop more efficient ways to extract elements and compounds from nature, or to find or develop appropriate substitutes (112-3)	Students can investigate how the research and development of more efficient and cost-effective ways to extract aluminum from various ores, for example, was precipitated by the accelerated need for lightweight metals in the transportation sector during this century. Other examples of elements and/or compounds that may be investigated are nylon and oil-based rubber.

Periodic Law *(continued)*

Tasks for Instruction and/or Assessment

Paper and Pencil

- Investigate how gold and iron ore are separated from the rocks in which they are formed and report on your findings. (112-3)
- Complete the following table. (307-16)

Components of Chemical Compounds

Name of Compound	Chemical Formula	Elements Present	Numbers of Atoms of Each Type
water	H_2O	hydrogen, oxygen	2 atoms of H, 1 atom of O
carbon dioxide	CO_2		
methane	CH_4		
hydrogen gas	H_2		
glucose	$C_6H_{12}O_6$		
vinegar	$C_2H_4O_2$		

Presentation

- Create a poster or bulletin-board of products or technologies that are developed because of our knowlege of chemistry. (111-1)
- Research how techniques for the extraction of aluminum from its ores have evolved over time. Create a multimedia presentation of your findings. (112-3)

Resources/Notes

Software

- Discover the Elements
- Interactive Chemistry Journey

Characteristics of Electricity

Introduction

Technologies based on the principles of electricity are an important part of the students' world. An understanding of the essentials of electrostatics and electric circuits will enable students to connect their learning to everyday applications. Investigations help students to learn the laws of electrostatic charges and study some features and properties of electrostatics and electrical circuits.

Students should be given ample opportunity to plan, design, and construct a variety of circuits, as well as to explore and investigate the relationships that exist among voltage, resistance, and current. Students should gather and organize their findings, and communicate them in an efficient manner.

Students must also be given the chance to investigate the technologies that permit the use of electrical energy and evaluate both the technologies and their direct and indirect impacts on the environment and society in general.

Focus and Context

The world of today's students is inundated with technology that is linked to and depends on electricity for its function. The focus of this unit is inquiry and the design process, with reference to technology and systems with which the students are familiar. The context revolves around electricity usage in and around the home.

Science Curriculum Links

Students investigated and explored everyday materials to produce static charges in grade 2. In grade 6, students are involved in a unit of study entitled "Electricity." The conductivity of a variety of solids and liquids, as well as characteristics of static and current electricity, are explored. In this unit, students also investigate simple series and parallel circuits, switches, and the relationship between electricity and magnetism when an electromagnet is used. Various methods by which electricity can be generated are addressed, as well as different factors that can lead to a decrease in electrical energy consumption in school and at home.

In high school, students have the opportunity to study electric field and Coulomb's Law. They will compare the way a motor and a generator function, using the principles of electromagnetism.

Curriculum Outcomes

STSE	Skills	Knowledge
Students will be expected to	*Students will be expected to*	*Students will be expected to*
Nature of Science and Technology **109-6** illustrate how technologies develop as a systematic trial-and-error process that is constrained by cost, the availability and properties of materials, and the laws of nature **109-14** explain the importance of using precise language in science and technology **110-9** compare examples of past and current technologies developed to meet a similar need **Relationships Between Science and Technology** **111-1** provide examples of scientific knowledge that have resulted in the development of technologies **Social and Environmental Contexts of Science and Technology** **112-7** provide examples of how science and technology affect their lives and their community **112-10** provide examples of science- and technology-based careers in their province or territory **113-6** evaluate the design of a technology and the way it functions on the basis of identified criteria such as cost and the impact on daily life and the environment **113-9** make informed decisions about applications of science and technology, taking into account environmental and social advantages and disadvantages **113-13** propose a course of action on social issues related to science and technology, taking into account human and environmental needs	**Initiating and Planning** **208-1** rephrase questions in a testable form and clearly define practical problems **Performing and Recording** **209-3** use instruments effectively and accurately for collecting data **Analysing and Interpreting** **210-5** identify the line of best fit on a scatter plot and interpolate or extrapolate on the basis of the line of best fit **210-7** identify, and suggest explanations for, discrepancies in data **210-8** apply given criteria for evaluating evidence and sources of information **210-10** identify potential sources of error and determine the amount of error in measurement **Communication and Teamwork** **211-2** communicate questions, ideas, intentions, plans, and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language, and other means	**308-14** identify properties of static electrical charges **308-13** explain the production of static electrical charges in some common materials **308-16** describe the flow of charge in an electrical circuit **308-15** compare qualitatively static electricity and electric current **308-17** describe series and parallel circuits involving varying resistance, voltage, and current **308-18** relate electrical energy to domestic power consumption costs **308-19** determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy **308-20** Describe the transfer and conversion of energy from a generating station to the home

Static Electricity
X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	Students have had opportunities in their daily life as well as formally in the primary and elementary grades to experience and investigate static electricity. Students may be asked to relate instances where they have encountered static electricity at home or at school. Students can also be asked what it is like when there are periods of no electricity at home or school in order to motivate discussion about its everyday uses and people's expectations of having it available.
• identify properties of static electrical charges: – like charges repel – unlike charges attract – induced charges (308-14)	
• explain the production of static electrical charges in some common materials (308-13)	Students have explored static charges in grade 3 and investigated static charges in grade 6 in order to define attraction, repulsion, electrons, positive charge, and negative charge. Students should be given opportunities to produce static electric charges with a variety of materials such as flannel, fur, wood, plastic, rubber, and metal. By creating static charges on suspended pith balls and/or balloons, students can further investigate the properties of static electricity with activities that involve attraction, repulsion, and the neutralizing of the static charge. This activity should eventually lead to the accepted scientific understanding and explanation of static charges. Students will be able to utilize what they have learned about the parts of atoms to create models to describe why some objects are considered to be neutral, positively charged, or negatively charged. Students should come to conceptualize and be able to explain the reasons for static electric charges through the transfer of electrons and inductions. Videos using animation to describe what is happening to the electrons are helpful.
• provide examples of how knowledge of static electricity has resulted in the development of technologies (111-1, 112-7)	Students should investigate technologies that use static electricity in a variety of ways to perform tasks. An investigation of how the school's photocopying machine functions can begin with an invitation to the sales/repair person to explain/demonstrate how static charges are used to create copies. Students can do research or interview a driver of a transport truck that carries flammable products to learn of the technologies and special tires used to reduce static build-up and thus prevent a potentially dangerous spark. Students can test the ability of various fabric softeners to reduce static cling by counting the number of puffed rice pieces a sock or other piece of clothing picks up. Electrostatic precipitators/air filters, electric eels, and lightning rods are other examples of technologies and living things that may be investigated.
• provide examples of careers related to electricity in their community and province (112-10)	Throughout the unit students should note and investigate some of the many careers that are related to electricity production and transfer. In addition, students should become aware of the many people and jobs associated with the production and maintenance of technologies using electricity.

Static Electricity

X hours

Tasks for Instruction and/or Assessment

Performance/Presentation

- Create a bulletin-board display of careers associated with electricity in your community and province. (112-9, 112-10)
- Have students demonstrate and explain the production of static charges by using a balloon, some fur and a glass rod. (308-13)
- Use the Internet to research Nikola Tesla and report on his contribution to our knowledge and understanding of static electricity. (308-13, 308-14)

Interview

- Explain how a charged balloon can cause an iron nail to have an induced charge without the transfer of electrons. (308-13, 308-14)

Paper and Pencil

- Use a sketch or drawing to help you explain why a balloon "sticks" to a wall after it is rubbed on your hair. (308-13, 308-14)
- Interview a photocopy repair person to learn how static electricity plays a part in making copies of a document. Report your findings. (112-7, 308-13, 308-14)
- Interview a person who transports fuel oil or gasoline in a transport truck to learn about the technologies that are used to reduce the chances of static charges being created during the loading and transportation of the fuels. (111-1, 308-13)
- Research lightning rods and make a diagram to illustrate their function. (111-1, 112-7, 308-13)
- Research the Van der Graef generator and report how static charges are produced and used. (308-14)

Portfolio

- Maintain a record in a scrapbook of current and past technologies that have utilized static electricity. (112-7)

Resources/Notes

Activities from Teacher's Resource

- Charge It!
- Obey the Law—Electric Charges Do!

Software

- Virtual Labs: Electricity

Videos

- *Learning About Electricity* (22262)
- *Physical Science: Bill Nye* (21650)
- *Energy Choices* (V2128)
- *Tuft's Cove Open House* (V1000)
- *Annapolis River Tidal Project* (V8775)
- *Maritimes and Northeast Pipeline* (V2366, 22864)
- *Geothermal: The Energy Within* (20852)

Static Electricity and Electric Current

X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	Students should be exposed to learning situations which illustrate the difficulty of controlling static electricity along a conductor. Students have had the experience of walking across a carpeted floor and getting a "shock" from the transfer of electrons when they touched a doorknob. Students can see that the rapid movement of the electrons can even light a fluorescent light bulb if it is touched against the doorknob.
• describe the flow of charge in an electrical circuit and describe the factors affecting the amount of resistance in a wire (length, diameter, type): – voltage – electric current – resistance (109-14, 308-16)	During this unit, students should have opportunities to explore and investigate, within the context of hands-on/minds-on activities, the notions of voltage (electromotive force), electric current (the flow of electric charge), ampere (rate of flow of electric charge), and resistance in electrical circuits and materials. Students should be involved in activities where factors influencing resistance in a wire in an electric circuit are investigated. Students can compare and contrast the current in wires of various lengths and various diameters. Students can try blowing through straws of different lengths, diameters, and types in order to experience the varying amounts of force required to blow through the different types of straws. Students can also compare the resistance of various conductors such as copper and nichrome.
• compare qualitatively static electricity and electric current (308-15)	Students should be involved in designing and constructing simple circuits using direct current (DC) created with wet cells and dry cells. Students should be able to explain, using the motion of electrons, how a current is being produced. This should be compared and contrasted with static electricity. Potential difference or voltage can be addressed in various activities in which more powerful cells and batteries are used to illustrate the results of more volts. Students should be involved in activities in which the resistance of the circuit varies by increasing or decreasing the number of light bulbs in a circuit or using conducting wires with varying resistances. Commercial multirange meters can be used when doing quantitative evaluations. Students can be challenged to design and construct a flashlight from a list of materials which meet the following criteria: • working switch • can operate with one hand • durability • has a replaceable battery or dry cell Students can evaluate their designs and flashlights according to a number of predetermined criteria.

Static Electricity and Electric Current

X hours

Tasks for Instruction and/or Assessment

Performance

- Design a fair test to determine the resistance of a variety of wires in a circuit. (308-16)

Interview

- What are the essential differences between static and current electricity. (308-15)

Paper and Pencil

- Create simple circuit diagrams in which the flow of a direct current is indicated. (308-16)
- Compare and contrast electric current and resistance. (109-14)
- Personify an electric current in a short story in order to tell what happens to the current in its journey in a direct system (dry cell-wire-light bulb-wire-dry cell). (308-15, 308-16)
- Research how an electric fence functions and report on its operation, using the terms voltage, electric current, ampere, and resistance. (208-7, 308-16)

Presentation

- Using straws of various diameters, demonstrate the relationship between voltage and resistance. (308-16)

Resources/Notes

Software

- Virtual Labs: Electricity

Videos

- *Creating and Controlling Static Electricity* (22912)
- *Static and Current Electricity* (21567)
- *Beyond the Mechanical Universe: Electric Circuits* (22668)
- *Beyond the Mechanical Universe: Static Electricity* (22671)

Series and Parallel Circuits

X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • rephrase questions in a testable form related to series and parallel circuits (208-1)	Students should be encouraged to identify questions and areas of exploration related to series and parallel circuits. Students should be able to transform their questions into a testable form. Students should have opportunities to construct a variety of series and parallel circuits and to test the amount of voltage, current, and resistance in each one, using appropriate ammeters, voltmeters, and/or multirange meters. Students should be encouraged to collect data regarding the voltage and current and present their findings in the form of a table or graph. Students should be asked to make predictions before making actual readings, and they should attempt to give possible reasons for these differences. Activities should be designed in order that students are able to derive the relationships in Ohms' Law.
• use an ammeter and a voltmeter to measure current and voltage in series and parallel circuits (209-3)	Students should manipulate and change variables such as the amount of voltage and resistance in a circuit. Students can vary the number of dry cells used, the type of wire, and the number and placement of light bulbs in simple series and parallel circuits.
• identify potential sources of error in ammeter and voltmeter readings (210-10) • identify and suggest explanations for discrepancies in data collected using an ammeter and a voltmeter (210-7)	Students should become familiar with the ammeter as an instrument used to quantitatively measure current. An ammeter and a bulb can be connected in a series, and students can observe that, whenever the bulb is brighter, the ammeter reads a bigger current. A voltmeter can be added to the circuits so that students can measure the voltage of different batteries. Students will probably note that the data they collect from readings of ammeters and voltmeters vary owing to a number of factors. Students should try to identify reasons for these different readings and suggest reasons for their data differences. Students can "feel" the resistance of a circuit if a hand-held generator is available. By adding resistance (lamps), students will appreciate the extra energy it takes to maintain brightness.
• present graphically the data from investigation of voltage, current, and resistance in series and parallel circuits (210-5, 211-2)	Students can construct, or design on paper, various series and parallel circuits and challenge other groups of students to predict and determine the voltage, current, and resistance in the circuit, as well as the type of circuit constructed or designed. Lines of best fit can be determined in scatter plots that communicate the relationship between voltage and the number of resistance branches in parallel circuits, for example. Students can investigate Christmas tree lights that are in series, as well as those that are in parallel. Note and discuss the positive and negative aspects of each.

Series and Parallel Circuits

X hours

Tasks for Instruction and/or Assessment

Performance

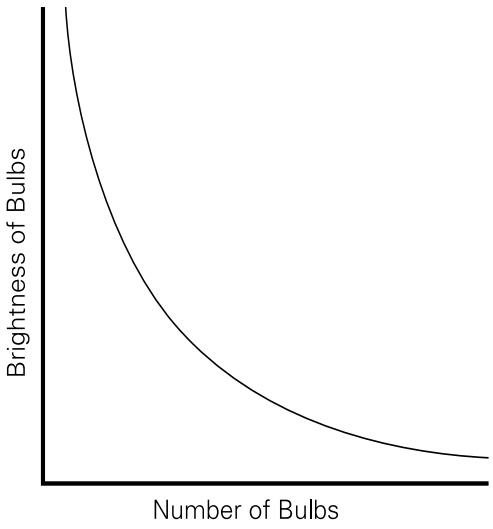
- Demonstrate the ability to accurately read an ammeter/voltmeter, using a constructed circuit. Ask why they may not be exact readings. (209-3, 210-10)

Journal

- List three potential sources of error when taking a voltage or amperage reading. (210-10)
- Something that I didn't realize before I explored different types of circuits was ... A question that I would like to investigate about series and parallel circuits is ... (208-1, 209-3)

Paper and Pencil

- In a lab report, graph the relationships between current and resistance of a number of circuits. (210-5, 211-2)
- Create a scatterplot graph of the data collected in class from voltage versus current activities. (210-5, 211-12)
- Use a sketch of your circuit to illustrate how one might get discrepant readings from a voltmeter. (210-7)
- Would the following graph illustrate what would happen in a series or parallel circuit? Explain your reasoning. (210-5, 211-2)



Resources/Notes

Software

- Virtual Labs: Electricity

Series and Parallel Circuits *(continued)*

Outcomes

Students will be expected to

- describe series and parallel (maximum two resistors) circuits involving varying resistance, voltage, and current, using Ohms' Law:
  - draw circuit diagrams, using circuit symbols for a cell, switch, battery, lamp, resistor, multirange meter (308-17)

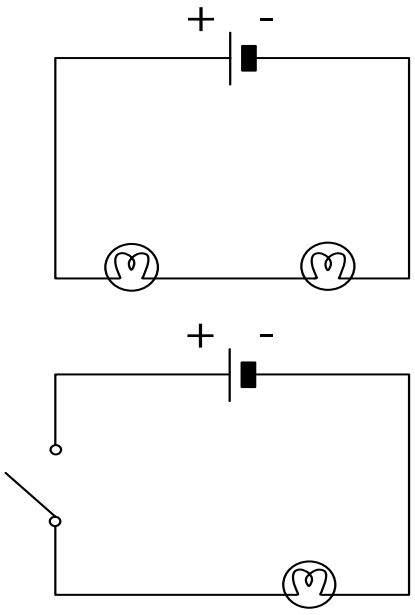
Elaborations–Strategies for Learning and Teaching

Activities should demonstrate Ohms' Law quantitatively. After constructing a circuit that includes a battery, a resistor (for example, lamp), and an ammeter, students can investigate what happens to the current as other resistors (lamps) are added to the series circuit. Students can add batteries to the circuit to explore voltage and current readings in the circuit. Through a number of guided activities and explorations involving study of the relationships between current, voltage, and resistance, students should discover that the amount of current in a circuit is directly proportional to the voltage (number of dry cells) and is inversely proportional to the resistance of the circuit. This will lead to an understanding and appreciation of Ohm's law, which states that

$$\text{current} = \frac{\text{voltage}}{\text{resistance}} \quad \text{or} \quad \text{amperes} = \frac{\text{volts}}{\text{ohms}}.$$

Measurements should include only those involving a single resistance. Investigation should only involve one resistance at a time. Students should not solve problems for an unknown resistance nor for multiple resistances.

Series Circuit



Series and Parallel Circuits *(continued)*

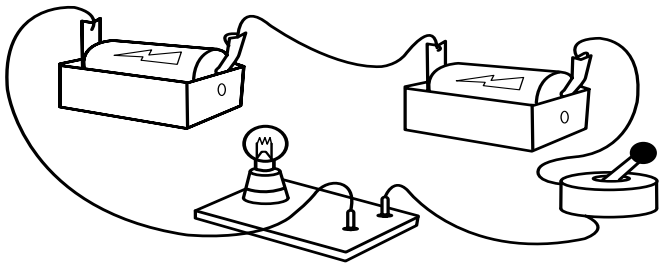
Tasks for Instruction and/or Assessment

Performance

- Construct both parallel and series circuits, using provided materials, and explain the differences between them. (308-17)

Paper and Pencil

- Determine the resistance of a circuit, given the voltage and current in a dry cell and lightbulb circuit. (308-17)
- What is the resistance of an electrical appliance that draws 22 amperes when connected to a 220-volt circuit? (308-17)
- Illustrate in a series of drawings or sketches the relationships between amperage and resistance within a circuit when the voltage remains constant. (308-17)
- Investigate why the lights dim in homes with older wiring. (308-17)
- Draw a circuit diagram for the following: (308-17)



Resources/Notes

Activity from Teacher's Resource

- Wired

Videos

- *Beyond the Mechanical Universe: Electric Circuits* (22668)
- *Creating and Controlling Static Electricity* (22912)

Use of Electrical Energy
X hours

Outcomes

Students will be expected to

- relate electrical energy to domestic power consumption costs:
  - watt as a unit of power (1 W = 1 J/s) (308-18)
- explain that precise language is required to properly interpret Energuide labels and to understand a utility bill (109-14)
- compare examples of past and current technologies that used current electricity to meet similar needs (110-9)
- determine quantitatively the efficiency of an electrical appliance that converts electrical energy to heat energy (308-19)

Elaborations–Strategies for Learning and Teaching

The study of the uses of electrical energy provides an appropriate context in which to explore and investigate the relationships among energy, work (joule = 1 newton x 1 metre), and power (1 watt = 1 J/s). Students ought to be given the chance to explore and experience a joule of work. Explorations and discussions about the amounts of energy, work, and power required to operate electric technologies will help the students gain an understanding and appreciation of these concepts.

Students can be challenged to determine kWh, given an example of a large figure involving watts. Students should come to understand the reason for using kWh as a convenient way of expressing energy usage. Students should research and determine the energy consumption ratings of a variety of home appliances. In many cases, the energy consumption ratings are indicated on the "Energuide/kWh" labels. Students can compare and contrast various electrical appliances that convert electrical energy to heat energy. Students can compare and contrast old and new models of irons and toasters, for example, and suggest reasons for differences in efficiencies.

Students should come to understand that not all the electrical energy that is used to make a stove element hot is transferred directly to the water in a cooking pot. Some of the electrical energy is converted to heat energy, some is converted to other forms such as light energy, and some is lost to the surroundings. Students should be able to determine the efficiency of an electrical appliance, given the energy used and the energy of the system. For example, if an electric kettle uses 150,000 J or 150 kJ to bring the water to a boil, but the water itself has only a 140,000 J or 140 kJ of energy difference, students should be able to determine that the kettle is 93% efficient. Students should come to realize that energy exists in a variety of forms and can be converted to a variety of forms.

Some time should be allotted to the study and discussion of the design and efficiency of a number of common electrical appliances and how much it costs to operate them. Students can compare monthly electric utility bills and suggest reasons for differences in kWh used (season, types of appliances used, time appliances are used, for example). Students should associate the use and efficiency of electrical appliances with their impact on our environment and our way of life.

Students can carry out investigations involving fuses and breaker switches during their study of resistance in circuits.

Use of Electrical Energy

X hours

Tasks for Instruction and/or Assessment

Interview

- Ask, "What is the efficiency of an electric stove if it requires 30,000 kJ and only 25,000 kJ is used to heat a pot of water? What do you think happened to the rest of the energy?" (308-19)

Paper and Pencil

- Suggest alternative sources of electrical energy that might be less costly for your region. (308-18)
- Write a letter to your local electric utility company to inquire how your energy consumption rates are determined. (308-18)

Presentation

- Create a poster based on an Enersave label on one of the appliances in your home. Explain the terms found on the label. (109-14)
- Create a mural or poster that shows the development of electrical technologies, such as the washing machine or radio, from their discovery to present day. (110-9)

Resources/Notes

Activities from Teacher's Resource

- Energy at What Cost?
- You've Got the Power

Videos

- *The Science of Energy* (V2051)
- *Energy Choices* (V2128)
- *Waterpower: Portrait of a Small Hydro* (V9504)

Electricity and the Environment

X hours

Outcomes

Students will be expected to

- describe the transfer and conversion of energy from a generating station to the home (308-20)
- evaluate evidence and sources of information when conducting research on electrical energy production and its impact on the environment (210-8)
- select recent data while conducting research on the environmental problems associated with various types of electrical energy production (113-6, 210-8)
- propose a course of action that reduces the consumption of electrical energy (113-9, 113-13)
- give examples of the development of alternative sources of energy (such as wind generators and solar energy) that are a result of cost and the availability and properties of materials (109-6)

Elaborations–Strategies for Learning and Teaching

The electrical energy that is used by homes and industry originates in electric generators in which a revolving magnet generates the electrical energy. Students investigated the link between magnets and electricity in grade 6. Students have the chance to investigate this relationship further in senior high. At this level, students need only be aware that this relationship exists (generator-electricity, electricity-motor). Students are expected to be able to trace the path of energy conversion and transfer from source to use. For example: wind energy-windmill generator-utility lines-porch light.

Students should investigate how electrical energy is produced and transported to their community. If there are a number of ways electricity is generated, they can be compared and contrasted.

Students should examine and discuss the positions of groups who support, and groups that are against, certain technologies that produce electrical energy. The damming of rivers in Labrador and coal-fired generators in New Brunswick can be used, for example, to evaluate evidence from a variety of sources.

Students should identify and propose a course of action that reduces electrical energy consumption either at home or in society in general. Students should be able to substantiate their course of action with evidence gathered or constructed throughout the course of study of this unit. Note whether students modify their behaviour with regard to energy usage and consumption as this behaviour is related to the attitudinal outcome of stewardship.

Examples of alternative sources of energy, such as windmills, solar panels, and wood chips, can be highlighted and discussed when investigating and exploring sources of electrical energy. These sources can be compared and contrasted in terms of cost, efficiency, and impact on the environment. Students should come to realize that the availability of energy resources in a region usually dictates the types of energy used in that region.

Electricity and the Environment

X hours

Tasks for Instruction and/or Assessment

Observation

- Conduct a debate on the use of nuclear energy to generate electric energy. (111-6, 210-8)

Journal

- How would you contribute to a cleaner or healthier world by reducing your energy consumption? (113-9, 113-13)

Paper and Pencil

- Make note of all of the uses of electricity throughout the day and note where savings can be made. (113-13)
- Write to an electric utility to ask where their energy is generated and how it is transferred to a customer location. (308-20)
- Note ways in which your school can possibly reduce its use of electrical energy and make your proposal to the school administration. (113-13)
- Research alternative sources of energy production in your community or province and present a report on your findings. (109-6)
- Compare technologies (for example, appliances) that use electricity in industralized countries with those that do not use electricity, for example, in non-industrialized countries. (113-9, 113-13)
- Compare and contrast a fan and an air-conditioner with regard to how much electric energy each requires, their costs, and their impact on the environment in terms of cooling or the energy needs to run the device. (113-6, 210-8)

Presentation

- Create a bulletin-board display of various technologies that require electrical energy and place them into categories on the basis of their cost and their impact on the environment. (113-6)
- Use a diagram or drawing, or picture poster to illustrate how the energy that your TV uses is generated and transferred to your location. (308-20)

Resources/Notes

Activities from Teacher's Resource

- Windmill Olympics

Videos

- *Energy in Canada* (22394, V0600)
- *Annapolis River Tidal Power Project* (V8775)
- *Solar House* (21507)
- *Making Waves and Pipedreams* (22229)
- *Energy Efficient Dog House* (21469)
- *Backyard Alternative Energy* (21562)
- *Energy Choices* (V2128)
- *Energy in Canada's Remote Communities* (V0598)
- *Greenhouse* (V0899, 2120?)
- *Geothermal: The Energy Within* (20852)
- *Harvest the Wind* (V0318)
- *Passive Solar Home Design* (V2008)
- *Race for the Future* (21578)
- *Solar Energy* (V2356)

Space Exploration

Introduction

Innovations and advancements in computers and other technologies related to astronomy in the past 20 years have enabled astronomers to collect new evidence about the nature of the universe. The study of space exploration is an opportunity for students to develop an understanding of the origin, evolution, and components of the solar system and the universe. As students become more aware of the solar system and the universe and understand them better, they develop a greater appreciation of them and how they function.

Students will continue their study of our solar system by exploring the various theories that exist to explain its formation. As well, students will learn about other parts of the universe such as galaxies, red giants, black holes, and quasars.

Focus and Context

The focus of this unit is inquiry. In addition to learning more about space and what is in it, students should learn how we have come to know and understand the solar system and the rest of the universe.

Science Curriculum Links

In the unit "Daily and Seasonal Changes" in primary science, students are introduced to the concept of daily and seasonal cycles. In grade 6, students describe the physical characteristics of components of the solar system—specifically, the sun, planets, moons, comets, asteroids, and meteors. They also investigate how the relative positions of the earth, the moon, and the sun are responsible for the moon phases, eclipses, and tides. Major constellations are investigated and identified.

In high school, students have the option of continuing their study of astronomy. They will continue to compare and contrast a variety of theories about the origin of the universe. Also, they will describe the life cycle of stars and compare the composition of stars at different stages of their life cycles.

Curriculum Outcomes

STSE	Skills	Knowledge
Students will be expected to	*Students will be expected to*	*Students will be expected to*
Nature of Science and Technology **109-3** describe and explain the role of experimentation, collecting evidence, finding relationships, proposing explanations, and imagination in the development of scientific knowledge **109-11** relate personal activities and various scientific and technological endeavours to specific science disciplines and interdisciplinary study areas **110-6** explain the need for new evidence in order to continually test existing theories **Relationships Between Science and Technology** **111-5** describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems **Social and Environmental Contexts of Science and Technology** **112-6** provide examples of how Canadian research projects in science and technology are supported **112-11** describe examples of science- and technology-based careers in Canada, and relate these careers to their studies in science	**Initiating and Planning** **208-4** propose alternative solutions to a given practical problem, select one, and develop a plan **Performing and Recording** **209-4** organize data, using a format that is appropriate to the task or experiment **210-9** calculate theoretical values of a variable **Analysing and Interpreting** **210-16** identify new questions and problems that arise from what was learned **Communication and Teamwork** **211-1** receive, understand, and act on the ideas of others **211-3** work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise **211-5** defend a given position on an issue or problem, on the basis of their findings	**312-4** describe and explain the apparent motion of celestial bodies **312-1** describe theories on the formation of the solar system **312-5** describe the composition and characteristics of the components of the solar system **312-6** describe the effects of solar phenomena on Earth **312-3** describe theories on the origin and evolution of the universe **312-2** describe and classify the major components of the universe

The Beginnings of the Solar System

X hours

Outcomes

Students will be expected to

- describe and explain the apparent motion of celestial bodies:
  - moon
  - sun
  - planets
  - comets
  - asteroids (312-4)

- describe theories on the formation of the solar system (312-1)

Elaborations–Strategies for Learning and Teaching

This unit can begin with an investigation into the planets that are visible at the time of year that this unit is being addressed. As well, students can be asked to identify any constellations that are obvious at this time of year. A "What I Know-Want to Know-Learned" (K-W-L) activity centred around this unit will indicate students' awareness of concepts in astronomy, as well as provide a time for them to reflect on their understanding of what they have learned formally in grade 6 about the solar system and stars.

Students should investigate the moon, sun, and planets in order to describe their apparent motion. Students should be involved in activities that demonstrate rotation and revolution of planets and moons. Students should also be involved with activities that illustrate the paths or orbits of the planets and our moon. Students can use plastic cups to trace and compare circular and elliptical orbits. The orbits of comets and asteroids should be explored.

Students should understand that our understanding of Earth's revolutionary motion around the sun is relatively recent (Copernicus, 1543). Through readings and videos, students can be exposed to the societal and scientific issues involved in the evolution of our understanding of the solar system. Particular attention should be paid to the contributions of Kepler and Galileo.

Students should investigate the major scientific theories that try to explain the formation and origin of the solar system. One must be sensitive to the fact that scientific and religious theories were, for most of recorded history, one and the same. Students should recognize the fact that evidence and data gathered from direct and indirect observation have led to the present theories that exist about the origin and formation of Earth and the rest of the solar system.

Students should understand that theories about the origin and formation of the solar system and the universe themselves change and evolve on the basis of evidence and ideas that bring new light to our understandings of these events.

It is generally accepted that our solar system is one-half to one-third as old as the universe. Most scientists believe that the parts of the present solar system were formed from a cosmic cloud about six billion years ago.

The Beginnings of the Solar System

X hours

Tasks for Instruction and/or Assessment

Journal

- On the basis of how we come to develop theories regarding the formation of the solar system, suggest improvements in technologies or new technologies which may refine our understanding of this topic. (312-1)
- What questions or problems might we have regarding the orbits of planets, comets, and asteroids? (312-4)

Interview

- Why might it be misleading to say that Pluto is the last planet in our solar system? (312-4)

Paper and Pencil

- Investigate Ptolemy's theory of the motion of the planets and compare it to our present understanding. (312-4)
- Research and report upon the events that led to changes in the scientific theory that the earth was the centre of the universe. (312-1)

Presentation

- Research and report upon the accepted view and understanding of a planetary movement during the time of Galileo. (312-4)
- Create a skit that demonstrates/illustrates the "apparent" movement of the sun as compared to the earth. (312-4)
- Make a drawing that compares and contrasts the orbits of a planet and a comet. (312-4)

Resources/Notes

Activities from Teacher's Resource

- Present the Case

Software

- Starry Night Backyard
- EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
- Interactive Encyclopedia of Space and the Universe

Videos

- *Galileo: The Challenge of Reason* (V8921, 22851)
- *The Sun* (V1735)
- *Close-up on the Planets/Comets: Time Capsules of the Solar System* (21240)
- *Stars and Planets* (V0835, 20957)
- *A Galactic Encyclopedia of History and Astronomy* (?)

Composition and Characteristics of the Solar System
X hours

Outcomes

Students will be expected to

- describe the composition and characteristics of the following components of the solar system:
  - terrestrial and gas planets and Pluto
  - periodicity of comets
  - asteroids/meteors (312-5)

- explain the need for new evidence in order to continually test existing theories about the composition and origin of our solar system and galaxies (110-6, 210-3)

Elaborations–Strategies for Learning and Teaching

At this level, students should investigate and learn about the two main classes of planets in our solar system: terrestrial planets and the gaseous giant planets. Students should be able to compare and contrast the inner terrestrial planets (Mercury, Venus, Earth, and Mars) with the outer gaseous planets (Jupiter, Saturn, Uranus, and Neptune). In addition, Pluto should be investigated in order to determine its similarities and differences when compared with the other planets.

Students have been introduced to comets in grade 6. In grade 9, students should come to realize that comets have unique orbits around the sun and tend to follow a pattern with regard to their passage by Earth and the sun. Students may investigate a well-known comet such as Halley's Comet in order to learn about its periodic nature and why it is easier to view during some pass-bys than during others. Asteroids and meteors should be explored in order to learn about their similarities and differences.

Students should come to understand that the main location for asteroids is between Mars and Jupiter and that most other asteroids have orbits similar to those of the planets. Students should come to understand that some asteroids have irregular orbits owing to collisions and gravitational attraction of the planets. Evidence on our planet, as well as on other planets, of meteor/asteroid impacts should be addressed.

Previously, students studied the physical characteristics of the various components (that is, comets, asteroids, meteors) of our solar system. Students should explore the nature of comets, asteroids and meteors at this level. Exploration of the periodicity of comets will provide an opportunity to learn how predictions are made regarding these part-time members of our solar system.

Students should explore the ways by which scientists gather information about our solar system. Earth-based telescopes, the Hubble telescope, and planetary space missions should be highlighted in this exploration.

Students can view pictures and/or videos of various components of the solar system taken from earth and from satellites and spacecraft in order to compare and contrast the quality of the two. In this way, students will learn how our understanding of the solar system has changed and improved with improved technologies. The "face" on Mars may be used as an example to illustrate how newer and more effective data-collecting technologies help reshape our thinking about certain theories.

Composition and Characteristics of the Solar System
X hours

Tasks for Instruction and/or Assessment

Interview

- Why would images appear clearer from the Hubble telescope than from an earth-based telescope? (110-6, 210-3)

Paper and Pencil

- Given the recorded periodicity of a given comet, make a prediction concerning its next appearance close to Earth. (312-5)
- Research, in order to compare and contrast, the differences and similarities of Earth-based telescopes and the Hubble telescope. Prepare a written report or a pictorial report. (110-6, 210-3)
- Write a travel brochure that will advertise and promote a planet in our solar system. (312-5)
- Give one of the most distinguishing features for each planet and challenge your teacher/classmate to give the planet's name. (312-5)
- Determine how many times bigger or smaller each planet is than Earth. (312-5)
- Make-believe that you are planning a colony on another planet in our solar system. Pick the planet you would choose and tell why you choose that planet for the colony. (312-5)

Presentation

- Given a table containing the atmospheric composition of Earth's nearest planetary neighbours, create an appropriate graph to communicate the information. (312-5)
- Make posters that compare Earth's orbit with those of several other planets. (312-5)
- Create a table that illustrates the common features of the inner terrestrial planets and the outer gaseous planets. (312-5)

Resources/Notes

Activities from Teacher's Resource

- Exercise Using Starry Night Backyard
- Clothes Make the Astro-Settler
- Make an Impression

Software

- Starry Night Backyard
- EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
- Interactive Encyclopedia of Space and the Universe

Videos

- *Tales from Other Worlds: Solar Family* (V0888, 20863)
- *Planets: New Discoveries* (22258)

Composition and Characteristics of the Solar System *(continued)*

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to • provide examples of how the Canadian Government and/or Canadian Space Agency is involved in research projects about space (112-6) • defend their position regarding societal support for space exploration (211-5)	Students can research our country's involvement in and its contributions to space exploration and the understanding of our solar system. Students should research, discuss, and debate the "need" to explore the solar system and the financial costs associated with space exploration. Canada's role, primarily through the Canadian Space Agency or NASA, can be investigated. Students should also recognize factors, other than purely scientific, that have motivated the exploration of our solar system. Students should be asked to express and defend their position on the continued support for space exploration from the point of view of Canadians and world citizens. Note whether students recognize the potential conflicts of different points of view on the time, energy and resources allotted to space exploration.
• describe the effects of solar phenomena on Earth: – sunspots – solar flares – solar radiation (312-6)	In grade 6, students have observed and studied the relative positions of Earth, the moon, and the sun in order to explain how these are responsible for moon phases, eclipses, and tides. Students should become aware of the fact that the sun influences almost all natural phenomena on Earth. From being the source of energy for green plants to impacting upon communication systems, the sun's influence is ever present. Students already have had the chance to associate the sun's effect on weather on Earth, and will do this in greater detail in grade 10. Students may request information from the Canadian Cancer Society to inquire how and why exposure to sunlight can be dangerous. Students should also research and identify various methods and technologies used to protect our bodies and eyes from harmful UV rays. Recent studies on the impact that UV rays have on plankton and fish fry in the ocean can be investigated. The discovery of sunspots and their properties can be approached in this study of the sun, to illustrate how one discovery can lead to other discoveries. For example, the fact that the sunspots move indicate that the sun actually rotates. Students can investigate, co-operatively and collaboratively, the periodicity of sunspot activity on the sun and how some types of solar activity have influences on electromagnetic waves (radio, TV, for example) created on Earth. The "northern lights" or aurora borealis and the "southern lights" or aurora australis may be investigated to demonstrate another observable influence the sun has on earth.
• in small groups, design and describe a model space station on the basis of what they have learned about the sun's influences on Earth (208-4, 211-1)	Students should work in small groups to design a "space station" that will safeguard the occupants from the effects of solar phenomena. Students will also need to consider resources that they will require, as well as how these resources can be reused and/or recycled in such an environment. Students will then present or report, using visual aids, what their plan encompasses.

Composition and Characteristics of the Solar System *(continued)*

Tasks for Instruction and/or Assessment

Performance

- Work collaboratively to research and design a model space station. (208-4, 211-1)

Interview

- Contact the Canadian Space Agency to find out its mandate and current activities (http://apwww.stmarys.ca/space). (112-6)

Paper and Pencil

- Research and report on various sunscreens and sunblocks and why people use them. (312-6)

Presentation

- Make a poster/large drawing showing what happens to the Earth's magnetic field when it is affected by solar flares. (312-6)
- Make a model or drawing of the sun in which solar flares and sunspots are illustrated. (312-6)

Portfolio

- Write a summary of the most important/interesting thing you learned about our universe in this unit. (various)
- Predict what might happen to the Earth and life on Earth if the sun were one light-year away. (312-6)

Resources/Notes

Software

- Starry Night Backyard
- EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
- Interactive Encyclopedia of Space and the Universe

Videos

- *The Lake That Fell to Earth* (V1704, 22424)
- *Roberta Bondar* (21694)
- *Personally Speaking* (21302)
- *Solar Sea: The Sun* (V0892, 20867)
- *Oceans and Space* (22646)
- *Solar Sun: Interactions Between the Earth and Sun* (V0893, 20868)

Composition and Characteristics of the Universe

X hours

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	
• describe theories on the origin and evolution of the universe: – big bang theory – oscillating theory (312-3)	The generally accepted theory that stars form from large clouds of dust and gas called nebulae should be examined. An investigation of the type of light emitted by a star may lead to a discussion of spectra signature. This can naturally lead into the various types of stars known to exist in the universe. Students should become familiar with the current theories about the origin and evolution of the universe. The big bang theory suggests that, because of the evidence we have for an expanding universe, the universe must have been more compact at an earlier time. Scientists estimate that the present matter in the universe was compressed together into a hot, dense mass 15 to 20 billion years ago. This matter began to move outward after a massive explosion.
• describe and classify the major components of the universe: – nebulae – galaxies – giant stars – dwarf stars – quasars – black holes (312-2)	The oscillating theory suggests that the universe will expand to a certain point in time and then, because of the forces of gravitation among the stars and galaxies, contract. Some scientists believe that this will result in another big bang. Students should be exposed to the types of galaxies known to exist in the universe. The main types are the elliptical galaxies, spiral galaxies, and irregular galaxies. Students should be challenged to calculate the travel time to a well-known star or galaxy at a given speed. The concept of the light-year could be addressed here. Students can view videos of components of the universe such as galaxies, nebulae, and black holes. Students should come to realize that nebulae are the supposed birthplaces of stars and that most stars are found in groups called galaxies. Students should become aware of the fact that stars, including of course our sun, have a specific lifetime and go through various stages (types of stars) before expending their energy or collapsing upon themselves and becoming black holes.
• calculate the travel time to a distant star at a given speed: – define and explain a light year (210-9)	Students should develop an introductory understanding of the unit light-year. A light-year is the distance light travels in space in one year. Light travels at 300 000 km/s or about 9.5 trillion km/year. Students may find it interesting to explore and determine how long it would take us to reach some of our nearest star neighbours at the speeds travelled by present space shuttles or probes.

Composition and Characteristics of the Universe
X hours

Tasks for Instruction and/or Assessment

Journal

- Given a flashlight and a powerful spotlight, explain how you can make both appear to be the same brightness. (312-2)

Pencil and Paper

- Write a narrative for a fictional radio/tv program in which theories of the formation and evolution of the universe are discussed. (312-3)
- Develop a concept map for the following terms: sun, nebula, galaxy, giant star, dwarf star, quasar, black hole. (312-2)
- Write a science-fiction story in which the following terms are used and explained: nebula, galaxy, giant star, dwarf star, quasar, black hole. (312-2)
- A given star is 6 light-years from Earth. Given that a particular space craft can travel at 14 km/s, determine how long it will take to reach the star. (210-9)

Presentation

- Create a bulletin board of technologies used to explore and investigate the universe and associate the science with each technology. For example, telescope (optics), radio telescope (physics). (109-3, 111-5, 112-11)

Resources/Notes

Activities from Teacher's Resource

- Create a Song
- Just the Facts

Software

- Starry Night Backyard
- EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
- Interactive Encyclopedia of Space and the Universe

Videos

- *Galactic Encyclopedia: In The Beginning* (?)
- *Stephen Hawking's Universe: The Big Bang* (22613)
- *Tales from Other Worlds: Origins* (V0889)
- *Creation of the Universe* (V2105)
- *Starlife* (V9543)
- *Stephen Hawking's Universe: Black Holes and Beyond* (22616)
- *Bill Nye: Earth Science* (21649)

Composition and Characteristics of the Universe *(continued)*

Outcomes	Elaborations–Strategies for Learning and Teaching
Students will be expected to	Theories that try to explain the origin of the universe and what will happen to it are derived from direct and indirect evidence. This section provides a very good opportunity for students to learn how theories about the origin and evolution of the universe are developed through analysis of data obtained from light telescopes, spectrometers, and radio telescopes. Students should have the opportunity to investigate how these and other technologies have allowed scientists to collect data to share and compare, in order to prove or disprove theories about the origin and evolution of the universe.
• explain how data provided by technologies contribute to our knowledge of the universe (109-3)	
• working collaboratively with group members, prepare a comparative data table on various stars, and design a model to represent some of these stars relative to our solar system (209-4, 211-1, 211-3)	Students can begin their study of the components of the universe by researching the constituent parts of galaxies: the various types of stars. Print, non-print, and electronic media may be used to research the location of the stars, their distance from Earth, their magnitude, size, and/or other similar information. Students should organize their information into a data table and use that information to create a model to demonstrate, for example, relative sizes of the stars. Posters or classroom models can be created to illustrate the diameters of various types of stars.
• describe examples of science- and technology-based careers in Canada that are associated with space exploration (112-11)	This section also provides an excellent opportunity to demonstrate and illustrate the wide variety of professions that work together when studying various aspects of the universe. Astrophysicists, computer programmers, electrical engineers, lens makers, and many others may be highlighted during the study of the unit. Students should be able to describe several technologies used to explore the universe and the sciences associated with them.
• identify new questions and problems that arise from the study of space exploration (210-16)	Students should be encouraged to identify questions and problems associated with theories and/or topics related to the universe such as "What are the limits of space travel?," "How old is the universe?," and "Are there other planetary systems similar to ours in the Universe?"
• describe the science underlying three technologies designed to explore space (109-11, 111-5)	Students should be able to associate a variety of sciences with technologies designed to explore space. The Hubble telescope (optics and electromagnetic waves—physics), preserved food and propulsion (chemistry), and radio telescopes (physics) provide opportunities for investigation of sciences related to various technologies used to explore space. Students should investigate the basic science of several technologies. Jet propulsion (chemical reaction and forces), reflecting and refracting telescopes (properties of light), and radio telescopes (electromagnetic radiation) are some of the technologies that may be explored.

Composition and Characteristics of the Universe *(continued)*

Tasks for Instruction and/or Assessment

Journal

- A small child says that a bright star must be closer to earth than a less bright star. What can you do to illustrate that this is not always the case? (209-4, 211-1, 211-3, 210-9)
- Why may it be possible to leave for another star without realizing that it no longer exists? (210-9)

Interview

- Why would light from a supernova be "old news"? (210-9)

Paper and Pencil

- Given the travel speed of the space shuttle, calculate the time it would take to get to a particular star. (210-9)
- If an object explodes five light-years away, when did the explosion actually occur? (210-9)
- Using the two drawings below, identify and describe several technologies and the sciences associated with them. (109-11, 111-5)

Presentation

- Research and explain how we have come to understand the planetary motion/orbits and solar system with respect to our galaxy and other galaxies. (209-4, 211-1, 211-3)
- Prepare a model/poster of the various types of stars investigated in this unit. (312-2)

Resources/Notes

Activities from Teacher's Resource

- It was a Dark and Stormy Night

Software

- Starry Night Backyard
- EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
- Interactive Encyclopedia of Space and the Universe

Videos

- *One Giant Leap* (22124)
- *NASA: Mission to Planet Earth* (21066)
- *Planets: New Discoveries* (22258)
- *Space for Four* (V2129)
- *Cosmic Zoom* (22506)
- *Awesome Space* (22217)
- *Putting Man in Space* (21228)
- *Space Shuttle* (22148)
- *Space Trek* (22602)

Appendices

Appendix A: Equipment Lists

The apparatus listed will supply one laboratory for 32 students. It is recommended that student lab groups be no larger than four. It goes without saying that the established high school will already have much of the equipment listed.

This list is, of course, a minimal inventory. We hope that schools will have on hand or be able to budget for a few pieces of apparatus for demonstration and motivational purposes.

Supply List - Reproduction Unit	**Quantity**
animal cell model	1
animal cell poster	5
blank slides, flat	100
blank slides, single depression	50
cover slips	250
DNA model	1
eye droppers	25
intel microscope	1
microscope, monocular - 3 objective	15
micro viewers	15
micro viewer slides of plant	1 set
micro viewer slides of mitosis and meiosis	1 set
plant cell model	1 set
plant cell poster	1
prepared slides of plant and animal cells	5 sets
prepared slides of mitosis and meiosis	5 sets
Other - Reproduction Unit	
blank playing cards for mitosis game sets	15
blank playing cards for meiosis game sets	15
2″ x 4″ labels to make card games	1 pkg

Supply List - Electricity Unit	Quantity
alligator clips, 10/pkg	10
ammeter	1
battery, 1.5 volt dry cell AA	20
battery, 1.5 volt dry cell D	20
bulb holder, screw base	50
copper wire, bare solid 22 gauge	1 roll
copper wire, enamel solid 18 gauge	1 roll
copper wire, bare solid 14 gauge	1 roll
copper wire, bare solid 20 gauge	1 roll
Edison computer program	1
friction rod, black plastic	5
friction rod, glass	5
knife, switch, single	15
lamps, miniature - 1.5 V, screw base	15
lamps, miniature - 3.5 V, screw base	15
lamps, miniature - 6 V screw base	15
nickel chromium wire, bare solid 20 gauge	1 roll
pith balls	30
power source	5
resistors	15
steel wool, 1 lb	2
Van der Graf generator	1
voltmeter	1
Consumables List - Electricity Unit	
Radio Shack™ static electricity ball	1
aluminum foil, 25 ft/pkg	5
balloons, 25/pkg	2
pepper shaker	1
plastic wrap, 25 ft/pkg	2
salt, 500g	1
string, balls	2

Other - Electricity Unit	
fur strips	10
silk pieces	10
Styrofoam packing peanuts	25
wool fabric pieces	10
Supply List - Atoms and Elements Unit	**Quantity**
balance	5
bar magnets	5
beaker, 1000 mL	5
beaker, 250 mL	5
beaker, 50 mL	15
beaker, 500 mL	10
candles, 25/box	3
cork stoppers, assorted sizes	2
density block set	5
eye droppers	10
eye wash kit	1
fire blanket	1
first aid kit	1
glass stir rods, 12/box	5
graduated cylinder, 100 mL	10
hand lens	15
Handbook of Physics and Chemistry	1
hardness kit	5
heat resistant gloves, pair	25
hot plate	5
iron filings, bottles	2
lab safety chart	1
molecular model kit	1
overflow cans	5
Periodic table wall chart	1
petrie dish	10
rubber stopper (for test tubes)	50

scoopula	10
streak plate	5
test tube (16/18 mm x 150 mm)	50
test tube rack	5
thermometers, 12/pkg	1
tongs	10
watch glasses	15
water bottle, spouted	10
zinc strips	5

Chemicals List - Atoms and Elements Unit

barium hydroxide, 500 mL	1
Benedict's solution, 500 mL	1
borax, 500 g	1
bromothymol blue solution, 50 mL	1
calcium chloride, granular, 500 g	1
carbon (solid sample), each	5
copper chloride, crystal, 500 g	1
ethanol, 1 L	1
hydrochloric acid, 1 L	1
iodine, 500 mL	1
lead (II) nitrate, 500 mL	1
magnesium sulfate, 500 g	1
methyl orange, 50 mL	1
nitric acid, 1 L	1
phenolphthalein, 50 mL	1
rennet tablets, 50/pkg	1
silicon (solid), each	1
sodium hyroxide, 1-normal, 1 L	1
sodium sulphate, 500 g	1
sulfuric acid, 1L	1
zinc strip	5

Consumables List - Atoms and Elements Unit	
aluminum foil, 25 ft/pkg	2
bamboo skewers, 50/pkg	2
barbecue starter	2
candy thermometer	1
clear plastic cups, 50/pkg	2
corn starch	1 box
distilled water, 4 L	1
lemon juice, 300 mL	1
markers, assorted	1 pkg
milk, 250 mL	1
paper towel, 8/pkg	1
plastic straws, 100/pkg	1
index cards, 100/pkg	2
salt, 500 g	1
sand, 12 kg	1
sandpaper, sheet 5/pkg	1
sugar, 2.2 kg	1
toothpicks, 1000/pkg	1
vinegar, 1 L	1
yeast, 3/pkg	1
Other - Atoms and Elements Unit	
block of wood	5
empty box	5
empty tuna tin	15
heavy sauce pan	1
assorted items to be sealed into boxes for "What's in theBox?" activity	
lids from frozen juice containers for melting elements	15
metal spoon for stirring	1
Supply List - Space Unit	**Quantity**
flashlight	25
bulbs to match flashlights	25

planet poster	1
solar system poster	1
luminous star finder	1
constellation poster	1
sun scale kit	1
batteries to match flashlights	50
Other - Space Unit	
Starry Night Backyard™, sets	class
stars and planets field guide	5
empty cereal boxes	30
umbrella, black	5

Appendix B: Video Resources

Teacher Resource

Safety videos from driver's training programs or personal development and relationships course video list

Media Services, Learning Resources and Technology

Outcomes	Title	Description
Reproduction: Cellular Processes		
305-1, 110-3, 304-11	*DNA: Molecule of Heredity* Call Number V9459 10 minutes	Concepts covered in this video include an introduction to DNA such as the double helix, chromosomes, and genetic code.
305-1, 110-3, 304-11	*Cells and Systems* Call Number V0832, 20954 20 minutes	The blood system transports oxygen and other vital materials to cells in the human body. Cells are the basic units of all living things. In order to survive, cells must take in certain materials to produce energy, new materials, or to multiply. The program describes how cells can be both useful and harmful to humans.
305-1, 110-3, 304-11	*Biotechnology* Call Number 21638 28 minutes	Scientists explain their work in the field of genetics and the business of biotechnology and also discuss the moral and ethical questions involved in this controversial subject.
305-1, 110-3, 304-11	*Mitosis and Meiosis* Call Number V2145 24 minutes	Microscopic images are interwoven with animated sequences to allow the processes of mitosis and meiosis to be more easily understood. Includes brief teacher guide and blackline masters.
Reproduction: Asexual and Sexual Reproduction		
305-2, 305-3, 209-6	*Sexual Reproduction* Call Number 20962 30 minutes	Topics described in this video include internal and external fertilization, eggs, and young and internal development.
305-2, 305-3, 209-6	*Flowering Plants: From Seed to Seed* Call Number 21932 11 minutes	The program examines the development of a common plant, the tomato, using time lapse photography. Germination, photosynthesis, the development of true leaves and flower buds, pollination, the development of the tomato fruit and seed, and the beginning of the new life cycle are shown.

Outcomes	Title	Description
305-2, 305-3, 209-6	*Kingdom of Plants* Call Number V2147 16 minutes	This video examines the major branches of the plant kingdom. Starting with one-celled plant-like protists, students learn the role of photosynthesis in producing food and oxygen. Then important characteristics and development trends are revealed as the program looks at seaweed algae, mosses and liverworts, ferns and horsetails, and seed plants. A brief teacher's guide with blackline master and an optional video quiz are provided at end of program.
305-2, 305-3, 209-6	*Seeds in Motion* Call Number V1825 15 minutes	This video uses time-lapse photography to show the many ways in which plants scatter their seeds.
305-2, 305-3, 209-6	*Anatomy of a Flowering Plant* Call Number V1616 15 minutes	Biology teacher Jim Cleveland dissects a lily flower under the microscope to demonstrate its reproductive cycle.
305-2, 305-3, 209-6	*Moss and Fern Life Cycles* Call Number V1614 9 minutes	Biology teacher Jim Cleveland dissects moss and fern plants in order to demonstrate their reproductive cycles.
Reproduction: Genetic Changes		
113-10, 305-5, 209-5, 210-8, 112-12	*Germ Wars* Call Number 22281 28 minutes	Some micro-organisms are harmful and others helpful to people. Bacteria, viruses and fungi and the ways they affect the human body are discussed. Their methods of reproduction and actions as scavengers in the ecological cycle are explored.
113-10, 305-5, 209-5, 210-8, 112-12	*Immune System: Your Magic Doctor* Call Number 21944 20 minutes	This animated video shows the body's natural defence systems to T and B cells work together to identify and destroy any invader which is not part of the human body. The program uses humourous cartoon police and criminal characters to explain macrophages, antigens, antibodies, bacterial and viral infections, and how chemicals fight infection and disease. A basic discussion of how AIDS attacks the immune system is provided. Good health recommendations such as good food, exercise, rest, cleanliness, reducing stress, and avoiding smoking, drugs, alcohol, and unprotected sex are provided.

Outcomes	Title	Description
113-10, 305-5, 209-5, 210-8, 112-12	*Our Genetic Heritage* Call Number 20152 14 minutes	The program uses microphotography to explain the functions and interactions to genes for human growth and development, and to explain why genes sometimes "go wrong," thereby causing dominant inheritance, recessive inheritance, and X-linked diseases. We witness embryonic development and see the genetic testing techniques of amniocentesis and CBS administered. Genetic counselling, mapping and therapy are briefly explained.
113-10, 305-5, 209-5, 210-8, 112-12	*Gene Therapy* Call Number 21459, V1893 50 minutes	This provides an excellent discussion of some familiar genetic disorders, Cystic Fibrosis and Alzheimers. The significance of advances in gene therapy are demonstrated. The fact that we can test for some specific genetic diseases leads to thought provoking ethical discussions.
113-10, 305-5, 209-5, 210-8, 112-12	*Fighting Diseases* Call Number V1891, 21543 50 minutes	The program discusses the role of the immune system in fighting disease, the research that is being done to discover how diseases mutate and the development of vaccines. We visit the Centers for Disease Control in Atlanta to learn how influenzas become pandemic. Multiple sclerosis and AIDS therapies are discussed.
113-10, 305-5, 209-5, 210-8, 112-12	*Biotechnology* Call Number 21638 28 minutes	Scientists explain their work in the field of genetics and the business of biotechnology and also discuss the moral and ethical questions involved in this controversial subject.
113-10, 305-5, 209-5, 210-8, 112-12	*Mutation and All That* Call Number V9493 10 minutes	Although the mechanism of meiosis constantly reshuffles the gene pool of a population, only mutation can account for the upward progression of a species. Examining the structure of DNA and the alteration of the genetic code, we learn why the relationship of mutation to the rate of evolution remains a subject of debate today.
113-10, 305-5, 209-5, 210-8, 112-12	*Genetic Fingerprinting* Call Number 22225 20 minutes	Everyone, with the exception of identical twins, has a unique genetic fingerprint. This program shows lab techniques used in genetic finger-printing and presents real-life applications of these techniques. Viewers learn how genetic fingerprinting of blood and semen samples from the scene of a crime can help the law identify and convict the guilty party.

Outcomes	Title	Description
113-10, 305-5, 209-5, 210-8, 112-12	*Genetics: The Amish* Call Number 22404 26 minutes	For over 200 years, the Amish have withstood pressures to become absorbed into changing North American society. Not only have the Amish retained their values and culture, they have kept records that permit geneticists to study the effects of inbreeding on gene frequency in a closed population. The program describes the findings of a John Hopkins study of the Lancaster County, Pennsylvania Amish.
113-10, 305-5, 209-5, 210-8, 112-12	*Genetics and Heredity* Call Number V2166 20 minutes	This video presents an overview of genetics: looking at DNA, genes, chromosomes, genetic counselling, and genetic engineering. A brief history with references to Mendel and Darwin is presented at the beginning of the program.
113-10, 305-5, 209-5, 210-8, 112-12	*Canadian Farming on the Go* Call Number V9967 29 minutes	The video presents a Canadian history of the technological improvements in agriculture and the genetic engineering of plants and animals which have permitted Canadians a high standard of food quality for a low consumer price.
113-10, 305-5, 209-5, 210-8, 112-12	*Canola Council of Canada: An Industry's Success* Call Number V1598, 21190 7 minutes	This industrial, agricultural promotion piece uses a combination of live and animated footage to sell the viewer on the virtues of canola farming and manufacturing. We learn where canola is grown, the testing, disease control and quality control features of agricultural and industrial businesses associated with the Canola Council of Canada, and the value of the products of canola—oil and protein products—to the Canadian economy.
113-10, 305-5, 209-5, 210-8, 112-12	*News in Review: Genetics in Food –Changing Mother Nature* Call Number 22830 XX minutes	Includes excellent teacher's guide with background information, Web sites to consult for further information as well as suggested topics for research.
113-10, 305-5, 209-5, 210-8, 112-12	*Biotechnology –National Film Board* Call Number 22463 60 minutes	Biotechnology is the use of a living organism to manufacture a chemical or biochemical product. Biotechnology was developed because of two new techniques—the ability to create new species by recombining DNA from two other species, and the ability to custom-make antibodies. From the video and activities, students will learn to describe the procedure to produce hybrids and genetically engineered new organisms, outline the steps which new products of biotechnology must go through to be registered in Canada, learn some of the benefits and problems associated with biotechnology, and the roles and responsibilities of the public governments, scientist and industry with regard to biotechnology.

Outcomes	Title	Description
Atoms and Elements: Safety Considerations and Physical Properties		
110-1, 209-7, 307-12	*Atomic Structure: Mapping the Invisible World* Call Number V2206 20 minutes	Dynamic animations bring to life the invisible world of the atom and explain how models of the atom have changed over time. The program looks at the atomic models of Dalton, Rutherford, Bohr, and contemporary physicists. Also outlined are important concepts such as subatomic particles, anti-particles, isotopes, atomic number, mass and radioactive particles. The program concludes by showing how radioactive isotopes are used to detect and fight disease, monitor the flow of pesticides through the environment, and to date fossil remains.
110-1, 209-7, 307-12	*Lab Sense* Call Number V1714, 21793 27 minutes	This video, conceived and performed by a team of high school students from Halifax Regional School Board, is designed to introduce students entering their first lab-based science course to the basics of safe procedure in the lab. Four student actors host this parody. "Labsense" directs the viewers to such topics as protective clothing, safe experimental procedure, basic safety equipment, and safety attitudes. A written lab curriculum accompanies the video.
110-1, 209-7, 307-12	*Matter: Form and Substance in the Universe* Call Number V2205 20 minutes	This program introduces students to the basic characteristics of matter. Included are the concepts of mass, density, weight, and inertia; the differences between elements, compounds, substances, and solutions; the unique physical properties (boiling and freezing points, conductor or insulator, solubility, hardness) and chemical characteristics (reactivity, flammability, acid or base, combustibility) of different types of matter, and the four states of matter: solid, liquid, gas, and plasma.
Atoms and Elements: Chemical Changes and Reactions		
307-13, 210-16	*Reactions: The Chemistry of Change* Call Number V2203 27 minutes	This program looks at various types of reactions: exothermic and endothermic, spontaneous and non-spontaneous, and how variables such as temperature, concentration, and the presence of a catalyst affect the rate of chemical reactions. The concepts of chemical equilibrium and the reversibility of reactions are also introduced. The importance of chemical reactions in biological processes like photosynthesis and in industrial applications are also examined.

Outcomes	Title	Description
307-13, 210-16	*Compounds: Electromagnetic Attraction in Molecules* Call Number V2208 24 minutes	Animations and graphics are used in this program to explain: how compounds are formed by either ionic or covalent bonding; the difference between various groups of compounds such as acids, bases, and hydrocarbons; chemical formulas, chemical equations, and the conservation of matter. Also explored are exothermic, endothermic, and neutralization reactions. This video contains exciting examples of why these processes and principles are important to our everyday lives.
307-13, 210-16	*Physical Science: Bill Nye* Call Number 21650 36 minutes	Bill Nye, "mad scientist," uses wacky humour and interesting experiments to demonstrate basic physical science principles. On this tape he looks at phases of matter (how atoms form solids, liquids, or gases depending on energy).
307-13, 210-16	*Energy and the Chemistry of Life* Call Number 22017 38 minutes	This two-part program, designed for use in grades 9–12 biology classes, explains the basic physical and chemical processes that allow energy to be stored and utilized by living things. Part one provides lessons in simple physics and chemistry. Physical concepts of matter and energy are explained, structure of atoms in described, then how elements combine to form molecules and chemical compounds. Part two utilizes the physical and chemical concepts from part one to analyse two of life's key metabolic processes: aerobic cellular respiration and photosynthesis. Includes teacher's guide.
Atoms and Elements: Atomic Theory		
110-3, 109-13, 307-14, 111-4, 112-8	*Structure of the Atom Series* Call Number V9446, V9451 10 minutes each	These programs explore the history and development of the model of the atom, from the hypotheses of early Greek philosophers to the wave–mechanical model of modern atomic physicists. Experiments by pioneer atomic scientist such as Bohr, de Broglie, Faraday, and Rutherford using electricity, radioactivity and spectroscopy, are recreated through animation, and the implications of their discoveries are discussed. Programs include: Earliest Models (V9446), Smaller than the Smallest (V9447), Rutherford Model (V9448), Bohr Model (V9449), Spectra (V9450), Wave Mechanical Model (V9451).

Outcomes	Title	Description
110-3, 109-13, 307-14, 111-4, 112-8	*Introducing the Players* Call Number V9440 10 minutes	This program introduces the atom and the three main subatomic particles: electron, proton, and neutron. The location, charge, and relative mass of these particles is explained. Ernest Rutherford's model of the atom is reviewed and its advantages and shortcomings discussed.
110-3, 109-13, 307-14, 111-4, 112-8	*Energy and the Chemistry of Life* Call Number 22017 38 minutes	This two-part program, designed for use in grades 9–12 biology classes, explains the basic physical and chemical processes that allow energy to be stored and utilized by living things. Part one provides lessons in simple physics and chemistry. Physical concepts of matter and energy are explained, structure of atoms in described, then how elements combine to form molecules and chemical compounds. Part two utilizes the physical and chemical concepts from part one to analyse two of life's key metabolic processes: aerobic cellular respiration and photosynthesis. Includes teacher's guide.
110-3, 109-13, 307-14, 111-4 112-8	*Atomic Structure: Mapping the Invisible World* Call Number V2206 20 minutes	Dynamic animations bring to life the invisible world of the atom and explain how models of the atom have changed over time. The program looks at the atomic models of Dalton, Rutherford, Bohr, and contemporary physicists. Also outlined are important concepts such as subatomic particles, anti-particles, isotopes, atomic number, mass and radioactive particles. The program concludes by showing how radioactive isotopes are used to detect and fight disease, monitor the flow of pesticides through the environment, and to date fossil remains.
110-3, 109-13, 307-14, 111-4, 112-8	*Eureka: Energy and Control* Call Number V2387 5 minutes each	Energy and Control includes nine programs on topics of atoms, electrons, volume and density, buoyancy, and others. Each program takes a simple and direct approach to the subject matter, while the basic concepts are explained in a voice-over, cartoon characters and a variety of animated objects demonstrate the principles on the screen.

Outcomes	Title	Description
110-3, 109-13, 307-14, 111-4, 112-8	*Chemistry in Action: Aluminum* Call Number 21268 19 minutes	Aluminum is extracted and purified from clays and rocks at a British plant by purifying bauxite ore to aluminum oxide and reducing this oxide to molten metal. The economic factors which influence the location of aluminum plants are discussed. Desirable properties of aluminum and its alloys are described. The link between specific properties of each alloy and its end use are demonstrated.
110-3, 109-13, 307-14, 111-4, 112-8	*Chemistry in Action: Iron and Steel* Call Number 21269 20 minutes	Iron ore is reduced and manufactured into steel in a modern plant where, in a continuous process, ore is crushed, mixed with coke, and fed into the top of a blast furnace. Molten iron flows from the bottom; slag is skimmed from the surface. Iron is converted to steel by blasting oxygen through the iron to remove residual carbon and by adding lime and magnesium powder to remove other trace solid impurities. Alloying metal are then added to the steel. The molten metal is cast into molds which are later rolled into required shapes.
110-3, 109-13, 307-14, 111-4, 112-8	*Organic Chemistry: The Carbon Connection* Call Number V0436, 20969 60 minutes	Beginning with a look at the structure of carbon, the atom common to all living matter, this series investigates the properties of carbon and some of its fascinating uses—in fuels, plastics, and industry. Computer animation is used to illustrate bonding and reaction at the molecular level, and to help simplify complex concepts. The program contains six segments: Carbon the Compromiser, The Shape of Carbon, Carbon Bonding, Fixing Fuels, Polyethylene, and Harvest of Enzymes.
110-3, 109-13, 307-14, 111-4, 112-8	*Organic Chemistry 2: Industrial Application* Call Number V0437, 20970 60 minutes	A sequel to *Organic Chemistry*, this program uses sophisticated three-dimensional animation to show how the molecules and properties of compounds lend themselves to a wide variety of industrial applications. Since the number of synthetic compounds under development is steadily increasing, the program concludes with a program on the benefits and risks of these materials. Segments include Fibres, Soaps, Glues, ASA, Cosmetics, and Life After Chemistry.

Outcomes	Title	Description
Atoms and Elements: Periodic Law		
210-1	*Periodic Table: Reactions and Relationships* Call Number V2207 24 minutes	The Periodic table contains a wealth of information, and this program helps students learn how to access it. The program explains the periodic law and the significance of the rows and columns of the periodic table and also outlines the physical and chemical qualities of the members of each group of elements from the alkaline metals to the noble gases. The importance of various groups of elements in industrial applications and in the environment is highlighted.
Characteristics of Electricity: Static Electricity		
308-14, 111-1, 112-10	*Learning About Electricity* Call Number 22262 16 minutes	An understanding of protons, electrons, and their charges is needed to best benefit from the program. Electricity exists in all things. Children demonstrate, using common household objects, how electricity is controlled to do work. Its importance to our lifestyles is demonstrated. A variety of sources of commercial electrical energy is explained. The importance of protecting oneself from electrical shock is demonstrated.
308-14, 111-1, 112-10	*Physical Science: Bill Nye* Call Number 21650 36 minutes	Bill Nye looks at electricity (the flow of electrons, electrical circuits, conductors, batteries, direct and alternating currents).
308-14, 111-1, 112-10	*Energy Choices* Call Number V2128 42 minutes	The conversion of fossil fuels and other primary forms of energy into electricity, heat and mechanical power needed for transportation and industry, accounts for a significant portion of all economic activity and an even larger share of all man-made pollution. The video features the Canadian pop group, Moxy Fruvous. A comprehensive teacher's guide is divided into four parts: history of energy use and technology, energy and the environment, energy efficiency, and renewable energy and hydrogen.
308-14, 111-1, 112-10	*Tuft's Cove Open House* Call Number V1000 9 minutes	A tour of Tuft's Cove generating station.

Outcomes	Title	Description
308-14, 111-1, 112-10	*Annapolis River Tidal Power Project* Call Number V8775 12 minutes	This video looks at the enormous power of water and tides in the Bay of Fundy, and looks at the design and construction of turbines. This pilot project is set up at Annapolis Royal, Nova Scotia.
308-14, 111-1, 112-10	*Maritimes and Northeast Pipeline* Call Number V2366, 22864 16 minutes	This program produced by Maritimes and Northeast Pipeline describes the construction of the lateral line through Nova Scotia and New Brunswick, one of the largest aspects of Sable off shore gas project.
308-14, 111-1, 112-10	*Geothermal: The Energy Within* Call Number 20852 17 minutes	The program explores the vast untapped energy source that is only now being developed, geothermal energy. Through the stories of a geologist and engineer, students learn how a geothermal field is explored, developed, and operated.
Characteristics of Electricity: Static Electricity and Electric Current		
109-14, 308-16, 308-15	*Creating and Controlling Static Electricity* Call Number 22912 13 minutes	This video covers the following concepts: circuits, conductors, insulators, atomic structure, energy conversion, wet and dry cell batteries. A teacher's guide with simple experiments is included.
109-14, 308-16, 308-15	*Static and Current Electricity* Call Number 21567 15 minutes	Electrical charges, whether static or moving, have their source in the charged particles that compose neutral atoms. How these charges are separated, accumulated, and discharged, as a brief or continuous flow of current, demonstrate the fundamental unity of static and current electricity. Animation, designed experiments, and comparisons of electrostatic copiers, static generators, capacitors, and batteries illuminate the behaviour of charges in contemporary applications of fundamental principles.
109-14, 308-16, 308-15	*Beyond The Mechanical Universe: Electric Circuits* Call Number 22668 30 minutes	Design and analysis of currents flowing in series and parallel circuits of resistors and capacitors depend not only on the celebrated laws of Ohm and Kirchkoff, but also on the less celebrated work of Charles Wheatstone.
109-14, 308-16, 308-15	*Beyond The Mechanical Universe: Static Electricity* Call Number 22671 30 minutes	This program discusses Coulomb's law and the principles of static electricity.

Outcomes	Title	Description
Characteristics of Electricity: Series and Parallel Circuits		
308-17	*Beyond The Mechanical Universe: Electric Circuits* Call Number 22668 30 minutes	Design and analysis of currents flowing in series and parallel circuits of resistors and capacitors depend not only on the celebrated laws of Ohm and Kirchkoff, but also on the less celebrated work of Charles Wheatstone.
308-17	*Creating and Controlling Static Electricity* Call Number 22912 13 minutes	This video covers the following concepts: circuits, conductors, insulators, atomic structure, energy conversion, wet and dry cell batteries. A teacher's guide with simple experiments is included.
Characteristics of Electricity: Use of Electrical Power		
308-20, 210-8, 113-6, 210-8, 109-6	*The Science of Energy* Call Number V2051 28 minutes	This video uses humourous animation, exciting film sequences, and Canadian pop group, Moxy Fruvous, who contribute original and amusing songs that summarize and reinforce science concepts. The video focuses primarily on physics and biology, but creates links between these subjects and chemistry. The video also connects scientific theory with real world applications and their social impact. A teacher's guide is included.
308-20, 210-8, 113-6, 210-8, 109-6	*Tuft's Cove Open House* Call Number V1000 9 minutes	A tour of Tuft's Cove generating station.
308-20, 210-8 113-6, 210-8, 109-6	*Energy Choices* Call Number V2128 42 minutes	The conversion of fossil fuels and other primary forms of energy into electricity, heat and mechanical power needed for transportation and industry, accounts for a significant portion of all economic activity and an even larger share of all man-made pollution. The video features the Canadian pop group, Moxy Fruvous. A comprehensive teacher's guide is divided into four parts: history of energy use and technology, energy and the environment, energy efficiency, and renewable energy and hydrogen.
308-20, 210-8, 113-6, 210-8, 109-6	*Waterpower: Portrait of a Small Hydro* Call Number V9504 28 minutes	In past years small hydro popularity had declined; today a resurrection has occurred. This program examines why small hydro declined. Current owners of small hydro water plants discuss some of the problems they faced in reopening these dams.

Outcomes	Title	Description
308-20, 210-8, 113-6, 210-8, 109-6	*Energy in Canada* Call Number 22394, V0600 9 minutes	This video provides an overview of Canada's energy picture today and some of the environmentally responsible steps taken to ensure that our future energy options are equally bright. Energy forms include conventional and frontier oil and gas, the Alberta tar sands, nuclear, coal, water, biomass, and wind.
308-20, 210-8, 113-6, 210-8, 109-6	*Annapolis River Tidal Power Project* Call Number V8775 12 minutes	This video looks at the enormous power of water and tides in the Bay of Fundy, and looks at the design and construction of turbines. This pilot project is set up at Annapolis Royal, Nova Scotia.
308-20, 210-8, 113-6, 210-8, 109-6	*Solar House* Call Number 21507 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Making Waves and Pipedreams* Call Number 22229 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Energy Efficient Dog House* Call Number 21469 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Backyard Alternative Energy* Call Number 21562 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Energy Choices* Call Number V2128 42 minutes	The conversion of fossil fuels and other primary forms of energy into electricity, heat and mechanical power needed for transportation and industry, accounts for a significant portion of all economic activity and an even larger share of all man-made pollution. The video features the Canadian pop group, Moxy Fruvous. A comprehensive teacher's guide is divided into four parts: history of energy use and technology, energy and the environment, energy efficiency, and renewable energy and hydrogen.
308-20, 210-8, 113-6, 210-8, 109-6	*Energy in Canada's Remote Communities* Call Number V0598 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Outcomes	Title	Description
308-20, 210-8, 113-6, 210-8, 109-6	*Greenhouse* Call Number V0899, 21203 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Geothermal: The Energy Within* Call Number 20852 17 minutes	The program explores the vast untapped energy source that is only now being developed, geothermal energy. Through the stories of a geologist and engineer, students learn how a geothermal field is explored, developed, and operated.
308-20, 210-8, 113-6, 210-8, 109-6	*Harvest the Wind* Call Number V0318 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Passive Solar Home Design* Call Number V2008 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Race for the Future* Call Number 21578 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
308-20, 210-8, 113-6, 210-8, 109-6	*Solar Energy* Call Number V2356 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Space Exploration: The Beginnings of the Solar System		
312-4, 312-1	*Galileo: The Challenge of Reason* Call Number V8921, 22851 26 minutes	Galileo's experiments led him to support Copernicus' view that the sun was the centre of the universe. For these beliefs, Galileo was brought before the Inquisition. After showing Galileo's experiments, the film dramatizes the conflict between Galileo's new scientific thinking and the church's authority. Although in the end Galileo recanted, it was his view which was to dominate the West in succeeding centuries.
312-4, 312-1	*The Sun* Call Number V1735 11 minutes	The birth of our local star, the sun, and metamorphosis of the early solar system is shown in this video. Auroras, eclipses, sun spots, flares, prominences, the solar wind are also illustrated. The program points out the enormity of the sun which converts four million tons of mass into energy every second—and upon which all life depends.

Outcomes	Title	Description
312-4, 312-1	*Close-up on the Planets/Comets: Time Capsules of the Solar System* Call Number 21240 32 minutes	This cassette contains two programs. Close up on the planets using NASA space photos and recent NASA information, students journey through our solar system. Comets: time capsules of the solar system—the program combines animation sequences, live action and documentary photography for a dramatic exploration of contemporary scientific research into comets.
312-4, 312-1	*Stars and Planets* Call Number V0835, 20957 20 minutes	The program traces how our understanding of our solar system has changed over time. It examines how we measure long distances between stars and planets, the similarities and differences between Earth and other planets, and discusses the life expectancy of our sun.
312-4, 312-1	*A Galactic Encyclopedia: History of Astronomy* Call Number 22668 11 minutes	The program traces human thinking about astronomy and the place of the Earth within the universe from the megalithic observatory of Stonehenge, England, to modern times. We learn how the circumference of Earth was measured seventeen hundred years before Columbus set sail. We review the evolution of early theories which put Earth at the centre of the universe to the dawn of sun-centred astronomy with Tycho Brahe, Johannes Kepler, Nicolaus Copernicus, and Isaac Newton. Far from being the centre, Earth is a mere speck in the cosmos.
Space Exploration: Composition and Characteristics of the Solar System		
312-5, 110-6, 210-3, 112-6, 312-6	*Tales from Other Worlds: Solar Family* Call Number V0888, 20863 XX minutes	Students will study the diversity of the planets and satellites of the solar system and begin to view the Earth as one among many planets, distinguished by the presence of life.
312-5, 110-6, 210-3, 112-6, 312-6	*Planets: New Discoveries* Call Number 22258 20 minutes	The newest generation of space probes provide current information about the Earth's celestial neighbours. Animated sequences and recent Voyager, Magellan and Galileo photographs are featured.
312-5, 110-6, 210-3, 112-6, 312-6	*The Lake that Fell to Earth* Call Number V1704, 22424 28 minutes	This is a video based on a research expedition to the New Quebec crater in Canada's North. It reveals the fascinating results of this research and illustrates what happens when a meteorite collides with the Earth.

Outcomes	Title	Description
312-5, 110-6, 210-3, 112-6, 312-6	*Roberta Bondar* Call Number 21694 30 minutes	The first Canadian female astronaut, Roberta Bondar, is an adventurous, focussed, and determined woman, who joined the NASA program in 1983. She sees space as an opportunity to find new ways to solve problems. Her love of exploration and adventure, and her clarity of vision emerge as she talks about the space program, as well as her goals in life, and society in general. She also discusses her status as a role model and her views on gender relations. She stresses the need for exploration, adventure, and curiosity to succeed in life.
312-5, 110-6, 210-3, 112-6, 312-6	*Personally Speaking* Call Number 21302 7 minutes	In this video Pamela Wallin interviews Dr. Roberta Bondar, a Canadian astronaut who was chosen for a space shuttle mission on board the "Discovery."
312-5, 110-6, 210-3, 112-6, 312-6	*Solar Sea: The Sun* Call Number V0892, 20867 30 minutes	Students will explore the fundamental energy source for the solar system in terms of its stability, its manifestations on the Sun's surface, and its means of transporting energy from the Sun's interior to the surface of the Earth.
312-5, 110-6, 210-3, 112-6, 312-6	*Oceans and Space* Call Number 22646 27 minutes	This program contains four segments: Earth, sun and moon, Stars and planets, Water cycle, What are the oceans.
312-5, 110-6, 210-3, 112-6, 312-6	*Solar Sun: Interactions Between the Earth and Sun* Call Number V2206 30 minutes	Students will study the significance of the interactions between the Sun and the Earth, especially as they are controlled by the Earth's magnetic field. Students will appreciate how it is that both the Earth and Sun have magnetic fields at all.
Space Exploration: Composition and Characteristics of the Universe		
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Galactic Encyclopedia: In The Beginning* Call Number (XX) 11 minutes	The birth of the universe, a journey back to the Big Bang. How time and distance are linked, the materials astronomers use to measure the cosmos and to date the moment when time and space began, the interaction of galaxies in cosmic evolution, black holes, the ultimate gravitational trap, quasars, the ultimate concentration of energy.

Outcomes	Title	Description
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Stephen Hawking's Universe: The Big Bang* Call Number 22613 60 minutes	Our sun at the centre of our solar system is just one star among billions in the Milky Way galaxy. Around us are billions and billions of other galaxies. Where could this entire universe come from? Scientists developed two theories: the Big Bang and the Steady State. In this century, science has come to understand how the universe began from a tiny point, fifteen billion years ago.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Tales from Other World's: Origins* Call Number V0889 30 minutes	Students will study the origin and evolution of the Earth in the context of the other members of the solar system. The origin and early history of our Solar System and the evolution of Earth are examined in some detail.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Creation of the Universe* Call Number V2105 90 minutes	This video covers several subjects including historical and factual information on the creation of the universe.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Starlife* Call Number V9543 20 minutes	This videotape traces the evolution of a star from its birth in the depths of a black nebula to its final extinction. Animated drawings recreating the beauty and immensity of the universe are amplified by a narrative describing the differing evolutionary processes followed by stars of different masses. The program touches on the creation of elements in the core of stars, red giants, bursters, space-time relationships, and "black holes". This animation piece will be of particular interest to students of physics, chemistry, and astronomy.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Stephen Hawking's Universe: Black Holes and Beyond* Call Number 22616 60 minutes	The invention of radio astronomy over 50 years ago opened new horizons for astronomers. It led to the Search Extraterrestrial Intelligence (SETI) which looks for stray alien communications. And it also led to astronomical discoveries. Among these were black holes and quasars: bizarre objects billions of light years away the same size as our solar system with a power output greater than all of the stars in our galaxy put together. The science of black holes has presented some strange possibilities since the rules of physics do not apply inside black holes.

Outcomes	Title	Description
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Bill Nye: Earth Science* Call Number 21649 36 minutes	The Earth and outer space provide Bill Nye with plenty of facts about the moon (its orbit, what moonlight really is, the phases of the moon, and an astronaut's moonwalk experiences), and outer space (immense distances in the solar system, and space and light years).
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*One Giant Leap* Call Number 22124 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*NASA: Mission to Planet Earth* Call Number 21066 XX minutes	XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Planets: New Discoveries* Call Number 22258 20 minutes	The newest generation of space probes provide current information about the Earth's celestial neighbours. Animated sequences and recent Voyager, Magellan, and Galileo photographs.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Space for Four* Call Number V2129 47 minutes	This video is a human interest documentary about hope, achievement, and quiet heroes in the making. It is the story of over 5 000 replies to a newspaper advertisement for astronauts. From the responses, two women and eighteen men were chosen as finalists. The committee, including Canadian astronaut Marc Garneau, prepared carefully phrased questions designed to draw out the way the candidates will deal with conflict, stress, teamwork, and their commitment to the program. Out of the twenty finalists, sixteen would be rejected. The video makes the candidates seem very human, be letting them talk about their insecurities.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Cosmic Zoom* Call Number 22506 8 minutes	This program probes the infinite magnitude of space, and its reverse, the ultimate minuteness of matter. Animation is used to take us to the farthest conceivable point of the universe and into an atom of a living human cell.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Awesome Space* Call Number 22217 30 minutes	This video takes you on a voyage to look at actual blast-offs from the launch pad, get up close to see what rockets and space ships really look like, see the skylab that the astronauts lived in while they floated in space, and watch the first time astronauts walked on the moon and see the ship that took them there.

Outcomes	Title	Description
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Putting Man in Space* Call Number 21228 15 minutes	The program examines the role mathematics played in the successful American space program. In 1969, a man first walked on the moon. The United States' commitment to a space station is discussed with astronaut Bonnie Dunbar at the Johnson Space Centre in Houston, Texas. She describes how math is fundamental to aviation and space engineering. We see NASA's Mission Control Centre, the Weightless Environment Training Facility, and the Flight Simulation and Robotics Laboratory.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Space Shuttle* Call Number 22148 90 minutes	This video profiles the people at NASA who prepare space shuttles such as Columbia, Discovery, Endeavour, and Atlantis for voyages. It describes many of tasks involved from the smallest to the most complex, from scanning the runway for debris prior to a shuttle landing to piloting the shuttles. Viewers can see interviews with workers, NASA administration and astronauts.
312-3, 312-2, 210-9, 109-3, 112-11, 210-16 109-11, 111-5	*Space Trek* Call Number 22602 30 minutes	This program features Bob MacDonald from the CBC Wonderstruck series. Students will explore the first spaceships to the future of space exploration. Vignettes include: Space Planes, Moonballs, Creating an Alien, Suzuki on UFOs, Sailcraft, Why Space Shuttle Compartments Don't Collapse, Trip to Mars, and Mars Fossils. A teacher's guide is included.

Appendix C: Software Resources

Media Services, Learning Resources and Technology

HIP Biology 1 and 2

This resource provides microimages of plant and animal cells as well as images of genetic material. This can be used in conjunction with activity resources provided as part of the software package to increase students' recognition of the nucleus of a cell and its processes. Activities in the package include: investigating the structure of other parts of cells (plant and animal), DNA profiles of natural versus restored populations, an exercise in recognizing the behaviours of the chromosomes during mitosis, examination of root cell micrographs to discover the area of the root in which growth is occurring, an activity in which actual images of chromosomes are matched to prepare a karyotype to identify chromosomal abnormalities, and a mitosis movie.

Outcomes	Strand	Resource
305-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5; RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Cellular Processes	HIP Biology 1 "Plants:The InsideStory"
305-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5; RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Cellular Processes	HIP Biology 2, "The Cell Factory"
304-11; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5; RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Cellular Processes	HIP Biology 1, "The Cell Cycle"
304-11; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5; RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Cellular Processes	HIP Biology 2, "Anaphase Animation"
304-11; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5; RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Cellular Processes	HIP Biology 2, "Mitosis Movie"
113-10, 305-5; 209-5; 210-8, 111-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5, RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Genetic Changes	HIP Biology 1, "Biology Bottlenecks"
113-10, 305-5; 209-5; 210-8, 111-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5, RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Genetic Changes	HIP Biology 1, "Gel Electrophoresis"
113-10, 305-5; 209-5; 210-8, 111-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5, RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Genetic Changes	HIP Biology 1, "Harris' Hawks"

Outcomes	Strand	Resource
113-10, 305-5; 209-5; 210-8, 111-1; BOC 9.1, 9.4; PTS 9.3, 9.4, 9.5, RSPD 9.1, 9.2, 9.4, 9.6	Reproduction: Genetic Changes	HIP Biology 2, "Karyotypes"

Interactive Chemistry Journey

This program is intended for students in high school chemistry courses and includes much more chemistry than needed for this topic. It combines tutorials, simulations, and some problem solving in a very interactive setting. It encourages students to explore ideas in chemistry as well as providing useful information. If it is available within the school, it contains tutorials on basic chemical structures that could be useful for Science 9 students. It might also provide enrichment activities for students who have scientific gifts and talents.

Outcomes	Strand	Resource
307-13, 210-11, 210-16; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Chemical Changes/Reactions	Interactive Chemistry Journey
110-3, 109-13, 307-14, 111-4; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Atomic Theory	Interactive Chemistry Journey
307-15, 109-2, 210-1, 307-16; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Periodic Law	Interactive Chemistry Journey
111-1, 112-3; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Periodic Law	Interactive Chemistry Journey

Discover the Elements

This is an interactive, multimedia CD-ROM for learning chemistry. It presents basic information about the periodic table in an interesting manner and is easy to use. A teacher can easily observe student progress in the program. It has several useful features including pronunciations and could be used at several levels.

Outcomes	Strand	Resource
110-3, 109-13, 307-14, 111-4; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Atomic Theory	Discover the Elements
307-15, 109-2, 210-1, 307-16; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Periodic Law	Discover the Elements
111-1, 112-3; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Periodic Law	Discover the Elements

PASCO Science Workshop with Temperature and/or pH Probes

This is a complete, hands-on, computer-based data acquisition system. The system includes curriculum activities, sensors, computer interfaces and software. It provides a real world, exploratory, hands-on learning, which accommodates interdisciplinary science learning. It allows students to "own" data from real scientific experiments. There are over 200 customizable experiments in print and on floppy disk. An in-depth detailed teacher's guide is included, along with easy-to-follow procedures and a library of over 200 experiments on disk. The temperature and pH probes are useful in this unit.

Temperature: The Temperature Sensor ensures a quick response and negligible impact on measured temperatures. It can be used in harsh liquids or chemical solutions. Typical applications include: general temperature experiments and measuring rapid temperature changes found in endothermic-exothermic reaction experiments.

pH: The pH Sensor is a fundamental sensor for studying a wide range of topics involving acid-base interactions. Typical applications include: monitoring acid-base titrations, understanding the role of buffers, and studying water quality.

Outcomes	Strand	Resource
307-13, 210-11, 210-16; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Atoms and Elements: Chemical Changes/Reactions	PASCO Science Workshop with Temperature and/or pH Probes

Virtual Labs: Electricity

This program is a virtual electrical laboratory which allows exploration into the behaviour of circuits. Topics included are series and parallel circuits, batteries, circuits with varying switches and resistors. The program provides many ready-to-use experiments, with worksheets. The experiments can be modified, and new experiments can be created by teachers or by students. The built-in activities are planned to start with simple explorations, and end with difficult and challenging work. Reference information related to electricity is also provided as part of the CD-ROM.

Outcomes	Strand	Resource
109-14, 308-16, 308-15; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Characteristics of Electricity: Static Electricity and Electrical Current	Virtual Labs: Electricity
209-3, 210-5, 211-2, 308-17;BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Characteristics of Electricity: Series and Parallel Circuits	Virtual Labs: Electricity

Starry Night Backyard

This program allows the user to explore the night sky, the Solar System, and the Universe, and to identify planets, stars, and constellations. Students can view the sky from a variety of locations all around the Solar System and the Universe. Features include auto identify, labels and illustrations of the constellations, interesting events, such as eclipses, an online connection to LiveSky, the ability to make movies in QuickTime, adjustment of light pollution levels, the ability to Go There to planets, comets, or stars. New objects may be added as information about them is available. Students can also invent objects to add to the solar system in order to investigate the effects. Star charts and other information may be printed, orbits can be traced, and time lapse sequences can be speeded up or slowed down.

Note: Starry Night Backyard has been provided for Science 9 classes by the Department of Education.

Outcomes	Strand	Resource
312-4, 312-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	The Beginnings of the Solar System	Starry Night Backyard
312-5, 110-6, 210-3, 112-6 211-5, 312-6, 208-4, 211-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Solar System	Starry Night Backyard

312-3, 312-2, 210-9, 109-3, 209-4, 211-1, 211-3, 112-11, 210-16, 109-11, 111-5; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Universe	Starry Night Backyard

EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer

This software is an interactive encyclopaedia of information about earth science.

EarthMission: This CD-ROM is intended for Middle School grades, and provides earth science information on the topics of Earth, Oceans, Atmosphere, and Space. The space section contains factual information about methods of exploration of space, the solar system, stars, galaxies, and the universe.

Earth-Ocean-Atmosphere-Space Explorer: This CD-ROM is similar to EarthMission, but is intended for students in Junior/Senior high school. There is a greater detail and depth of information provided.

Astronomer Explorer: This CD-ROM is intended for students in high school Astronomy classes. It provides extensive information about astronomical facts and theories. This might be useful for extension/ enrichment activities and for research.

Outcomes	Strand	Resource
312-4, 312-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	The Beginnings of the Solar System	EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer

Outcomes	Strand	Resource
312-5, 110-6, 210-3, 112-6 211-5, 312-6, 208-4, 211-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Solar System	EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer
312-3, 312-2, 210-9, 109-3, 209-4, 211-1, 211-3, 112-11, 210-16, 109-11, 111-5; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Universe	EarthMission, Earth–Ocean–Atmosphere–Space Explorer, Astronomy Explorer

Interactive Encyclopedia of Space and the Universe

This is a reference guide to astronomy, space exploration, and the cosmos. It contains information on stars, planets, galaxies, astronauts and their spacecraft, satellites and probes. It provides lists of space and NASA Internet sites. Students could use the 'stardome' to prepare for real observing sessions. This could be used as a demonstration program for a whole class or as an independent reference tool.

Outcomes	Strand	Resource
312-4, 312-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	The Beginnings of the Solar System	Interactive Encyclopedia of Space and the Universe
312-5, 110-6, 210-3, 112-6 211-5, 312-6, 208-4, 211-1; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Solar System	Interactive Encyclopedia of Space and the Universe
312-3, 312-2, 210-9, 109-3, 209-4, 211-1, 211-3, 112-11, 210-16, 109-11, 111-5; BOC 9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7; PTS 9.2, 9.3, 9.4, 9.5; CT 9.1, 9.3, 9.7; RSPD 9.1, 9.2, 9.4, 9.6; SEHI 9.1, 9.7	Composition and Characteristics of the Universe	Interactive Encyclopedia of Space and the Universe