*Public District School Board Writing Partnership*

Science

# Course Profile

## Science

Grade 12
University/College Preparation
SNC4M

• *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course. It may be used in its entirety, in part, or adapted.

Spring 2002

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# Course Overview
# Science, SNC4M, Grade 12, University/College Preparation

**Policy Document:** *The Ontario Curriculum, Grades 11 and 12, Science, 2000.*
**Prerequisite:** Grade 11, SNC3M, Science, University/College Preparation

## Course Description

This course enables students, including those who do not intend to pursue science-related programs at the postsecondary level, to further develop their understanding of science and its technological applications. Students will explore a range of topics, including organic products in everyday life; pathogens and disease; energy alternatives and their impact globally; communications systems; and science and contemporary societal issues. Emphasis will be placed on relating these topics to global issues as well as to daily life, and on developing skills in the areas of experimentation, research, critical thinking, and analysis.

## Course Notes

### The Goals of Grade 12 Science

SNC4M has identified three goals in The Ontario Curriculum, Grades 11 and 12: Science, 2000, (p. 6):
- To relate science to technology, society, and the environment;
- To develop skills, strategies, and habits of mind required for scientific inquiry;
- To understand basic concepts of science.

The activities and assessment tasks in this Course Profile reflect the importance of the three goals and have been developed around clusters of Specific Expectations. A design-down approach was used in developing the overall course and individual units. Based on the Overall Expectations, the Final Assessment Task for the course was developed first, followed by the End-of-Unit Tasks. The Expectations in each unit were clustered into activities that connected together logically and provided the necessary background knowledge and skills to be applied in the completion of the End-of-Unit Tasks. The unit activities were then expanded following each overview chart. The list of suggested activities is not intended to be either restrictive or prescriptive; instead its intent is to provide teachers with suggestions for course development. Teachers may adapt the profile, including the clustering of Expectations, to suit their circumstances and to match the needs of their students.

### Scientific Literacy for All Students

The paramount task of science education, and perhaps particularly this course, is to equip all students with scientific literacy – that combination of values, knowledge, and skills that enable them to think creatively, reason logically, evaluate information critically, and communicate effectively. This is an essential base for making productive and ethical decisions, not only about scientific and technological issues, but in all areas of life.

*The Ontario Curriculum, Grades 11 and 12: Science, 2000* (p. 4) notes that, "Achieving excellence in scientific literacy is not the same as becoming a science specialist." This statement is particularly appropriate to Grade 12 Science, where achievement of scientific literacy is the prime goal of the course. The policy document goes on to note, "The newer aspects of the science curriculum – especially those that focus on science, technology, society, and the environment (STSE) – call for students to deal with the impacts of science on society and the environment, which includes both the natural environment and the workplace environment. This requirement brings in issues that relate to human values. Science can therefore not be viewed as merely a matter of 'facts'; rather, it is a subject in which students learn to weigh the complex combinations of fact and value that developments in science and technology have given rise to in modern society." This perspective is consistent with the vision advanced in this Course Profile.

## Policy Directions

*The Ontario Curriculum, Grades 11 and 12, Science, 2000* (pp. 8-10) contains recommendations regarding teaching approaches and curriculum expectations that are reflected clearly in this Course Profile. Among them are the following key statements:

- The expectations in science courses call for an active, experimental approach to learning, and require all students to participate regularly in laboratory activities.
- Where opportunity allows, students might be required, as part of their laboratory activities, to design and conduct research on a real scientific problem for which the results are unknown.
- Where possible, concepts should be introduced in the context of real-world problems and issues.
- In all courses, a list of expectations is given that precedes the strands. These expectations describe skills that are considered to be essential for scientific investigation, e.g., skills in research, in the use of materials, and in the use of units of measurement, and skills required for investigating possible careers in the subject area. These skills apply to all areas of course content and must be developed in all strands of the course. Assessment of students' mastery of these skills must be included in the evaluation of students' achievement of the expectations for the course. In this Course Profile these expectations are called *Science Investigative Skills* (SIS).

## The Audience for Grade 12 Science

Grade 12 Science, SNC4M, is a departure from courses available in the past to Grade 12 students in Ontario. Like the Grade 11 Science course, its cross-disciplinary nature makes it ideal for students whose destination is college or university but not in a science-related field. Individuals must be scientifically literate to thrive in a science-based world regardless of career path. SNC4M provides an excellent overview of content from a variety of science disciplines and focuses on the process of science and the issues surrounding scientific developments as they pertain to the home, workplace and society in general.

## Planning and Implementing Grade 12 Science

As teachers organize and plan the delivery of expectations of SNC4M, using and/or adapting activities described in this Course Profile, they should consider the following:

- SNC4M is a science course with an emphasis on inquiry skills. Through a variety of investigations, students describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. They identify their assumptions, use critical and logical thinking, and consider alternative explanations. A degree of scientific rigour should be clearly evident in the delivery of the course and in the work done by the students taking it.
- How science influences (and is influenced by) society is clearly evident throughout the guideline and in this Course Profile, but the course should not be delivered so that sociology overshadows the process of science in developing understanding of key concepts and scientific principles.
- The breadth of content in SNC4M is such that teachers must make decisions regarding the depth to which any given topic should be addressed. The opportunity for students to be exposed to the broad scope of science must not be jeopardized by extending the study of any one aspect to excess. All topics in the course are important. At the same time, the study of a few key topics in greater depth, suggested by class interest or teacher expertise, is appropriate, as long as the overall scope of the course does not suffer.
- Learning activities are set in a context of science as it relates to technology, society, and the environment.

- A number of activities in this Course Profile have a research focus that requires accessing information beyond the laboratory or field trip. Students should be taught how to use all available sources of information – people, print, online sources, and other media, both within the school and in the community. They should also be given opportunities to use those skills, and to experience the frustrations that invariably accompany the location and acquisition of quality information. However, care must be taken that student time is spent primarily on processing information rather than accessing information, so that the research does not become an end in itself.
- The expectations are central to all aspects of this Course Profile. The context in which each unit is delivered, the skills and concepts developed, and the assessment tasks used must be interconnected, and linked to the Expectations. The assessment data accumulated throughout the course must be sufficient (in kind and number) to permit teachers to evaluate the most consistent level of performance for each student in each of the categories in the Achievement Chart for Science (*The Ontario Curriculum, Grades 11 and 12, Science, 2000* pp. 174-175).
- Some of the expectations in the guideline, those focusing on science investigative skills (SIS), are so critical to the development of scientific literacy that they are given special emphasis in learning activities and are often revisited. These are expectations that are taught, assessed, evaluated and, where necessary, revisited using alternate instructional strategies in a cyclic process throughout the course.
- Students interpret new information in terms of what they already know. They try to make sense of what is taught by trying to fit it with their experience. Understanding a key concept results when students personally examine significant examples that represent the concept, then create a generalization from those personal experiences. The teacher must be aware of the experiences that students have already had from their work prior to Grade 12, and use those as building blocks to new and more complex concepts. Students may also arrive with misconceptions from their experience that will interfere with their ability to understand new concepts. Identifying and revising misconceptions through concrete experiences may be required at times.
- Terminology, formulae and algorithms should be viewed by students as tools for solving problems and communicating ideas, not as problems to be solved, and should not dominate the curriculum. In SNC4M, which is intended more to promote scientific literacy than to build a detailed background in a science discipline, it is particularly important to emphasize key skills and concepts without obscuring them by expecting students to memorize a multitude of facts and formulae.
- This Course Profile describes a science course in which students are encouraged to ask their own questions, and in many cases to find their own answers by inquiry – through experimentation, research, or the innovation of a device or process. Fundamental to the skill set of a scientifically literate person/citizen is the ability to ask quality questions and to interpret the answers critically, including identifying unstated assumptions.
- In this Course Profile there is an emphasis on developing students' ability to devise and carry out their own procedures within well-defined limits. The teacher's role is to decide what knowledge and skills students must have to proceed safely and successfully in a laboratory setting, without reducing their part in the process to being doers of investigations with entirely predictable results.

## Rationale for the Unit Sequence of the Course Profile

The expectations of the Science and Contemporary Societal Issues strand are interwoven (and identified) throughout the course and serve as the underlying principles for the four remaining strands from the curriculum. Discussion of the expectations dealing with the nature of science (SSV.01, SS1.01, SS1.02, SS1.03, SS1.04) should occur on an ongoing basis as the teacher introduces terms such as *principle, law, theory,* etc. Concepts such as the acquisition and evolution of scientific knowledge should take place within these discussions. The expectations that focus on the connections among science, technology, and contemporary societal issues are used to introduce and/or set the context for the units. In the activities suggested in the Course Overview, instances where these expectations provide the focus are indicated by listing the expectation code with the activity. Since the units in this course are distinct, with few natural connections, the Science and Contemporary Issues expectations are used to provide the unifying theme.

The distinct nature of the units allows for their presentation in any order. To reinforce from the outset of the course the multitude of STSE implications, the teacher should choose a starting point based on current societal issues from the local or global community.

The writers have chosen to start with the unit on Energy Alternatives and Global Impacts, given current issues surrounding energy, e.g., deregulation of electrical energy production, coal-fired generators, nuclear power plants, wind turbines. The focus of the strand is a comparison of the scientific principles of energy production by conventional and alternative methods. The costs, demand, environmental impacts, and contemporary societal issues related to energy use will also be explored.

The second unit in this Course Profile, Communications Systems, focuses on privacy and information access issues arising from the use of modern communications systems. The scientific principles and functioning of modern communications systems, e.g., the cell phone, satellite phones, global positioning systems, are also addressed. Within this unit, the evolution of scientific knowledge and scientific discovery are linked to communication technology.

Unit 3, Organic Products in Everyday Life, allows students to investigate the properties, benefits, and hazards of organic products used in their daily lives, industry, and agriculture. Comparisons of conventional and alternative products are made from both a personal and global/cultural perspective. Building on students' background from Grades 9, 10 and 11, this strand introduces the chemistry of common organic chemicals. It also serves as a review and extension of their laboratory and data management skills.

In the Unit 4, Pathogens and Disease, students explore the reproduction, transmission and biological effects of micro-organisms. The human immune response and the techniques for the prevention of disease are also examined. Current news items related to pathogens and disease, e.g., flu outbreaks, West Nile disease, *E-coli*, anthrax, and the many societal issues that surround local and global responses are used to set the context for the unit.

Unit 5 is the Final Assessment Task and includes a written exam component and a culminating activity based on a contemporary societal issue that relates to one or more of the four previous units. Students research, define, and develop an understanding of the chosen issue(s) and demonstrate their learning through both a written and an oral project. The Science in the News Portfolio developed throughout the course serves as both practice and resource for the written and oral project.

## Units: Titles and Times

| | | |
|---|---|---|
| * Unit 1 | Energy Alternatives and Global Impacts | 25 hours |
| Unit 2 | Communications Systems | 24 hours |
| Unit 3 | Organic Products in Everyday Life | 24 hours |
| Unit 4 | Pathogens and Disease | 25 hours |
| Unit 5 | Final Assessment Tasks | 12 hours |

* This unit is fully developed within this Course Profile.

## Unit Overviews

### Unit 1: Energy Alternatives and Global Impacts

**Time:** 25 hours

**Unit Description**

In this unit students examine some of the societal issues related to the production and consumption of electrical energy. Following an initial discussion, they develop an understanding of the scientific principles in power production technologies as well as the natural resources required for these technologies. Students research and evaluate the variety of both conventional and alternative power resources, their environmental impact, and the advantages and disadvantages of their use, always moving from an individual/local focus to a global one. They then begin to look more closely at alternative sources of energy and expand their skills of scientific inquiry through the development of a model of an alternative energy source. As part of the underlying theme of contemporary societal issues, students start collecting articles related to science issues for their Final Assessment Task portfolio.

**Unit Overview Chart**

| Activity/ Time | Focus | Learning Expectations | Assessment Categories |
|---|---|---|---|
| 1.1<br><br>2.5 h | Going Beyond the Gut Reaction | SSV.01, SSV.02, SSV.03, SS1.01<br>SS1.01, SSI.02, SS1.04, SS2.01, SS2.03, SS3.03<br>SIS.04, SIS.08 | Inquiry<br>Communication |
| 1.2<br><br>1.0 h | The Use of Electrical Energy | EAV.02, EA2.01<br>SIS.02, SIS.04, SIS.09 | Communication<br>Inquiry<br>Knowledge/Understanding |
| 1.3<br><br>5.0 h | The Physics of Generating Electricity | EAV.01, EA1.01, EA1.05, EA1.06<br>SIS.01, SIS.02, SIS.07<br>SSV.01, SSV.02, SS2.01 | Knowledge/Understanding<br>Inquiry<br>Communication |
| 1.4<br><br>2.5 h | Costs and Benefits of Conventional Energy Sources | EAV.01, EAV.02, EAV.03, EA1.01, EA1.04, EA2.03, EA3.01, SSV.02, SSV.03, SS2.02, SS3.02<br>SIS.05, SIS.06, SIS.08 | Knowledge/Understanding<br>Making Connections<br>Communication<br>Inquiry |
| 1.5<br><br>7.5 h | Alternative Energy Resources | EAV.01, EAV.02, EAV.03, EA1.01, EA1.02, EA1.03, EA2.02, EA2.05, EA3.02, EA3.03, EA3.04, EA3.05, SSV.01, SS1.05, SSV.02, SS2.02, SSV.03, SS3.03, CS2.03<br>SIS.05, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Making Connections<br>Communication |
| 1.6<br><br>6.5 h | End-of-Unit Task: The Energy Debate | EAV.01, EAV.02, EAV.03, EA1.02, EA2.04, EA3.05, SSV.03, SS3.01<br>SIS.05, SIS.06, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Making Connections<br>Communication |

## Unit 2: Communications Systems

**Time:** 24 hours

**Unit Description**

Throughout the unit, students consider how the advent of modern communication technology has altered the way the world is viewed. This unit develops students' understanding of the fundamental scientific principles of modern communications systems. Students, through laboratory investigations, explain how modern communications systems function. They evaluate the advantages and disadvantages of such systems for both the individual and society.

**Unit Overview Chart**

| Activity/ Time | Focus | Learning Expectations | Assessment Categories |
|---|---|---|---|
| 2.1<br><br>4 h | General Science of Communication | CSV.01, CS1.01, CS1.03, CS1.04, CS1.05, CS2.02, SSV.01, SS1.01, SS1.02, SS1.03<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Communication |
| 2.2<br><br>4 h | Science Behind Communication Technology | CSV.01, CSV.02, CS1.02, CS1.07, CS2.01, CS2.04, SSV.01, SSV.02, SS1.04, SS1.05, SS1.06, SS2.01, SS3.03<br>SIS.01, SIS.02, SIS.04, SIS.05, SIS.06, SIS.07 | Communication<br>Inquiry<br>Knowledge/Understanding<br>Making Connections |
| 2.3<br><br>5 h | Using the Communication Technology | CSV.02, CSV.03, CS2.01, CS3.01, SSV.02, SS2.01<br>SIS.04, SIS.05, SIS.06, SIS.07 | Making Connections<br>Inquiry<br>Knowledge/Understanding<br>Communication |
| 2.4<br><br>5 h | Communication Issues | CSV.03, CS3.01, CS3.02, CS3.03, SSV.02, SSV.03, SS2.03, SS2.04, SS3.02<br>SIS.04, SIS.05, SIS.06, SIS.07 | Making Connections<br>Inquiry<br>Communication |
| 2.5<br><br>6 h | End-of-Unit Task: Development of a Device | CSV.01, CSV.02, CSV.03, CS2.03, CS1.03, CS1.04, CS1.06, CS1.08, CS1.09, CS2.01CS3.01, CS3.02, CS3.03, SS3.01, SS3.02, SSV.03, SS3.01, SS3.02<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.08 | Inquiry<br>Making Connections<br>Knowledge/Understanding<br>Communication |

| Key to Abbreviations in Unit Overviews |
|---|
| K/U = Knowledge/Understanding<br>I = Inquiry<br>C = Communication<br>MC = Making Connections |

### Suggested Activities

**General Science of Communication**

2.1.1. Students express their initial views of the benefits and dangers of modern communication technology. They are introduced to the End-of-Unit Task with reference to the Final Assessment Task and the ongoing Science in the News Portfolio.

2.1.2. Students investigate relationships among length, period, and frequency using wave machine or ripple tank (to demonstrate wave properties leading to electromagnetic spectrum). Include explanations of observation, inference, theory, and causality. (SS1.01).

2.1.3. Students investigate production and transmission of electromagnetic radiation through various mediums including identification of total internal reflection (fibre optics). Include both the visible and non-visible spectra, e.g., IR, radio waves, microwaves. Students prepare a wall chart outlining wavelength and frequencies of the spectrum and related technologies associated with each range. Relate spectra to evidence for the Bohr model of the atom and the evolving model of the atom. (SS1.02, SS1.03)

**Assessment** Lab Reports (I, C), Written Quiz (K/U)

**Science Behind Communication Technology**

2.2.1. Students participate in a teacher-led lesson on transformations for transmission and reception of communication, including the use of invisible light, e.g., communication using infra-red light, if appropriate materials are available. Demonstrate some of the general properties of communication devices and the scientific principles behind them, e.g., cell phone, IR remote, RF remote, Sonic Finder, GPS, the Internet. Students consider the impact of this technology on society. (SS1.4, SS3.03)

2.2.2. Students discuss how the growth of scientific knowledge is related to the development of various forms of communication technology: sound (sonar, ultra sonic, sub sonic, audible), light (electro-magnetic radiation, visible and non-visible in communications), semi-conductors (space travel, computers, data projectors). They also discuss what led to the development of various forms of communication technologies. (SS1.06)

2.2.3. Students research and discuss analog communication vs. digital and basic scientific principles of each. Students decide which of these technologies is appropriate for specific applications, e.g., sound communication, photographs, data, replication technology. (SS1.05)

2.2.4. With teacher assistance, students identify the scientific principles involved in GPS, ultra-sound, Sonic Finder, RF and IR remote, cell phone, night vision goggles, the Internet. (SS1.05)

**Assessment** Written Quiz (K/U, MC)

**Using the Communication Technology**

2.3.1. Students identify some of the variables that affect specific communication technologies, choose one, and design an experiment related to it, e.g., antenna length and clarity of radio reception, effectiveness of walkie-talkies as distance between them increases, quality of satellite reception as obstructions are placed in front of the dish, reception of digital vs. analog cell phones. (SS2.01)

2.3.2. Students use Internet and print resources to research societal issues related to communication in preparation for the next activity.

**Assessment** Lab Reports (MC, I, C), Report on Research (K/U, I, C)

**Communication Issues**

2.4.1. Using surveys, Internet research, and interviews, students investigate the impact of new communications systems on individual lifestyles. In particular, they focus on home and workplace influences. They interview people covering a wide range of ages. (SS2.03, SS2.04)

2.4.2. Students discuss privacy issues with respect to the Internet (anonymity), cell phones and portable phones (eavesdropping) and surveillance technologies. In particular, the risks and benefits are assessed, and responsibilities for ethical use considered.

2.4.3. Research health risks of communication devices (cell phones) and/or medical devices (ultra sound). (SS3.02)

**Assessment** Lifestyle/Health Risk Report (MC, I, C)

**End-of-Unit Task: Development of a Device**

2.5.1. Students design, construct, and test a simple communication device, e.g., a modulated laser communicating with a photodiode, that transforms energy from one form to another and explain the principles involved in its operation.

2.5.2. Students write a report on a recent communication innovation/device and include the relevant transmission type (e.g., sound, light, electrical) its frequency, and wavelength where relevant. Students also conduct a qualitative risks/benefits analysis and report on the impact of this new technology on individual lifestyles, privacy, and global communication systems in general. (SS3.01, SS3.02)

2.5.3. Unit Test

**Assessment** Oral Presentation – theory and hypothesized use of device (K/U, MC, C), Prototype – development, testing, effectiveness (I, K/U), Unit Test (K/U, MC)

**Resources**

CRTC – http://www.crtc.gc.ca/
Information related to the Canadian Radio and Television Commission

Canada's SchoolNet – http://www.schoolnet.ca/home/e/services.asp
General source of information about education resources including Internet accessibility

Davidson Education Site – http://webphysics.davidson.edu/Applets/Applets.html
Doppler effect applet.

Glenbrook South The Physics Classroom –
http://www.glenbrook.k12.il.us/gbssci/phys/Class/BBoard.html
covers most Physics topics.

## Unit 3: Organic Products in Everyday Life

**Time:** 24 hours

**Unit Description**

Students examine the properties, benefits, and hazards of representative everyday organic products, and the use of these products in personal daily life, industry, and agriculture. There is an emphasis on emulsifying agents, pharmaceutical products, fertilizers and pesticides. Students use appropriate scientific procedures and tools to investigate the separation of crude oil, production of emulsifying agents and chemical action of pharmaceutical products. Students evaluate the social and environmental implications of substances such as pharmaceuticals, pesticides, and fertilizers. In the End-of-Unit Task, students design an experiment, collect and analyse data, assess the environmental impacts and offer resolutions. The End-of-Unit Task is introduced early to ensure sufficient time to collect and analyse data and information from a variety of sources.

**Unit Overview Chart**

| Activity/ Time | Focus | Learning Expectations | Assessment Categories |
|---|---|---|---|
| 3.1<br><br>4 h | Introduction to Organic Products | OPV.01, OP1.01, OP1.02, SSV.01, SS1.05<br>SIS.01, SIS.02, SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |
| 3.2<br><br>3 h | Separation of Crude Oil | OPV.01, OPV.02, OP1.05, OP2.03<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |

| Activity/ Time | Focus | Learning Expectations | Assessment Categories |
|---|---|---|---|
| 3.3<br><br>2 h | The Production and Nature of Emulsifying Agents | OPV.01, OPV.02, OP1.03, OP1.04, OP2.01, OP2.02<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Communication |
| 3.4<br><br>6 h | The Properties and Actions of Pharmaceutical Products | OPV.01, OPV.02, OPV.03, OP1.07, OP1.08, OP2.05, OP3.03, SSV.02, SSV.03, SS2.01, SS3.02, SS3.03, SS3.04<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.05, SIS.06, SIS.07, SIS.08, SIS.09 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |
| 3.5<br><br>5 h | Fertilizers and Pesticides | OPV.01, OPV.02, OPV.03, OP1.06, OP2.04, OP3.01, OP3.02<br>SIS.01, SSV.02, SS2.04, SIS.02, SIS.03, SIS.04, SIS.05, SIS.06, SIS.07, SIS.08, SIS.09 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |
| 3.6<br><br>4 h | End-of-Unit Task Analysis of the Impact of an Organic Product on the Environment | OPV.01, OPV.02, OPV.03, SSV.02, SS2.02<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.05, SIS.06, SIS.07, SIS.08 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |

## Suggested Activities

**Introduction to Organic Products**

3.1.1. Students rotate through a variety of lab stations to assess background skills and knowledge, e.g., safety procedures, appropriate disposal of chemicals, appropriate use of apparatus, measuring accurately.

3.1.2. Students work in small groups to create a concept map identifying and defining representative everyday organic products. They may need to use reference materials, e.g., the Internet, textbooks, videos, magazine articles.

3.1.3. Students participate in a teacher-directed lesson accompanied by a demonstration to compare the properties and structure of organic and inorganic substances. Students create a Venn diagram or T-chart outlining the similarities and differences.

3.1.4. Students are introduced to the End-of-Unit Task. The task involves designing an experiment to assess the impact of an organic substance on the environment, e.g., impact of fertilizers on the growth of bean plants, or phosphate detergents on the aquatic environment. Students may conduct an experiment themselves, use a computer simulation, or research a study already completed.

Discuss expectations for the End-of-Unit Task and develop a rubric for assessment in collaboration with the students. Students are provided with one week to generate a proposal outlining their idea. Time will be allotted throughout the unit for data collection.

3.1.5 Students research the discovery of bucky balls and their role in the development of nanotechnology. Students summarize their findings in a report outlining what bucky balls are, how they were discovered, and the role they play in nanotechnology. (SS1.05)

**Assessment** Venn Diagram (C, K/U), Proposal (I), Report (C, I, MC)

**Separation of Crude Oil**

3.2.1. Students review reference material in order to create a flowchart that illustrates the scientific principles involved in the separation of crude oil into its fractions and the physical and chemical properties of the derivatives.

3.2.3. Students use a computer simulation to illustrate the scientific principles upon which fractional distillation of petroleum products are based. An alternative or additional activity may be to conduct an experiment to demonstrate the process of distillation.

3.2.4. Students participate in a teacher-led discussion to explain how the discovery of crude oil separation techniques has impacted us globally, e.g., the production of plastics or synthetics used for the manufacturing of clothing. Students discuss issues surrounding the use of natural resources to manufacture products such as plastics and the appropriate disposal of these products. Students summarize the key points in a note, e.g., point form, graphic organizer, embedded note.

**Assessment** Flowchart (K/U, C), Lab Report (I, MC, C), Note (C, K/U)

**The Production and Nature of Emulsifying Agents**

3.3.1. Students create and submit a proposal outlining the details of the experiment for the End-of-Unit Task. The teacher conferences with the student to ensure the proposal is appropriate and feasible.

3.3.2. A teacher-directed lesson describes properties of emulsifiers, provides examples of their use in personal daily life and industry, and explains how they work. Students further their understanding by using reference material, e.g., textbook or the Internet, and record their findings.

3.3.3. Students design and conduct an experiment to examine the nature of emulsifiers. They can demonstrate the production of an emulsifier, e.g., preparation of mayonnaise or hand cream, or examine how emulsifiers function, e.g., use a control to demonstrate why and how an egg is used to make a cake. Since there is an opportunity for students to perform many different experiments, individual students provide the class with a brief synopsis of their experimental procedure and results.

3.3.4. The teacher conducts a Socratic lesson to explain the process of soap making (including the principles of bonding related to the making of detergents) and the relationship between the structure and the function of a soap molecule. The lesson is accompanied by a demonstration to help explain the effect of dish detergent on fats.

3.3.5. Students use illustrations to help explain how soap is produced and construct a model of a soap molecule identifying all the parts, including the hydrophilic and hydrophobic ends.

**Assessment** End-of-Unit Task: Proposal (I, C), Lab Report (I, C),
Illustrations and Model (K/U, C), Quiz (K/U)

**The Properties and Actions of Pharmaceutical Products**

3.4.1. Students review information (recent and past) from videos, periodicals, the Internet, and other sources to discuss the dangers of UV radiation and the role of sunscreen in protecting the skin. Students form an opinion and support it with scientific evidence explaining whether or not they will use sunscreen in the future. (SS2.01)

3.4.2. Students select and research a pharmaceutical product used to protect against a human pathogen or disease. They construct a flow chart to clearly describe how it works, its historical development, how it is produced, what drug or treatment it has replaced, who funded the development, e.g., private sector, government, how long it has been on the market, any side effects it may have, and the cost involved to manufacture or to purchase it. (SS3.02, SS3.04)

3.4.3. Students design and conduct a lab investigation related to the production and/or properties of a pharmaceutical product, e.g., production of aspirin, or use thin layer chromatography to analyse analgesics.

3.4.4. Students research and debate issues related to a pharmaceutical product used to treat a disease, e.g., the positive and negative effects to society and/or environment, of the societal needs/demands that spurred its production. Students should be directed to consider global ramifications, both positive and negative, of the use or production of the product. (SS3.02, SS3.03)

**Assessment** Supported Opinion (K/U, I, C, MC), Flow chart (K/U, C),
Lab report (MC, I, C), Debate (C, MC)

**Fertilizers and Pesticides**

3.5.1. Students work in small groups to research/brainstorm a variety of chemicals used in agriculture. They use thin layer chromatography to separate a variety of agricultural chemicals. The teacher must select products which are safe for students to use.

3.5.2. Students work individually or in pairs to prepare a pamphlet displaying information about a chemical used in the garden. Students determine the following characteristics about the chemical: product name, chemical name, structural formula, solubility, physical properties, toxicity, chemical properties, how it works, where it is used, biodegradability, and method of disposal.

3.5.3. The focus of this activity is to investigate alternate farming/gardening practices used in various cultures and their global implications. Students work in pairs using research and/or telephone/ personal interviews; one individual investigates conventional farming practices and pest control methods while the other focuses on alternate methods. Students work collaboratively and construct a Venn diagram illustrating the similarities and differences. (SS2.04)

3.5.4. Students participate in a teacher-led discussion analysing the costs and benefits associated with chemical and alternative pest control methods, including their global impact on the environment. Students summarize the information.

3.5.5. The Supreme Court of Canada recently decided to uphold the power of municipal governments to restrict the use of pesticides within their communities. Students write a letter to the city council in support or disagreement with the Supreme Court's decision. Students support their opinion with scientific evidence and assess the effect on local companies, municipalities, and other countries.

**Assessment** Pamphlet (I, C, MC), Venn diagram (K/U, C, MC), Letter (C, K/U, MC)

**End-of-Unit Task: Analysis of the Impact of an Organic Product on the Environment**

3.6.1. Students submit a report investigating the impact of an organic substance on the environment. The report contains a proposal outlining the details of the experiment, data collection and analysis, benefits and risks associated with the use of the product, societal and environmental implications, and possible alternatives. (SS2.02)

3.6.2. Unit Test

**Assessment** Report (C, I, MC), Unit test (K/U, MC)

**Resources**

Bucky Balls – http://qlink.queensu.ca/~7jld/Chem210/index.htm
Nanotechnology and bucky balls

Marshall Brain's How Stuff Works – www.howstuffworks.com
Function of sunscreen, pharmaceutical products

Links to Chemistry Experiments, Demonstrations
– www.chemistrycoach.com/Links%20to%20chemistry_experiments.htm
Soap and aspirin production, thin layer chromatography (agricultural chemicals)

Pesticide Reduction is Possible – http://www.wwfcanada.org/satellite/prip/index.html
Pesticide use and related issues as posted by the World Wildlife Fund

The Skinny on Sunscreen Testing – www.discovery.com/area/skinnyon/skinnyon970704/skinny1.html
Sunscreen article

## Unit 4: Pathogens and Disease

**Time:** 25 hours

**Unit Description**

This unit involves the study of microorganisms and their role in disease. Transmission of disease and prevention of disease are discussed while growth and control of growth are explored through inquiry activities. The human immune response and the use of antibiotics are presented, and the implications surrounding misuse or overuse of antibiotics is researched. Bacteria are also discussed as agents of genetic manipulation and as keys to survival because of their role as decomposers in the food chain.

**Unit Overview Chart**

| Activity/ Time | Focus | Learning Expectations | Assessment Categories |
|---|---|---|---|
| 4.1<br><br>2 h | What are Pathogens? | PDV.01, PD1.01, PD1.03, PD1.05, PDV.03, PD3.01, PD3.05, SSV.03, SS3.03<br>SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/Understanding<br>Communication<br>Making Connections |
| 4.2<br><br>3 h | Bacterial Growth | PDV.01, PDV.02, PD1.01, PD1.02, PD2.01<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.08 | Knowledge/Understanding<br>Communication<br>Inquiry<br>Making Connections |
| 4.3<br><br>9 h | Bacterial Controls and Human Immune Response | PDV.01, PDV.02, PDV.03, PD1.04, PD1.05, PD1.06, PD2.03, PD2.04, PD2.02, PD3.02, SSV.01, SS1.02, SS1.04<br>SIS.01, SIS.02, SIS.03, SIS.04, SIS.05, SIS.06, SIS.07, SIS.08 | Knowledge/Understanding<br>Communication<br>Inquiry<br>Making Connections |
| 4.4<br><br>3 h | Is Bacteria Good or Bad? | PDV.01, PD1.01, SSV.01, SSV.02, SSV.03, SS1.02, SS1.03, SS1.04, SS1.05, SS2.01, SS3.01<br>SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/Understanding<br>Inquiry<br>Making Connections<br>Communication |
| 4.5<br><br>3 h | Pathogens, Diseases and Issues | PDV.02, PDV.03, PD2.05, PD3.01, PD3.03, PD3.04, SSV.01, SSV.02, SSV.03, SS1.04, SS1.05, SS2.03, SS2.04, SS3.03<br>SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/Understanding<br>Inquiry<br>Communication<br>Making Connections |
| 4.6<br><br>5 h | End-of-Unit Task: Controlling the Spread of Disease | PDV.01, PDV.02, PDV.03, SSV.02, SS2.02, SS2.03<br>SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/Understanding<br>Communication<br>Inquiry<br>Making Connections |

### Suggested Activities

**What are Pathogens?**

4.1.1. Working in groups with chart paper, students participate in a "graffiti" activity to answer focus questions that act as a diagnostic assessment to determine what they already know about pathogens and disease. A discussion about pharmaceuticals research may be appropriate. Use the results to lead to a teacher-directed lesson – kingdom Monera: bacteria and virus (structure), roles in the ecosystem (decomposer, parasite) terminology – pathogen, non-pathogenic viruses/bacteria, pathogenesis.

4.1.2. Through a case study, students read an article related to vaccination programs (possibly in the local community) and as a class discuss the global implications and funding process for such programs. They may refer back to the assignment on pharmaceuticals used in the last unit. The teacher assigns a mini research project for the class to gather data on the impact on populations of the use of vaccines to control disease. Data is collected and posted on a bulletin board for class reference. Discuss news articles related to pathogens and disease for the culminating task portfolio and plan presentation dates for articles for this unit. (SS3.03)

4.1.3. Students participate in a brief teacher-led lesson on transmission of pathogens followed by a jigsaw activity. Articles that illustrate different types of bacteria/virus (both helpful and harmful) and how they are transmitted (e.g., airborne, insect borne, water borne, food borne, or sexually transmitted), are read and summarized in small expert groups and then shared with home group members. Construct a concept map of pathogens: types, transmission, impacts.

4.1.4. The teacher introduces the End-of-Unit Task: An investigation on the use of antibacterial agents/sterile techniques or pharmaceuticals to prevent the spread of pathogens in the home/workplace/community/global population. This will involve culturing bacteria and testing an antibacterial agent as chosen by the student (not mouthwash as it will be done by the class) and testing the hypothesis proposed by the student. (Activity 4.6.1)

**Assessment** Checklist for Research (C, MC), Concept Map of Pathogens (K/U, C, MC), Quiz (K/U)

**Bacterial Growth**

4.2.1. Students review related safety procedures and then design and develop an investigation involving locations around the school where ideal conditions for bacterial growth exist. Cultures will require 36-48 hours to culture on nutrient agar plates. Culturing procedures and safety concerns should be discussed at some length prior to doing this activity. Cultured plates should be sealed and secure once inoculated. Proper disposal of cultured plates should be discussed with Health and Safety representative and done following school board policy. Alternately, use a virtual bacteria growth program or create hypothetical growth data and analyse the data.

4.2.2. The teacher leads students in a lesson on cycles of representative pathogens, including explanation of gram positive bacteria and gram negative bacteria, and the modes of transmission of bacteria. The use of prepared microscope or microviewer slides would enhance this lesson. Students create a comparative analysis (chart/map) of the modes of transmission/life cycles of different types of pathogens.

**Assessment** Lab Report (I, C, MC), Comparative analysis (MC, C, K/U,)

**Bacterial Controls and Human Immune Response**

4.3.1. Students design an investigation to answer a question based on the use of mouthwash to control bacterial growth (pathogenesis). Bacteria will require 36-48 hours to culture on nutrient agar plates. Continue to address safety concerns raised in Act 4.2.1.

4.3.2. With teacher direction, students describe the human immune response (primary and secondary) including all the body's natural defence mechanisms for fighting infection. Include effects of vaccines on human response. Discuss how scientific discovery leads to alternative medicines and technologies. (SS1.04)

4.3.3. In small groups, students read, summarize and present information from various articles highlighting non-medicinal ways to prevent contraction of pathogenic disease and the use of antibiotics, antiseptics and other drug therapies to control pathogenesis.

4.3.4. Students discuss the misuse of antibiotics in the control of infection; they read media articles involving the re-emergence of diseases thought to have been killed off (resistant strains of bacteria, viral mutations). (SS1.02)

**Assessment** Lab Report (C, MC, I), Article Information (K/U, C), Quiz, (K/U, MC)

**Are Bacteria Good or Bad?**

4.4.1. Teacher-directed lesson: Are Bacteria useful? Review the role of bacteria in the food chain, in yoghurt, microbes cleaning oil spills, etc. Other ways of introducing helpful bacteria are microviewer slide activities or articles and a jigsaw or group type review.

4.4.2. Conduct a teacher-led lesson or an overview of the growth of science with increasing information on the structure of DNA and the role of bacteria in manipulating genes for the production for example of hormones, and genetically modified foods. Discuss perception of gene splicing and gene therapies by different interest groups in the community. Students create a timeline for genetic therapies starting with the discovery of DNA. (SS1.02. SS1.03, SS1.04, SS1.05, SS2.02, SS3.01)

4.4.3. Activity: Use DNA model kits to construct basic DNA molecules. Students then design and carry out a procedure that shows how gene splicing might occur using the DNA model kits. Follow up with a discussion of plasmid use in gene splicing and manipulation of DNA codes.

**Assessment** Timeline (C, K/U, MC), Quiz (K/U, MC), Gene Splicing Procedure (I, MC)

**Pathogens, Diseases, and Issues**

4.5.1. Students discuss the control of pathogenesis. The focus should fall on workplace and industrial settings – moving from antibacterial agents towards sterile techniques.

4.5.2. Students move through various stations and practise aseptic/sterile techniques such as the use of alcohol (other chemicals), flame, radiation (UV lamp), pressure cooker (autoclave). Demonstration: Louis Pasteur – the use of pasteurization techniques. A chart summarizing the methods, effects on pathogens and appropriate use of the different techniques should be produced by each student.

4.5.3. The teacher conducts a lesson covering the technologies of disease control and their impacts on society. Students should research the impact of these techniques of food production and marketing and prepare a one-page advertisement that describes their method of choice for preparing or preserving food safely. (SS1.04. SS1.05, SS2.03, SS2.04, SS3.03)

**Assessment** Chart (I, C, MC), Advertisement (K/U, C, MC)

**End-of-Unit Task: Controlling the Spread of Disease**

4.6.1. Students are presented with the problem of having to prevent the spread of pathogens in a specific work location. They create a focus question, design a procedure and carry out an investigation. The same precautions for culturing bacteria presented in Activity 4.2.1 should be re-emphasized. Data should be collected from the investigation and analysed in terms of implications for the work site, the community, and globally. (Who is responsible for maintaining the aseptic environment? What are the impacts of improper maintenance of the work site?). (SS2.02, SS2.03)

4.6.2. Unit Test: Knowledge of the structure of pathogens, transmission, pathogenesis – disease, immune response and control.

**Assessment** Lab report (I, MC, C), Unit test (K/U, MC)

**Resources**

Institute of Infection and Immunity – http://www.cihr.ca/institutes/iii/iii_e.shtml
Information on funding for research

Emerging Infectious Diseases – http://www.cdc.gov/ncidod/EID/tauxe.htm
Articles on pathogens and transmission

Plants, Pathogens, and People – http://nautilus.outreach.uiuc.edu/ppp/
Articles on pathogens and transmission

Avigen – http://www.avigen.com
Information on non-pathogenic viruses in gene therapy

Anthrax as Disinformation – http://nov55.com/athr.html
Anthrax misinformation in the media

Fortune City, Useful Bacteria – http://victorian.fortunecity.com/bronte/205/bacteria.html
Information on useful bacteria

EnviroSense, New Process User Bacteria to Transform Waste Gases Into Useful Chemicals – http://es.epa.gov/techinfo/facts/nu-prcss.html
Bacteria to transform wastewater gases

Variations in Life Science, Video Unit 3: Useful Allies, Beneficial Bacteria – http://www.learn.motion.com/lim/var/des3.html
Information on useful bacteria

Biotech/Biomedical – http://biotech.about.com/library/weekly/aa033100b.htm
Antibiotic-resistant bacteria

http://ci.mond.org/9510/951010.html
Transgenic livestock in agriculture and medicine

TV Features, Xeno Transplants: Promise and Peril – http://www.gist.com/tv/article.jsp?adf=dn032301.adf
Frontline: Organ Farm

## Unit 5: Final Assessment Task

**Time:** 12 hours

**Unit Description**

Throughout the course, students collect and critique science-related news articles. Towards the end of the course, they select an issue that is important to them from among the news articles collected, and produce an in-depth critical analysis. The student and the teacher negotiate the format of the final product; this should reflect student learning styles. A comprehensive examination is completed.

**Final Assessment Task Overview Chart**

| Activity/ Time | Focus | **Learning Expectations | Assessment Categories |
|---|---|---|---|
| 5.1<br><br>5 h | Portfolio of Science in the News | OPV.01, OPV.02, OPV.03, PDV.01, PDV.02, PDV.03, EAV.01, EAV.02, EAV.03, CSV.01, CSV.02, CSV.03, SSV.01, SSV.02, SSV.03 SIS.04, SIS.05, SIS.06, SIS.07 | Knowledge/ Understanding<br>Communication<br>Making Connections |
| 5.2<br><br>5 h | In-Depth Critical Analysis of a Current Issue | OPV.01, OPV.02, OPV.03, PDV.01, PDV.02, PDV.03, EAV.01, EAV.02, EAV.03, CSV.01, CSV.02, CSV.03 SIS.04, SIS.05, SIS.06, SIS.07, SSV.01, SSV.02, SSV.03 | Knowledge/ Understanding<br>Communication<br>Making Connections<br>Inquiry |
| 5.3<br><br>2 h | Exam | OPV.01, PDV.01, EAV.01, CSV.01, SSV.01, OPV.03, PDV.03, EAV.03, CSV.03, SSV.03 | Knowledge/ Understanding<br>Making Connections |

** The expectations listed will not all be addressed by an individual student. Since the Final Assessment Task allows for student choice of emphasis, only those expectations from the chosen unit(s) will be addressed.

Suggested Activities

5.1.1. Students build a portfolio throughout the course based on selecting fifteen (15) articles from the media, e.g., newspaper, journal, science periodical, websites, relating to a scientific issue. They collect three articles related to each of the four units and an additional three that they find interesting. In completing a commentary on each article, they state the issues surrounding the article in the form of an open-ended question, and critically assess the contained information following a research-analysis approach. They briefly evaluate the social, economic and political/environmental impact on society from at least two opposing perspectives involved in the issue. They also briefly assess the strengths and limitations of scientific knowledge and procedures as a means of resolving the issues. Every three weeks, students are given the opportunity to present one of their articles to a small group of peers. Peers can provide assessment of the critical comments as well as further insight into the issue. The structure of the group should not be the same for each presentation session.

5.2.1. Students critically assess and research information on one of the portfolio articles using a research-analysis approach format. The issue chosen should be connected to any two of the four units/strands of study: Communication Systems; Organic Products; Pathogens and Disease; and Energy Alternatives and Global Impact. They gather relevant data (primary or secondary) and develop a timeline of evolving knowledge related to the issue. They also perform an in-depth assessment of the strengths and limitations of scientific knowledge and procedures as a means of resolving the issue. They perform an in-depth evaluation of the social, economic and political/ environmental impact on society, from two opposing perspectives involved in the issue. After analysing the data, students make a personal statement related to the issue using relevant data to support their argument. Students present their material in an appropriate and interesting way, e.g., visual demonstration, essay, flow chart, web page, computer presentation.

5.3.1. Exam: Given the destination designation of this course, a comprehensive examination covering a large portion of the course content is appropriate. In that scientific literacy is a key goal of this course, the exam should not be strictly knowledge driven. The STSE expectations need to be stressed. An open-note exam could be considered.

**Assessment** Portfolio (K/U, C, MC); Critical Analysis (K/U, I, C, MC); Exam (K/U, MC)

**Resources**

The following provide useful guidelines for developing commentaries and the critical analysis:

Ritter, Bob, D. Plumb, F. Jenkings, H. van Kessel, and A.J. Hirsch. *Nelson Science 10.* Toronto: Nelson Thomson Learning, 2001. ISBN0-17-607501-1 – for the PERC method of analysis and other suggestions for student research and communication

White, Fiona et al. *Course Profile Science, Grade 10 Academic, Public Board, 2000.* Teacher Support Material 3C: The 5Rs Process (Recognition, Research, Resolution, Responsibility, Review) for Environmental Issues. p. 12.

## Teaching/Learning Strategies

The over-riding aims of this course are to develop scientific literacy and to prepare students for entry into non-science related programs at the post-secondary level. Students explore a wide range of science topics and the contemporary societal issues surrounding them. It is important that teaching/learning strategies be designed to give students opportunities to be actively involved in their own learning and to relate the concepts and skills they develop to their present and future life beyond the classroom. A variety of instructional strategies is needed to provide learning opportunities that accommodate a wide range of interests, learning styles, and ability levels.

In planning activities for this course, ensure that students have:

- opportunities to work individually, in pairs or small groups, and as a whole class;
- both direct instruction and opportunities for open-ended exploration;
- opportunities to interpret observed data and develop concepts for themselves;
- tasks in which they define some of the parameters;
- opportunities to communicate using standard formats, e.g., lab reports, bulletin board displays, presentation software, as well as opportunities to choose and develop the format;
- opportunities to design, perform, and evaluate experimental activities;
- opportunities to acquire knowledge and apply that knowledge in a variety of contexts;
- opportunities to complete activities related to their different learning styles.

Field trips and guest speakers are an integral part of teaching/learning strategies. These must be closely connected to the expectations of the course, the resources of the community, and the interest of the students. Field trip sites and guest speakers are suggested throughout the Course Profile. Teachers are reminded to follow board policy in arranging for these aspects of the activity.

Students bring a range of background and experiences in science to this course. One of the most important ways to engage students in the learning process is to take advantage of student interests when developing and extending activities and when providing examples of applications. By focusing on student questions, the teacher can learn of their interests and in some situations, these questions can be given back to students as research challenges.

The teaching/learning strategies as developed in this Course Profile provide students with the skills and knowledge necessary to allow them to successfully complete the End-of-Unit Task. The End-of-Unit Tasks together lay the ground work to prepare the students for the Final Assessment Task. The Final Assessment Task connects the units and meets the three goals of all science courses.

The teaching/learning strategies assist with the development of students' literacy skills by:

- using written material with immediate and lasting value and relevance to students;
- allowing students to read documents such as instruction manuals, assembly guides and trouble-shooting manuals for understanding;
- creating step-by-step instructions for other students to follow;
- using diagrams, charts, and graphic organizers for communication.

The teaching/learning strategies support students in becoming educated consumers by:

- using resources such as buyers' guides, consumer reports and articles from current magazines;
- discussing how to make informed choices, both at home and in the workplace;
- testing consumer products;
- making connections among personal, workplace and community responsibilities.

Experimental and research inquiry skills are enhanced by:

- manipulating apparatus;
- collecting and analysing data;
- locating and accessing information from a wide variety of resources in addition to textbooks;
- clarifying misconceptions regarding commonplace phenomena;
- relating skills to everyday situations requiring those skills;
- documenting skills required for a variety of careers.

Media literacy skills are developed through:

- using newspapers, radio, and television to locate current information and issues;
- relating information to personal situations and interests.

### Use of Computer Technology

Computer applications should be included in activities whenever they enhance student learning by enabling them to complete work more efficiently or to complete work that otherwise could not be done. A wide variety of software tools could be used to record and display information. Examples include word-processing; spreadsheets, e.g., class data from measurements taken in the laboratory; graphics, e.g., flow charts, concept maps, diagrams in place of written reports of investigations; databases, e.g., incorporating observations taken by small groups or individuals; collections of data from replicated experiments; and presentation. Probe-ware should be used to collect data, e.g., to permit replications of experiments where complex procedures would limit students to single experiments. Simulations may substitute for experiences but should not be used to replace direct experiences that are safe, ethical, and available. The portability of calculator-based laboratory systems makes them useful for work outside the classroom.

Online communication between teacher and students could occur throughout the course. Homework assignments and answers could be posted, along with reminders about upcoming assignment deadlines and evaluation dates. Sample exam questions could be included and links made to pertinent sites, covering a variety of STSE topics. Online tutorials could be arranged and part of a later unit in the course could be presented online. Many of these experiences will mirror what students will encounter at college or university.

### Learning Skills

While not counted towards students' achievement of course learning expectations, Learning Skills – Works Independently, Teamwork, Organization, Work Habits/Homework, Initiative – are keys to success in school and beyond. As with other skills, they should be taught, practised, and assessed in the science classroom. Variety is essential: individual assignments foster independence; small-group co-operative learning experiences (including laboratory work done in pairs) provide opportunities to develop teamwork.

### Making Connections

The knowledge expectations of this course have intrinsic worth as useful information, but they also serve as vehicles for developing other expectations:

- acquisition of knowledge through inquiry develops inquiry skills;
- connecting science concepts to social and environmental issues develops the necessary habits of mind for making connections;
- applying scientific knowledge to practical problems makes connections to technology;
- considering how scientific knowledge is acquired, e.g., through tools and equipment use, helps develop an understanding of the role that technology plays in scientific discovery.

During their study of science, students should be encouraged to develop awareness of the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

## Assessment & Evaluation of Student Achievement

Seventy per cent of a student's final grade will be based on assessments and evaluations conducted throughout the course. Thirty per cent of the grade will be based on a final evaluation in the form of an examination, performance, essay, and/or other methods of evaluation. Assessment is a process of gathering information and providing descriptive feedback about student learning. Evaluation is the process of judging work and assigning a value, based on established criteria.

The purpose of assessment is to improve student learning. This means that judgements of student performance must be criterion-referenced so that feedback can be given that includes clearly expressed next steps for improvement. Tools of varying complexity can facilitate this.

- For assessing/evaluating a test or quiz, a marking scheme is used.
- Where completion or non-completion is the issue, a checklist is sufficient.
- Where quality of performance is easily identifiable, a rating scale can be used.
- For more complex tasks, the criteria may be incorporated into a rubric where levels of performance for each criterion are stated in language that can be understood by students.

Rubrics describe performance of a generalized skill (such as Inquiry) or can be task-specific. Checklists, rating scales and rubrics become powerful tools for improving learning when students understand the criteria and levels of performance before they undertake the task. Discussion of the criteria for success should be part of every learning task. It is often beneficial to involve students in the development of the rating scale or rubric (identifying criteria and setting levels of achievement in terms they understand).

Assessment must be embedded within the instructional process throughout each unit rather than being an isolated event at the end. Often, the learning and assessment tasks are the same, with formative assessment provided throughout the activity. In every case, the desired demonstration of learning is articulated at the beginning and the learning activity is planned to make that demonstration possible. When planning learning activities for Science, this process of beginning with the end in mind helps to focus on the expectations and to reduce the inclination to expand what is taught beyond what is required by the curriculum.

Assessment, Evaluation and Reporting are tied to the learning expectations and the Achievement Chart for Science *(Ontario Curriculum, Grades 11 and 12: Science, 2000*, pp. 172-175). Every learning activity and its assessment should allow teachers to collect data for making judgements about performance in one or more of the Achievement Categories: Knowledge/Understanding, Inquiry, Communications, and Making Connections. Within each unit and across the course, teachers must collect sufficient data (in kind and number) to make valid judgements about each student's performance in all categories.

In the end, the final grade must be expressed as a percent based on the Achievement Levels. That judgement must be based on each student's demonstration of the criteria, not relative to other students' performances. Final evaluations should reflect the teacher's informed, professional judgement of each student's most consistent level of performance in each category of the Achievement Chart.

A wide and balanced range of assessment strategies is needed to accommodate the varied learning styles of all students, to meet the needs of exceptional students, and to encompass a broadened range of knowledge and skills expectations.

There must be opportunities for students to demonstrate learning at all levels of the Achievement Chart. With clearly articulated criteria, students become partners in the assessment process. Strategies include:

- performance tasks and pencil-and-paper instruments. Both are needed to assess the full range of expectations;
- communication activities and tasks. When students are engaged in group tasks it is appropriate to consider group interaction as one indicator of each student's learning skills. However, assessment must focus on each student's individual demonstration of the learning expectations.

### Diagnostic Activities

Students enrolled in SNC4M come with a wide variety of learning experiences. Certainly, the number and kind of science courses in the student's background vary, but many students have also completed technology courses in different disciplines. Part-time jobs and hobbies also provide these students with various sets of knowledge and skills. Diagnostic activities, at the start of all units, are important for providing a context for the unit design (based on student interest and background), for planning lessons to meet student needs, for filling in gaps and correcting misconceptions, and for tapping into student strengths.

Diagnostic activities should consider knowledge, inquiry, and communication skills, and making connections. A range of activities should be considered including:

- pencil-and-paper quiz (marks are not recorded);
- class discussion suggested by one or more focus questions;
- brainstorming activities, such as placemat or graffiti;
- carousel of laboratory activities for assessment of skills;
- KWL charts (**K**now, **W**ant to know, and then later, what was **L**earned);
- carousel of different applications;
- student survey;
- responding to a short reading passage (fiction or non-fiction) or a video clip (fiction, documentary, or news broadcast) on a connected societal issue.

A diagnostic activity may be suggested within the Course Profile, but this can be substituted by any of the above or one of the teacher's own design. By varying the diagnostic activity from unit to unit, different learning styles of students are addressed.

## Group Work Considerations

A number of group activities are described in this Course Profile. These activities allow students opportunities to practise and be assessed and evaluated for Teamwork, one of the five Learning Skills. Teamwork is often identified as a key employability skill. Initiative, Organization, and Work Habits/Homework, three other Learning Skills, can also be practised, assessed, and evaluated to some extent through group work.

However, when group assignments are used to evaluate course expectations, the teacher must ensure that this is done on an individual basis. This can be accomplished in a number of ways:

- Arrange individual teacher/student conferences. Student responses to a series of questions can be used to evaluate Knowledge/Understanding, Communication skills and Making Connections most easily, but can also be used for Inquiry.
- On a regular basis, collect and evaluate work logs, where students describe their role and responsibility in completion of an activity.
- Students use reflection journals to describe their learnings from a certain activity, and then are evaluated for Knowledge/Understanding and Making Connections.
- Work logs and reflection journals can be in formats other than pencil-and-paper. Some students might produce more complete and detailed answers if they were using a tape recorder or a concept map. This would allow different learning styles to be addressed.
- Students could pool their experimental or research results, and produce an independent, individual final product that would be evaluated.
- Students could contract for different aspects of research or communication for a group project. This is another opportunity to address individual learning styles. When evaluating the group presentation, the teacher is aware of individual responsibilities.
  A quiz could be used to evaluate specific Knowledge or Making Connections expectations gained through a group activity.
- Teacher observation, using a checklist, and on the spot questioning can be used to assess and evaluate meeting expectations on an individual basis.
- Acquisition of technical skills could be evaluated in another individual situation such as a summative practical skills test.

Self- and peer assessment of individual performances within a group setting are appropriate and useful to assist students in becoming self-monitoring. However such assessments are not to be the basis for evaluation; evaluation is the responsibility of the teacher and based on individual student performance.

## Accommodations

Some students whether identified formally or not, need additional or alternative supports to succeed in Grade 12 Science to their full potential. Teachers should consult individual student IEPs for specific direction on accommodation for individuals. Where there are specific accommodations required in an activity, the suggestions are noted within the activity. The following are examples of accommodations and aids that may be helpful in a general way:

- Check the IEPs of all identified students for specific accommodations in teaching methodologies and evaluation.
- Alter the number and depth of assignment components as required.
- Ensure that peer helpers are available when students are working in small groups.
- Provide handout sheets with sample calculations and specific skill instructions.
- Help students create data charts into which they record information.
- Allow students to report verbally to a scribe who can help in note making.
- Utilize student strengths by permitting them a wide range of options for recording and reporting their work, e.g., drawings, diagrams, flow charts, concept maps.
- Extend timelines to give students more time to process language and express their thoughts.
- Give readings in advance or provide a selection of materials at different reading levels.
- Provide extended timelines in situations where students do not have access to computers outside of school.
- Post new words and terms, along with their definitions and/or a graphical representation about the classroom.
- Provide additional time on assessments for dictionary use and processing language.
- Provide assistance to identify resources with appropriate reading level when research is required.
- Have students keep a science dictionary of terms using pictures and first language words.
- Permit the use of a translation dictionary on assessments.
- Record key words on the board when students are expected to make their own notes.

## Resources

Units in the Course Profile make reference to the use of specific texts, magazines, films, videos, and websites. Teachers need to consult their board policies regarding use of any copyrighted materials. Before reproducing materials for student use from printed publications, teachers need to ensure that their board has a Cancopy license and that this license covers the resources they wish to use. Before screening videos/films with their students, teachers need to ensure that their board/school has obtained the appropriate public performance videocassette license from an authorized distributor, e.g., Audio Cine Films Inc. Teachers are reminded that much of the material on the Internet is protected by copyright. The copyright is usually owned by the person or organization that created the work. Reproduction of any work or substantial part of any work on the Internet is not allowed without the permission of the owner.

Resources are found throughout the Course Profile, whenever the writers felt it would be most useful for teachers. Those appearing below are of general use throughout the course:

Bennet, Barrie and Carol Rolheiser. *Beyond Monet – The Artful Science of Instructional Integration*. Toronto: Bookation, Inc., 2001. ISBN 0-9695388-3-9

Brennan, Richard P. *Dictionary of Scientific Literacy.* Toronto: John Wiley and Sons, Inc., 1992. ISBN 0-471-53214-2

Brennan, Richard P. *Levitating Trains and Kamikaze Genes.* Toronto: John Wiley and Sons, Inc., 1990. ISBN 0-471-07902-2

Flaste, Richard (ed.). *The New York Times Book of Scientific Literacy.* New York: Harper, 1992. ISBN 0-06-097455-9

Hirsch, Alan J., D. Martindale, S. Bibla, and C. Stewart. *Nelson Physics 11: National Edition,* 1st Edition. Toronto: ITP Nelson Publishing. ISBN 0-17-612136-6

Johansson, Thomas B., H. Kelly, A. K. N. Reddy, and R. H. Williams. *Renewable Energy*. Washington D.C.: Island Press, 1993. ISBN 1-55963-138-4

Lean, Geoffrey, D. Hinrichsen, and A. Markham. *Atlas of the Environment.* Toronto: Prentice-Hall Press, 1990. ISBN 0-13-050436-X

Plumb, Donald, B. Ritter, E. James, and A. J. Hirsch. *Nelson Science 9.* Toronto: ITP Nelson Publishing, 1999. ISBN: 0-17-612032-7

Wall, Byron E. *Science in Society: Classical and Contemporary Readings.* Toronto: Wall and Emerson, 1989. ISBN 0-921332-254

World Resources Institute. *The 1992 Information Please Environmental Almanac.* Boston: Houghton Mifflin Company, 1992. ISBN0-395-59626-2

### Sources of recent news articles related to Science

The URLs for the websites were verified by the writers prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Internet Library – www.elibrary.com

Popular Science, Times Mirror Magazines – http://www.popsci.com

Discover Magazine, Disney Corp. – http:// www.discover.com

National Geographic – http://nationalgeographic.com

Scientific American – http://www.sciam.com

Most of the above Internet magazines are available in print form from community and/or school libraries.

## OSS Policy Considerations

Students can apply and refine the skills, knowledge, and habits of mind they acquire in SNC4M through Cooperative Education, work experience and service placements within the community.

A work site placement must be directly connected to the expectations of SNC4M if it is to contribute to a student's perspective of future careers or educational opportunities. The wording in the document *Cooperative Education and Other Forms of Experiential Learning (Ontario, Ministry of Education, 2000*) provides clear direction, and should be the focus of the personalized learning plans for students. "The personalized learning plan must include the following: the Curriculum Expectations of the related course that describe the knowledge and skills the student will extend and refine through application and practice at the workplace." (p. 23) The placement is not intended to introduce the student to the expectations, but should connect closely enough that significant expectations are clearly extended and refined in a workplace setting. Both workplace and community experiences may offer unique opportunities for students to achieve the goal of SNC4M "To relate science to technology, society, and the environment" and to gain experience in the Science Investigative Skills defined at the beginning of the course description in the guideline. The personalized placement learning plan of a student who has an Individual Education Plan (IEP) must be developed with direct reference to the IEP.

# Coded Expectations, Science, Grade 12, University/College Preparation, SNC4M

## Scientific Investigation Skills

**SIS.01 -** demonstrate an understanding of safety practices consistent with Workplace Hazardous Materials Information System (WHMIS) legislation by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials (e.g., safely handle organic compounds);
**SIS.02 -** select appropriate instruments and use them effectively and accurately in collecting observations and data (e.g., microscopes, electrical equipment, meters, data loggers);
**SIS.03 -** demonstrate the skills required to plan and carry out investigations using laboratory equipment safely, effectively, and accurately (e.g., design and carry out an experiment to investigate the effectiveness of different antacids);
**SIS.04 -** select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results (e.g., draw and label a diagram of the structure of an organic molecule, identifying its active sites);
**SIS.05 -** locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites;
**SIS.06 -** compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams (e.g., summarize in a chart the various modes of disease transmission);
**SIS.07 -** communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports (e.g., an investigation of physical and chemical properties of organic products in everyday life; an investigation concerning the application of solar power in battery-driven cars);
**SIS.08 -** research and evaluate information on a specialized topic in science, and apply it to the world outside the school (e.g., conduct an impact survey on emerging global communication systems; assess the positive and negative aspects of the Human Genome Project);
**SIS.09 -** select and use appropriate SI units;
**SIS.10 -** identify and collect information on careers related to the science subject area under study (e.g., TV repair person, VCR technician).

## Organic Products in Everyday Life

### Overall Expectations

**OPV.01** · describe the properties, benefits, and hazards of representative everyday organic products, and the use of these products in personal daily life, industry, and agriculture;
**OPV.02** · investigate the properties of everyday organic products, using appropriate laboratory procedures and equipment safely and accurately, and gathering and integrating information from print and electronic sources;
**OPV.03** · analyse the impact on society and the environment of the use of organic products.

## Specific Expectations

**Understanding Basic Concepts**

**OP1.01** – define, with examples, terms such as: *soap, detergent, emulsion, emulsifying agent, herbicide, pesticide*;

**OP1.02** – compare the properties and structures of inorganic and organic substances (e.g., draw diagrams to show the similarities and differences between inorganic and organic molecules);

**OP1.03** – explain the scientific principles involved in the making and use of soaps and detergents (e.g., the principles of bonding related to the making of detergents);

**OP1.04** – explain, giving examples, the action of an emulsifying agent (e.g., the effect of dish detergent on fats);

**OP1.05** – explain the scientific principles involved in the separation of crude oil into its fractions (e.g., into diesel fuel, gasoline, petroleum jelly);

**OP1.06** – describe the properties of chemical fertilizers and pesticides, and their use in agriculture;

**OP1.07** – summarize, using scientific principles, the dangers of UV radiation and the role of sunscreens in protecting the skin;

**OP1.08** – explain the action of various pharmaceuticals, and their role in personal health-care products (e.g., draw flow charts to show the action and use of aspirin/ASA, antacids, and vitamins in personal health care).

**Developing Skills of Inquiry and Communication**

**OP2.01** – illustrate the relationship between the structure and function of various organic products by constructing for each a simple model of its molecule and identifying its active parts (e.g., draw and label a diagram of a soap molecule, including its hydrophylic and hydrophobic parts);

**OP2.02** – investigate through experimentation the nature of emulsifiers and emulsions (e.g., conduct an experiment to make mayonnaise, or hand cream);

**OP2.03** – use laboratory investigation or computer simulation to illustrate the scientific principles upon which fractional distillation of petroleum products is based (e.g., conduct an experiment on the fractional distillation of oil);

**OP2.04** – compare, through research in print and electronic sources, the nature and action of chemical and natural fertilizers (e.g., draw a Venn diagram showing the similarities and differences in the action of chemical and natural fertilizers);

**OP2.05** – conduct a laboratory investigation into the chemical properties and chemical action of pharmaceutical products (e.g., into the function of antacids or aspirin/ASA).

**Relating Science to Technology, Society, and the Environment**

**OP3.01** – analyse the costs and benefits of using organic products (e.g., most pesticides, phosphate detergents), and assess their global impact on the environment;

**OP3.02** – identify and describe strategies for pest control other than the use of organic products (e.g., research alternatives to pesticide use in agriculture and the home);

**OP3.03** – describe the use and production of representative organic products over time (e.g., cosmetics and other pharmaceutical products).

## Pathogens and Disease

### Overall Expectations

**PDV.01** · demonstrate an understanding of micro-organisms, their biological effects, the diseases they cause, and the metabolic and environmental barriers to the spread of disease;

**PDV.02** · investigate the nature and growth of representative pathogens, the response of the immune system to them, and the effect on them of various drug therapies and sterilization techniques, using appropriate laboratory procedures and equipment safely and accurately, and gathering and integrating information from print and electronic sources;

**PDV.03** · evaluate the measures available for the control of disease, including the role of public policy and the use of health-related technologies and scientific knowledge.

### Specific Expectations

**Understanding Basic Concepts**

**PD1.01** – define, with examples when appropriate, such terms as: *micro-organism, pathogen, parasite, disease, epidemiology, pathogenesis, vector*;

**PD1.02** – describe the characteristics and reproductive cycles of representative pathogens (e.g., lysogenic cycle, lytic cycle, infectious cycle of malaria);

**PD1.03** – describe the modes of transmission of diseases, including those that are insect-borne (e.g., malaria, encephalitis), airborne (e.g., influenza, tuberculosis), water-borne (e.g., cholera, poliomyelitis), sexually transmitted (STDs; e.g., AIDS), and food-borne (e.g., mad cow disease, trichinosis, food poisoning);

**PD1.04** – describe and explain the immune response of the body as a natural defence against infection (e.g., the immune response to salmonella food poisoning, or trichinosis);

**PD1.05** – describe the use of vaccines, antibiotics, antiseptics, and other drug therapies in the control of pathogenesis;

**PD1.06** – describe non-medicinal ways to protect oneself from contracting pathogenic diseases (e.g., aseptic techniques, personal hygiene).

**Developing Skills of Inquiry and Communication**

**PD2.01** – investigate experimentally, using aseptic techniques, the characteristics and growth of non-pathogenic bacteria (e.g., conduct an experiment to compare different types of bacteria, using commercially prepared slides);

**PD2.02** – present a comparative analysis, based on their own research, of the various modes of transmission of pathogens;

**PD2.03** – research and report on the nature of the immune response in the human body (e.g., summarize the steps in the human immune response to a typical pathogen);

**PD2.04** – identify, through laboratory investigation, the effects of various drug therapies on pathogenesis (e.g., ask a testable question, propose a hypothesis, and conduct an experiment related to the effect of mouthwash or penicillin on the growth of bacteria);

**PD2.05** – demonstrate, through laboratory investigation, the effect on pathogenesis of the use of sterile techniques (e.g., the effect on pathogenesis of the pasteurization of dairy products).

**Relating Science to Technology, Society, and the Environment**

**PD3.01** – describe some of the means used by agencies and governments to control the spread of disease, both locally and globally;

**PD3.02** – evaluate the impact on an individual and on society of the misuse of antibiotics in the control of infection (e.g., chart the cause-and-effect relationships between the use of antibiotics and vaccines and the development of viral mutations and resistant strains of bacteria);

**PD3.03** – research and explain the impact on disease control of technological advances in food preparation and preservation (e.g., the impact of freezing, pasteurization, radiation, and canning on food marketing);

**PD3.04** – describe aseptic techniques used in the workplace and explain their importance (e.g., the techniques used to prevent food poisoning or the spread of disease in a food preparation facility or a restaurant);

**PD3.05 –** research and describe the impact on populations of the use of new technologies to control disease (e.g., gather and integrate information on community demographics and rates of infant survival to illustrate the effect over time of new vaccines and antibiotics).

## Energy Alternatives and Global Impact

### Overall Expectations

**EAV.01** · demonstrate an understanding of the scientific principles of energy production from conventional and alternative sources;

**EAV.02** · compare the practical value of a variety of alternative energy sources, through investigation and cost-benefit analysis;

**EAV.03** · assess conventional and alternative energy sources in terms of their ability to satisfy societal demand and of their environmental impact.

### Specific Expectations

**Understanding Basic Concepts**

**EA1.01** – define, with examples when appropriate, terms such as: *joule, rad, watt, fission, fusion, chain reaction, activation energy, renewable/non-renewable resources, conventional/alternative energy sources*;

**EA1.02** – compare and contrast conventional and alternative energy sources with respect to criteria such as availability, renewability, cost, and environmental impact (e.g., draw a Venn diagram showing similarities and differences between the use of fossil fuels and geothermal energy);

**EA1.03 –** describe technologies created in response to dwindling non-renewable energy resources (e.g., windmills, solar panels, electric cars);

**EA1.04 –** compare the relative amounts of energy released in various physical, chemical, and nuclear transformations (e.g., create charts to compare the energy released in condensation of water vapour, combustion of gasoline, and splitting of the atom);

**EA1.05** – describe the scientific principles of fission and a chain reaction and their applications in nuclear generating stations (e.g., the scientific principles applied in the CANDU reactor);

**EA1.06** – compare and contrast nuclear fission and nuclear fusion according to such criteria as feasibility, costs, and energy efficiencies.

**Developing Skills of Inquiry and Communication**

**EA2.01** – analyse data to determine which human activities consume the most energy, and how changing patterns of behaviour can reduce the total amount of energy consumed;

**EA2.02** – gather and analyse data, experimentally or through research, to evaluate alternative and emerging technologies as examples of responsible energy use (e.g., technologies related to wind power, solar power, electric cars, ethanol fuel, or the fermentation of waste products);

**EA2.03** – evaluate arguments for the use of nuclear technology, based on research into its advantages and disadvantages (e.g., production of greenhouse gases from fossil fuels is reduced but production of nuclear waste is increased);

**EA2.04** – present an argument, based on research and scientific analysis, for the use of an alternative energy system (e.g., a solar cooker, or a solar collector);
**EA2.05** – design a system that uses an alternative energy source (e.g., design, build, and test a working model of a wind generator, or a solar-powered car).

**Relating Science to Technology, Society, and the Environment**
**EA3.01** – identify, based on information integrated from print and electronic sources, short- and long-term environmental effects of by-products from nuclear generating stations;
**EA3.02** – identify new energy applications inspired by traditional energy sources (e.g., battery-operated cars including those powered by fuel cells);
**EA3.03** – evaluate the environmental impact of a specific alternative source of energy (e.g., conduct an environmental impact survey that covers such issues as costs and waste production/management);
**EA3.04** – analyse the costs and benefits to society of alternative energy systems, and assess the impact of their use on a global scale (e.g., wind generators, or tidal power plants);
**EA3.05** – evaluate the suitability of alternative energy sources, using research into the regional availability of natural resources in Canada (e.g., draw a correlation map for Canada showing regional energy systems and the distribution of natural resources, including water, fossil fuels, heat sinks, and wind and tides).

## Communications Systems

### Overall Expectations
**CSV.01** · explain the fundamental scientific principles that are applied in modern communications systems;
**CSV.02** · explain, on the basis of their findings from laboratory investigations, how modern communications systems function;
**CSV.03** · evaluate the advantages and disadvantages of modern communications systems, for both the individual and society.

### Specific Expectations
**Understanding Basic Concepts**
**CS1.01** – define, with examples when appropriate, terms such as: *wave, wavelength, frequency, semi-conductor, electromagnetic spectrum, fibre optic cabling*;
**CS1.02** – identify and describe the technologies involved in various communications systems (e.g., technologies involved in the Global Positioning System [GPS], or the Internet);
**CS1.03** – explain the fundamental scientific principles related to the use of a communications technology (e.g., fibre optics in a communications system);
**CS1.04** – explain, based on information from print and electronic sources, how electromagnetic radiation, as a form of energy, is produced and transmitted (e.g., radio waves);
**CS1.05** – identify and describe (e.g., outline, in a concept diagram) the properties and applications of the various regions of the electromagnetic spectrum;
**CS1.06** – identify and describe the applications of the electromagnetic spectrum in communications systems (e.g., radio, television, telephone, radar, satellites, fibre optics, or converters);
**CS1.07** – identify and explain the application of semi-conductors in communications systems (e.g., the use of semi-conductors in computers and graphic projection devices);
**CS1.08** – explain the energy transformations that take place to permit the transmission and reception of signals in communications systems;
**CS1.09** – describe how sound energy is received, analysed, and reproduced electronically (e.g., energy transformations in the functioning of a microphone).

**Developing Skills of Inquiry and Communication**

**CS2.01** – explain and analyse scientific principles related to communications systems (e.g., the Internet) using appropriate terminology;

**CS2.02** – describe and follow procedures for the safe and accurate use of electrical equipment as outlined in the Occupational Health and Safety Act and the Fire Code (e.g., describe the safety measures followed in an experiment involving the use of electrical equipment);

**CS2.03** – design, construct, and test a simple device that transforms energy (e.g., sound, light) from one form to another (e.g., design, construct, and test a prototype of a photovoltaic cell, loudspeaker, or doorbell);

**CS2.04** – identify and describe, through experimentation, how common communications equipment functions (e.g., conduct an experiment related to the design and functioning of a telephone or radio).

**Relating Science to Technology, Society, and the Environment**

**CS3.01** – assess the impact of new communications systems (e.g., cell phones) on individual lifestyles and on home and workplace environments;

**CS3.02** – assess the impact of new communications systems (e.g., the Internet, surveillance technologies) on the privacy of individuals and communities, focusing on risks and benefits;

**CS3.03** – forecast and assess the future effects of the use of new communications systems, locally and globally (e.g., the effects on time management, networking, and world trade).

## Science and Contemporary Societal Issues

### Overall Expectations

**SSV.01** · demonstrate an understanding of how scientific knowledge has evolved and continues to evolve through scientific discoveries, past and present;

**SSV.02** · assess the strengths and limitations of scientific knowledge and procedures as means for resolving contemporary societal issues;

**SSV.03** · evaluate the social and environmental implications and technological applications of contemporary scientific discoveries, and consider different cultural and societal perspectives on the discoveries.

### Specific Expectations

**Understanding Basic Concepts**

**SS1.01** – formulate definitions of scientific terms such as: *principle, law, theory, fact, observation, concept, inference, causality*;

**SS1.02** – explain how scientific knowledge evolves as new evidence comes to light and as theories are modified (e.g., draw a timeline chart to outline the historical relationship between experimental evidence, scientific inference, and accepted theory);

**SS1.03** – explain how evidence, theories, and paradigms contributed to a recent scientific discovery (e.g., write a report on James Watson and Francis Crick’s work in establishing the physical structure of DNA, describing the relationship between scientific ways of thinking, experimental evidence, and the nature of the resulting theory);

**SS1.04** – explain how a scientific discovery can lead to a paradigm shift in responses to a problem (e.g., conduct a media search on how the discovery of stomach bacteria changed the treatment of “lifestyle” diseases such as stomach ulcers);

**SS1.05** – identify technologies that have been developed as a result of a scientific discovery (e.g., the standard tungsten incandescent bulb or the tungsten-halogen bulb following research into high-resistance filaments);

**SS1.06** – identify examples of the growth of scientific knowledge as a result of a technological invention (e.g., compile and display recent data on distant galaxies obtained by the Hubble Space Telescope).

**Developing Skills of Inquiry and Communication**

**SS2.01** – demonstrate, through laboratory investigation, case study, or computer simulation, the habits of mind appropriate to scientific investigation, including objectivity, tentativeness, accuracy, and consistency (e.g., collect, record, and analyse data related to a case study involving the possible impact of the physical environment on genetic expression in humans);

**SS2.02** – analyse and interpret, through laboratory investigation, case study, or computer simulation, scientific evidence relevant to a contemporary societal issue (e.g., ask a testable question and propose a hypothesis related to the cause-and-effect relationship between water chlorination and formation of organo-chlorides);

**SS2.03** – research and defend, from a scientific perspective, a particular view of a contemporary societal issue as reported in the media (e.g., summarize the point of view presented in a magazine article on government support for hepatitis sufferers, and assess its merit from a scientific perspective);

**SS2.04** – evaluate, through interview and research, differing cultural perspectives on a contemporary subject or issue to which science is also relevant (e.g., a First Nations' perspective on maintaining natural balance through the use of alternative medicines).

**Relating Science to Technology, Society, and the Environment**

**SS3.01** – explain how a particular technological application of a scientific discovery is perceived by various interest groups in the community (e.g., present the views of different groups on the risks and benefits of using bovine growth hormone in milk production);

**SS3.02** – assess the possible positive and negative effects of a scientific discovery on society and the environment (e.g., positive and negative aspects of the Human Genome Project);

**SS3.03** – analyse ways in which societal needs or demands influence scientific and technological endeavours (e.g., relate levels of funding for AIDS research over time to societal influences);

**SS3.04** – describe the processes by which the private and public sectors have cooperated to establish and fund some Canadian research projects in science and technology.

# Unit 1: Energy Alternatives and Global Impact

**Time:** 25 hours

## Unit Description

In this unit students examine some of the societal issues related to the production and consumption of electrical energy. Following an initial discussion, they develop an understanding of the scientific principles in power production technologies as well as the natural resources required for these technologies. Students research and evaluate the variety of both conventional and alternative power resources, their environmental impact, and the advantages and disadvantages of their use, always moving from an individual/local focus to a global one. They then begin to look more closely at alternative sources of energy and expand their skills of scientific inquiry through the development of a model of an alternative energy source. As part of the underlying theme of contemporary societal issues, students start collecting articles related to science issues. Portfolios and summaries are prepared for presentation to the class.

## Unit Synopsis Chart

| Activity | Learning Expectations | Assessment Categories | Task Focus |
|---|---|---|---|
| 1.1<br>Going Beyond the Gut Reaction<br><br>2.5 h | SSV.01, SSV.02, SSV.03, SS1.01, SS1.02, SS1.04, SS2.01, SS2.03, SS3.03<br>SIS.04, SIS.08 | Inquiry<br>Communication | Teacher-led discussion: using a current energy issue, students give their initial response and then are taught to support it using research and critical thinking. They discuss the ways in which scientific knowledge evolves. |
| 1.2<br>The Use of Electrical Energy<br><br>1.0 h | EAV.02, EA2.01<br>SIS.02, SIS.04, SIS.09 | Inquiry<br>Communication<br>Knowledge/ Understanding | Teacher-directed lesson: students examine their own energy use and consider possible alternative actions. |
| 1.3<br>The Physics of Generating Electricity<br><br>5.0 h | EAV.01, EA1.01, EA1.05, EA1.06, SSV.01, SSV.02, SS2.01<br>SIS.01, SIS.02, SIS.07 | Communication<br>Inquiry<br>Knowledge/ Understanding | Teacher-directed lessons on heat involved in reactions. Students perform investigations involving activation energy. Through schematic diagrams students develop understanding of how energy is produced. Students participate in a group jigsaw involving Candu reactors and design experiments using model water wheel. |
| 1.4<br>Costs and Benefits of Conventional Energy Sources<br><br>2.5 h | EAV.01, EAV.02, EAV.03, EA1.01, EA1.04, EA2.03, EA3.01, SSV.02, SSV.03, SS2.02, SS3.02<br>SIS.05, SIS.06, SIS.08 | Knowledge/ Understanding<br>Making Connections<br>Communication<br>Inquiry | In small groups, students compare and contrast the three conventional power sources using a qualitative cost/benefit analysis. |

| Activity | Learning Expectations | Assessment Categories | Task Focus |
|---|---|---|---|
| 1.5<br>Alternative Energy Resources<br><br>7.5 h | EAV.01, EAV.02, EAV.03, EA1.01, EA1.02, EA1.03, EA2.02, EA2.05, EA3.02, EA3.03, EA3.04, EA3.05, SSV.01, SSV.02, SSV.03, SS1.05, SS2.02, SS3.03, CS2.03<br>SIS.05, SIS.08 | Knowledge/ Understanding<br>Making Connections<br>Inquiry<br>Communication | In small groups, students research and share their findings on alternative resources and develop a working model. Students also examine case studies on fuel cells and a fusion/fission comparison. |
| 1.6<br>End-of-Unit Task: The Energy Debate<br><br>6.5 h | EAV.01, EAV.02, EAV.03, EA1.02, EA2.04, EA3.05<br>SSV.03, SS3.01<br>SIS.05, SIS.06, SIS.08 | Knowledge/ Understanding<br>Inquiry<br>Making Connections<br>Communication | Students discuss increased energy production from the points of view of a town council, power suppliers, and an environmental group. |

## Activity 1.1: Going Beyond the Gut Reaction

**Time:** 2.5 hours

### Description

In this activity students examine a current energy issue, e.g., the Kyoto accord. Students discuss their immediate reaction to the issue, and then research it further by going through a series of questions. By answering these questions, students model the inquiry process needed for their End-of-Unit Task and Final Assessment Task.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact

**Learning Expectations**

SSV.01 - demonstrate an understanding of how scientific knowledge has evolved and continues to evolve through scientific discoveries, past and present;
SSV.02 - assess the strengths and limitations of scientific knowledge and procedures as a means for resolving contemporary societal issues;
SSV.03 - evaluate the social and environmental implications and technological applications of contemporary scientific discoveries, and consider different and societal perspectives on the discoveries;
SS1.01 - formulate definitions of scientific terms such as: *principle, law, theory, fact, observation, concept, inference, and causality*;
SS1.02 - explain how scientific knowledge evolves as new evidence comes to light and as theories are modified;
SS1.04 - explain how a scientific discovery can lead to a paradigm shift in responses to a problem;
SS2.01 - demonstrate, through laboratory investigation, case study, or computer simulation, the habits of mind appropriate to scientific investigation, including objectivity, tentativeness, accuracy, and consistency;

SS2.03 - research and defend, from a scientific perspective, a particular view of a contemporary societal issue as reported in the media;
SS3.03 - analyse ways in which societal needs or demands influence scientific and technological endeavours.
SS1.04 - explain how a scientific discovery can lead to a paradigm shift in responses to a problem (e.g., conduct a media search on how the discovery of stomach bacteria changed the treatment of "lifestyle" diseases such as stomach ulcers);
SIS.08 - research and evaluate information on a specialized topic in science, and apply it to the world outside the school (e.g., conduct an impact survey on emerging global communication systems; assess the positive and negative aspects of the Human Genome Project).

### Prior Knowledge & Skills

- Students draw on the knowledge gained in the electricity strand from Grade 9 Science of sources and uses of electricity.

### Planning Notes

- Teachers should have a current newspaper article on hand, describing an energy-related issue, e.g., global warming, the Kyoto Accord, rising costs of fossil fuels. This article serves as an example of the type of article that students can include in their "Science in the News" portfolio; it can also trigger a class discussion to stimulate the inquiry process.
- The "PERCS" (**P**erspective, **E**vidence, **R**elevance, **C**onnections, **S**upposition) technique could be used to help students in their analysis of news articles (see Resources).

### Teaching/Learning Strategies

1.1.1. **Student Activity:** Students are presented with a news article related to a current energy issue. After an initial reading/viewing, students provide their first reactions. By responding to focus questions from the teacher, students are challenged to explore the issue more deeply and write a related commentary in preparation for the Final Assessment Task. By analysing the process through which the teacher takes them, they also begin to examine the way scientific knowledge develops and its relationship to political and societal needs or demands.

**Teacher Facilitation:** After students give their "gut reaction" to the article, the teacher proposes a series of questions such as: What is the article about? What in the article interested you, impressed you, angered you, and why? What else do you know about the issue? Is information presented as fact, inference, or observation? What do you need to know? How would you go about finding out more? Be specific. (The teacher encourages student understanding of the habits of mind needed for effective inquiry.) Challenge the students to offer a more informed response to the article by conducting further research and writing a commentary. The teacher can provide examples of commentaries from newspaper magazines, journals, books, the Internet, etc.

1.1.2. **Student Activity:** Students are introduced to the course's Final Assessment Task which requires that they prepare a written report and oral presentation on a societal issue using skills developed throughout the course. A "Science in the News" portfolio is incorporated as preparation for the Final Assessment Task. Students collect 15 issue-related articles (in either the printed or electronic news media) throughout the course, three from each unit, and three others of interest. They paraphrase and critique the article, describe the issues, point out the science vs. non-science concepts, and articulate their opinion with supporting argument. Once every three weeks, students in small groups choose one article and discuss with their peers, receiving peer-assessment feedback. Students are then introduced to the End-of-Unit Task (Activity 1.6), which requires that they participate in a debate comparing, analysing, and deciding on a power-production technology for their own community. Students ask questions to clarify the nature and assessment criteria of the tasks.

**Teacher Facilitation:** A teacher-led discussion on the End of-Unit and Final Assessment Task will start students thinking of the knowledge and skills required for these tasks. As part of the ongoing "Science in the News" portfolio, students are required to present to the class. Students should present to small groups anywhere from three to five times during the whole course leading up to the Final Assessment Task. Decide on a firm number depending on class size. Emphasize that the research, debates, and class discussions in this unit help prepare students for the kind of thinking and type of delivery expected in the unit and course culminating assessments. Use the newspaper clippings as a trigger to begin discussion. The responses of students can be used as a diagnostic tool to determine their understanding of issues related to energy sources and uses in Ontario. Prior to the end of class, students are asked to collect the information from a variety of home appliances as required for the next activity.

### Assessment & Evaluation of Student Achievement

The commentary is assessed to provide students with feedback on their initial research and communication. Assessment can be given in the form of an anecdotal comment. It is diagnostic in nature and not meant to be included in the evaluation. The portfolio will be assessed in the Final Assessment Task for the course.

### Accommodations

- If possible, several articles of differing reading levels, but on the same issue could be used for student research prior to the commentary.
- Some students may require additional "coaching" through this initial inquiry process to better understand what is expected in future activities.

## Activity 1.2: The Use of Electrical Energy

**Time:** 1.0 hour

### Description

Having looked at a societal issue in the previous activity, students now investigate their personal electrical energy use. Looking first at where they use energy in the home, students then consider how energy is measured, and in what quantities it is purchased and used. Students reflect on their own electrical energy needs and possible strategies for lowering their energy usage.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact

**Learning Expectations**

EAV.02 - compare the practical value of a variety of alternative energy sources, through investigation and cost-benefit analysis;
EA2.01 - analyse data to determine which human activities consume the most energy, and how changing patterns of behaviour can reduce the total amount of energy consumed;
SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data;
SIS.04 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results;
SIS.09 - select and use appropriate SI units.

## Prior Knowledge & Skills

- Students draw on the knowledge of uses and units of measurement for power and energy gained in the electricity strand from Grade 9 Science.

## Planning Notes

- Prior to this class, students should be told to collect information on the power requirements of many of the electrical devices in their homes and estimate their usage times.
- The teacher should have some electricity bills and rates available for those students whose families do not directly pay for electricity, e.g., where utilities are included in rent.

## Teaching/Learning Strategies

1.2.1. **Student Activity:** In small groups or as a class, students list as many devices as they can that use electricity in the home. They indicate which devices they feel consume large amounts of energy. Students are asked to recall the units of measurement for power and energy relating them to the units used to measure electrical energy purchased for and consumed in the home. From information gathered prior to the class, e.g., power consumption ratings labelled on all appliances, and through discussion, students in small groups then determine the energy usage of a variety of appliances in their home. They perform an analysis that shows how much use the appliances get for some established time period. They then calculate the energy used by each device for the established time period (in kW h) and determine its cost. They share their calculations with the class and compare their findings with their predicted list. Students then outline suggestions that would reduce their energy requirements, determine how much energy and money would be saved by implementing the suggestions, and offer suggestions as to related costs and benefits of implementation.

**Teacher Facilitation:** Lead the students into thinking about devices that use energy. Expand their thinking into devices that are always on, even when people are not present in the home, e.g., clocks, VCRs, water heaters, refrigerator. All devices in a home either have a power rating measured in watts or a current rating. Some devices show both. If the power rating is not shown, the current rating can be multiplied by the household voltage to give the power consumption. All appliances sold in Canada carry an Energuide sticker indicating the annual power consumption. If the sticker is not on the device, students can be encouraged to visit a local appliance store and check the ratings on similar models to their own. This information is also available on a number of Internet sites. Have students predict the items they feel use the most (and least) electricity. Guide students through the calculations, completing a few with the class as necessary, and guide the sharing of their findings. The teacher challenges students to consider related costs and benefits to their suggestions for energy savings, looking at why some people implement the suggestions while others do not.

## Assessment & Evaluation of Student Achievement

It may be useful for groups to critique one other group's work, including organization of data, to receive anecdotal feedback prior to submission of work to the teacher. Students should submit their findings for assessment. This information may be useful later when students complete a cost-benefit analysis of switching to an alternate energy source (Strategy1.4.4).

## Accommodations

- Students may require help with the mathematical skills. Extra time may be given to students as necessary. Templates for calculations may be helpful.
- Posters showing the necessary formulae and calculations could be hung in the classroom for easy reference when completing this activity.

- Students having difficulty with finding the power ratings or energy usage can make a list of devices and visit retail centres or check Internet sites to determine the power ratings of new appliances that are listed.

### Resources

Solar Dome Energy Alternatives – http://www.solardome.com
Educational site on a variety of alternative energies. Also includes power ratings for some common home appliances at http://www.solardome.com/SolarDome72.html

## Activity 1.3: The Physics of Generating Electricity

**Time:** 5.0 hours

### Description

The teacher and students address some of the misconceptions related to nuclear and other forms of conventional electrical generation. Students first gain an understanding of the role of the generator and turbine in converting one form of energy into electrical energy. Students then examine the similarities and differences in conventional generating stations. They design an experiment to investigate one of the variables affecting a water-wheel generator. Students also compare amounts of energy involved in different reactions and show how that relates to energy production and efficiency.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact, Science and Contemporary Societal Issues

**Learning Expectations**

EAV.01 - demonstrate an understanding of the scientific principles of energy production from conventional and alternative sources;
EA1.01 - define, with examples when appropriate, terms such as: *joule, rad, watt, fission, fusion, chain reaction, activation energy, renewable/non-renewable resources, conventional/alternative energy sources;*
EA1.05 - describe the scientific principles of fission and a chain reaction and their applications in nuclear generating stations;
EA1.06 - compare and contrast nuclear fission and nuclear fusion according to such criteria as feasibility, costs, and energy efficiencies;
SSV.01 - demonstrate an understanding of how scientific knowledge has evolved and continues to evolve through scientific discoveries, past and present;
SSV.02 - assess the strengths and limitations of scientific knowledge and procedures as means for resolving contemporary societal issues;
SS2.01 - demonstrate, through laboratory investigation, case study, or computer simulation, the habits of mind appropriate to scientific investigation, including objectivity, tentativeness, accuracy, and consistency;
SIS.01 - demonstrate an understanding of safety practices consistent with Workplace Hazardous Materials Information System (WHMIS) legislation by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials;
SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data;
SIS.07 - communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports.

## Prior Knowledge & Skills

- Refer students to electrical energy production methods from Grade 9 Science.
- Students draw on the knowledge gained in the Chemistry strand in the Grade 10 Science course, particularly with respect to writing balanced chemical reactions and reaction rates.

## Planning Notes

- Obtain some AC generators for use with the water wheels.
- Obtain hand-held generators.
- Consult chemical inventory to determine whether necessary chemicals are available.
- If the school is near a conventional power production plant, a field trip to the plant could be considered as part of Strategy 1.3.2.

## Teaching/Learning Strategies

1.3.1. **Student Activity:** Students are first challenged to describe the similarities and differences among fossil fuel, hydro, and nuclear generators in electrical production. Following the discussion, students observe, through teacher demonstration, the magnetic field around a coil carrying a current, and predict the outcome of moving a magnetic field through a coil. They relate this to the functioning of generators and observe/use several types of generators. They then revisit the original question about the similarities and differences of electrical generators and relate this to the law of conservation of energy. Following a brief discussion on the nature of scientific laws, students produce their own summary notes of the lesson.

**Teacher Facilitation:** Introduce the motivating question (see above) and lead the class through the discussion. Conduct the demonstrations involving the coil, compasses and magnet, guiding students to understand that moving a coil in a magnet will produce a current. Use a variety of generator kits to lead students in experiencing how electricity is generated. Discuss how this basic concept has evolved into the modern generator that is used to produce most of the world's electricity. By emphasizing that the major differences in types of large scale generators are primarily due to the way the turbines move, not in the way the electricity itself is generated, allows the teacher to address what may be major misconceptions on the part of some students. As part of the SSV.01 expectation, include references to the law of the conservation of energy (with discussion on what a law is and how it is found).

1.3.2. **Student Activity:** Given the appropriate graphic schematics of power plants for the conventional sources, students should make a Venn diagram showing the common parts of power plants and some of the differences. Students should look at the schematics and develop a summary of how each technology works.

**Teacher Facilitation:** Prior to beginning, students should be allowed to analyse graphic schematics of the conventional power production technologies and as groups come up with common parts. Students should arrive at the idea that all the technologies, save hydroelectric, use some sort of fuel to produce heat; the heat is used to turn water into steam and the steam is used to spin a turbine. The turbine that is connected to a generator spins it to produce electricity. Hydroelectric power production skips the heating part and directly turns a water turbine connected to a generator to produce electricity. Students should then work individually on their Venn diagrams.

1.3.3. **Student Activity:** Investigation: students connect a water wheel to a generator and determine the effects that water quantity and water height have on electricity production. Students write an informal lab report.

**Teacher Facilitation:** Gather generators and appropriate water wheels. Discuss energy produced through the mechanical energy conversion. An estimate of the mechanical energy that water can provide by falling approximately $10^2$ m is $10^{-2}$ kJ/mol. This number should be used for comparison purposes.

1.3.4. **Student Activity:** Students observe different reactions as demonstrated by the teacher and measure how long it takes for the reaction to be completed. Once the reactions have been observed, students should discuss what is needed to start reactions and what has to be overcome to initiate a reaction.

**Teacher Facilitation:** Emphasize safe handling of materials and laboratory techniques while demonstrating various reactions involving different activation energies, e.g., mixing sucrose and sodium chloride showing no reaction; collecting small amounts of hydrogen and oxygen from the electrolysis of water and igniting them with a burning splint showing a low energy of activation; rubbing a wooden match, held with tongs, with a small metal file at various speeds showing a medium activation energy. The concept of activation energy, e.g., spend energy to get energy, is necessary for students to understand that most reactions require energy input to start. This energy input relates to the efficiency of the power-generating technology. Following the demonstrations, a teacher-led discussion clarifies the concept of activation energy. Discuss energy produced through the chemical energy conversion. Alternate activities can be used as indicated in Resources. As another alternative, if computers are available, students can view Internet demonstration videos of reactions. Draw attention to the amount of energy in an average combustion reaction, e.g., approximately $10^2$ kJ/mol of energy are in a typical combustion reaction.

1.3.5. **Student Activity:** Students participate in a jigsaw activity. They become experts in one aspect of the Candu nuclear reactor. Experts then present their information to their home groups.

**Teacher Facilitation:** Divide the class into groups so that each group becomes an expert in one aspect of the Candu reactor, e.g., the fuel, the moderator, the reactor core, heat exchange system, steam turbines and generators, safety, its reputation. The number of groups depend on the number of topics. To increase resources, book time in the library/resource centre.

1.3.6. **Student Activity:** Through teacher presentation and question-and-answer sessions, students develop further understanding of the process of fission reactions used to produce heat. Students then briefly compare fission reactions with those of fusion and make their own summary notes.

**Teacher Facilitation:** The teacher-leads a discussion showing a typical nuclear fission reaction and listing its binding energy. Teachers should show the Uranium 235 reaction equation:

${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{94}_{36}Kr + {}^{139}_{56}Ba + 3\,{}^{1}_{0}n$ . Focus on the initial neutron that is required to initiate the reaction. The three neutrons produced are of the correct energy to initiate the reaction of three more uranium 235 atoms and these lead to a chain reaction. The Candu fission reaction should also be included in the discussion:

$${}^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U \rightarrow {}^{239}_{93}Np + {}^{0}_{-1}e \rightarrow {}^{239}_{94}Pu.$$

Make note of the products of fission, e.g., radiation and long half-life plutonium. Briefly discuss ionizing radiation and the unit of measurement, the *rad*. Show the difference between a fusion and fission reaction indicating approximate binding energies on the order of $10^9$ kJ/mol.

A typical fusion reaction is:

$${}^{3}_{1}H + {}^{2}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n .$$

- Do not emphasize the nuclear equations but just treat them as tools to show what the reactants and products are. Emphasize the activation energy required to begin these types of reactions. Although sometimes regarded as a potential alternative energy source, fusion is introduced here in order to compare its physics with that of fission. This is also an opportunity to address misconceptions some students might have regarding the similarity of fission and fusion, and the perceived “closeness” of fusion as a ready alternative energy source. Fusion is revisited in Activity 1.5, Alternative Energy Resources. Students who wish to learn more about the relationship between electricity and magnetism could be encouraged to consult Grade 11 Physics textbooks or other physics resources to investigate solenoids, electromagnetic induction, and the motor principle.

### Assessment & Evaluation of Student Achievement

| Key to Abbreviations |
|---|
| K/U = Knowledge/Understanding<br>I = Inquiry<br>C = Communication<br>MC = Making Connections |

Understanding of content of power production technologies and the Candu reactor can be assessed using a written test (K/U). Venn diagrams can be evaluated for content and clarity (K/U, C) using a marking scheme or rating scale. A rubric can be used to evaluate the water wheel laboratory activity (K/U, I, C). Alternatively, the teacher may wish to collect only a portion of the lab report, data tables and calculations for example, checking for accuracy and offering suggestions for data table organization (K/U).

### Accommodations

- Some students may require additional assistance in reading schematic diagrams.
- Students with specific motor impairments may require assistance when manipulating materials.
- Those students who show aptitude in this activity can be encouraged to further explore how an AC generator can be modified to produce DC current, why AC generators are used, why transformers are used, and the different systems of voltage, e.g., 120 V in Canada vs. 240 V in parts of Europe.

### Resources

Shakhashirir, B.Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry* – A print resource for various demonstrations including low activation energy reactions

How an Electric Generator Works – http://www.wvic.com/how-gen-works.htm
Interactive site on how an electrical generator works. Provides background information as well as an animation to help students understand the scientific principle.

Explosive Decomposition of Nitrogen Triiodide – http://genchem.chem.wisc.edu/demonstrations/Gen_Chem_Pages/16entropypage/decomposition_of_ntriiodide.htm – Video clip showing reaction with a low activation energy.

World Information Service on Energy – http://www.antenna.nl/wise/436/4306.html
Information on problems with the CANDU reactor.

Candu Nuclear Reactor – http://204.225.143.1/millennium/candu/candu_home.html
Information on the CANDU reactor.

CPEP Fusion – Physics of a Fundamental Source of Energy – http://fusedweb.pppl.gov/CPEP/chart.html
General site about nuclear fusion

## Activity 1.4: Costs and Benefits of Conventional Energy Sources

**Time:** 2.5 hours

### Description

To legitimately evaluate the potential use of alternative energy sources, students must develop an understanding of the costs and benefits of conventional forms. This activity enables students to understand that during reactions different amounts of energy are released depending on the source used. Given this, students share their current knowledge and then research the resources required for conventional power production, e.g., fossil fuel, hydroelectric, and nuclear. Students discuss energy consumption in Canada and hypothesize about future trends from a Canadian and global perspective.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact, Science and Contemporary Societal Issues

**Learning Expectations**

EAV.01 - demonstrate an understanding of the scientific principles of energy production from conventional and alternative sources;
EAV.02 - compare the practical value of a variety of alternative energy sources, through investigation and cost-benefit analysis;
EAV.03 - assess conventional and alternative energy sources in terms of their ability to satisfy societal demand and of their environmental impact;
EA1.01 - define, with examples when appropriate, terms such as: *joule, rad, watt, fission, fusion, chain reaction, activation energy, renewable/non-renewable resources, conventional/alternative energy sources;*
EA1.04 - Compare the relative amounts of energy released in various physical, chemical, and nuclear transformations;
EA2.03 - evaluate arguments for the use of nuclear technology, based on research into its advantages and disadvantages;
EA3.01 - identify, based on information integrated from print and electronic sources, short- and long-term environmental effects of by-products from nuclear generating stations;
SSV.02 - assess the strengths and limitations of scientific knowledge and procedures as means for resolving contemporary societal issues;
SSV.03 - evaluate the social and environmental implications and technological applications of contemporary scientific discoveries, and consider different cultural and societal perspectives on the discoveries;
SS2.02 - analyse and interpret, through laboratory investigation, case study, or computer simulation, scientific evidence relevant to a contemporary societal issue;
SS3.02 - assess the possible positive and negative effects of a scientific discovery on society and the environment;
SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites;
SIS.06 - compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams;
SIS.08 - research and evaluate information on a specialized topic in science, and apply it to the world outside the school.

## Prior Knowledge & Skills

- Students draw on the knowledge and skills gained in Activity 1.1 on how generators work, as well as information on power production technologies from Grade 9 Science.

## Planning Notes

- The teacher should book time in the library/resource centre. Prepare handouts on conventional power production technologies and resources. Students could complete some research as homework.
- Decide in advance the number of student groups for Strategy 1.4.2, e.g., one group for each production method; the make-up of those groups; and the time to be allotted to present material to the class, e.g., 20 minutes per power source. Alternatively, if there are sufficient resources, each group could research all three production methods and the presentation time might be used for group discussion.
- Since "standards of living" differ considerably between and within Ontario communities, when discussing this in Strategy 1.4.2, the teacher needs to be sensitive to the backgrounds of students and their communities.

## Teaching/Learning Strategies

1.4.1. **Student Activity:** Through a teacher-led discussion, students compare the efficiencies and relative amounts of energy released in various physical, chemical, and nuclear transformations. In groups, students discuss their views then rigorously research the fuel or resource requirements for each of the conventional power sources, the methods of obtaining the resources, the environmental impact, the costs involved, and the benefits provided by using that power source. They present their work to their classmates, leaving it on display for the next activity. Students then prepare their own summary note or graphic organizer, e.g., flow chart or plus/minus/ interesting chart, on each of the power resources.

**Teacher Facilitation:** Spend some time with the class comparing the energies that different types of energy transformation can produce, e.g., show how much more heat is generated by nuclear reactions than chemical reactions or physical changes. Lead a discussion and include statistics. This is expanded into directly comparing amounts of fuel and/or resources required for hydroelectric power, e.g., moving water, vs. fossil fuel power vs. nuclear power. Set the parameters for the discussion and research to follow, emphasizing the rigor required for the research. Direct the class to their small discussion groups where students begin to share their views. Guide the discussion to include the fuel and resource requirements for each of the conventional power sources, and how these resources are obtained. To help the students, suggest points that will make them think of other ideas, e.g., the size of the development as in "mega-projects"; the availability of the resource, its purchase from within Canada or from other countries. Resources should be made available and research begun as soon as group needs demand. Research should include the methods of obtaining the resources, the environmental impact, the costs involved, and the benefits provided by using a specific production method (SS3.02). Students will likely want to know the amount of energy generated using each of the power-production technologies. This information is available in some Grade 9 Science textbooks as well as some atlases. The amount of airborne pollution that thermoelectric power produces as well as the amount of solid waste that nuclear power produces can be found from some of the resources listed. Once research is completed, students are given time to present their work to the class. The work is displayed for use in the next activity.

1.4.2. **Student Activity:** Following a teacher introduction of the percentage used of each energy production method in Ontario, students consider the standard of living which energy use allows. In small groups, using the displayed materials from the previous activity, they discuss: our current societal demands for energy production as compared to those of other parts of the world; the amount and type of waste materials that usage generates; the implications (both positive and negative) should other parts of the world strive to achieve the standard of living enjoyed in much of Canada and North America; and our responsibilities (as individuals, a province, and a nation). A whole-class discussion follows. Students then write an individual reflection piece supported by data from the class research.

**Teacher Facilitation:** If not already presented by students in the previous activity, students should be made aware of the local energy production percentages in Ontario, e.g., fossil fuels 20%, hydro 25%, nuclear 49%, and the type and amount of waste that these production methods generate. Next, direct the class to consider some or all of the topics described above. Move from group to group acting as facilitator for individual groups as required, then for the class as a whole. Questions that might be asked of students include: Do Canadians use power wisely or do we tend to abuse its readily available nature? How does this relate to our societal or cultural views? How does Canadian consumption of energy compare to the rest of the world? How do we compare to countries that have similar climates in terms of energy usage? How does North America compare to Europe in terms of energy consumption? Provide articles or statistics related to these issues. Conclude the activity by refocusing the class on a question such as, "Given all we've just talked about, what are the strengths and the limitations of science in helping people resolve issues such as those we've been discussing on energy?" (SSV.02) This type of question can also be asked on a written test.

## Assessment & Evaluation of Student Achievement

The group presentation and displayed material can be assessed using a rubric (K/U, I, MC, C). The individual reflection piece can be evaluated using a rating scale for the same areas. To help prepare students for the End-of-Unit Task, small and large group discussions can be used to provide feedback (by teacher, self or peers) on effective use and delivery of research, facts, and opinions.

## Accommodations

- ESL/ELD students may present to the teacher during the jigsaw group exercise.
- As an extension, students wishing to know more about the conventional resources and the operation of a power plant could be encouraged to pick a power production technology and fully explore its operation. This could be useful for Activity 1.5, the energy debate.

## Resources

Atomic Energy of Canada Limited – www.aecl.ca/english/energy/energy_f.html
General Information on Nuclear Power in Canada

The Coal Association of Canada – www.coal.ca/class.htm
Covers details on coal use in Canada

Public Power Institute Tennessee Valley Authority – http://www.publicpowerinstitute.org/
Resource on environmental impacts and suggested action plans.

World Information Service on Energy – http://www.antenna.nl/wise/436/4306.html
Information on problems with the CANDU reactor

Energy Fact Sheets – http://www.iclei.org/efacts/
General site on all power production technologies and their impact

Wolfe, Elgin, et al, *Science Power 9*. Toronto: McGraw-Hill Ryerson, 1999.
ISBN 0-07-560361-6

## Activity 1.5: Alternative Energy Resources

**Time:** 7.5 hours

### Description

This activity helps develop student understanding of the reasons for seeking alternative resources and power technologies as well as the science behind their development. Students research alternative renewable energy resources and power technologies, and include a comparison of fission and fusion. A timeline of the development of the fuel cell is created. Students build a model showing how one of the alternative resources is used to make electricity.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact, Science and Contemporary Societal Issues

**Learning Expectations**

EAV.01 - demonstrate an understanding of the scientific principles of energy production from conventional and alternative sources;
EAV.02 - compare the practical value of a variety of alternative energy sources, through investigation and cost-benefit analysis;
EAV.03 - assess conventional and alternative energy sources in terms of their ability to satisfy societal demand and of their environmental impact;
EA1.01 - define, with examples when appropriate, terms such as: *joule, rad, watt, fission, fusion, chain reaction, activation energy, renewable/non-renewable resources, conventional/alternative energy sources;*
EA1.02 - compare and contrast conventional and alternative energy sources with respect to criteria such as availability, renewability, cost, and environmental impact;
EA1.03 - describe technologies created in response to dwindling non-renewable energy resources;
EA2.02 - gather and analyse data, experimentally or through research, to evaluate alternative and emerging technologies as examples of responsible energy use;
EA2.05 - design a system that uses an alternative energy source;
EA3.02 - identify new energy applications inspired by traditional energy sources;
EA3.03 - evaluate the environmental impact of a specific alternative source of energy;
EA3.04 - analyse the costs and benefits to society of alternative energy systems, and assess the impact of their use on a global scale;
EA3.05 - evaluate the suitability of alternative energy sources, using research into the regional availability of natural resources in Canada;
SSV.01 - demonstrate an understanding of how scientific knowledge has evolved and continues to evolve through scientific discoveries, past and present;
SSV.02 - assess the strengths and limitations of scientific knowledge and procedures as means for resolving contemporary societal issues;
SSV.03 - evaluate the social and environmental implications and technological applications of contemporary scientific discoveries, and consider different cultural and societal perspectives on the discoveries;
SS1.05 - identify technologies that have been developed as a result of a scientific discovery;
SS2.02 - analyse and interpret, through laboratory investigation, case study, or computer simulation, scientific evidence relevant to a contemporary societal issue (e.g., ask a testable question and propose a hypothesis related to the cause-and-effect relationship between water chlorination and formation of organo-chlorides);
SS3.03 - analyse ways in which societal needs or demands influence scientific and technological endeavours;
CS2.03 - design, construct, and test a simple device that transforms energy from one form to another;

SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites; SIS.08 - research and evaluate information on a specialized topic in science, and apply it to the world outside the school.

### Prior Knowledge & Skills

- Students draw on the knowledge gained in Activity 1.3 about the problems associated with conventional resources, in particular the non-renewable nature of fossil fuels and uranium.

### Planning Notes

- Teachers should be aware of the misconceptions around the term *alternative energy*. In many cases the term "alternative" is specific to a particular time and location; what is often an alternative energy source in one area is being used, or has been used, regularly in other areas or times.
- Book the library/resource centre to accommodate time for research needs. Prepare handouts on the alternative power production technologies and resources and make them available to students.
- The teacher might also wish to consult various scientific company catalogues for fuel cell kits that are available. Alternatively, hand made generators from Activity 1.3 could be prepared to facilitate the design and construction of the device.

### Teaching/Learning Strategies

1.5.1. **Student Activity:** Students participate in an initial placemat activity (see Resources) to determine and share their current understanding of alternative energy sources, and to identify related areas of interest and avenues for further research later on in Activity 1.5. Using the placemat format, students individually jot down notes describing their own understanding of the topic, then as a group they identify common background knowledge related to alternative energy sources. They share their knowledge with other groups and as a class, develop a list of alternative energies from which they will later choose a research topic as well as common areas that require further research.

**Teacher Facilitation:** The placemat activity (see Resources) should be used to help students determine the knowledge they bring to the class on alternative power. The purpose is to involve students in discussion about some of the current technologies that are being developed to replace some of the non-renewable resources in use now. Review some of the problems with the conventional resources. Help students create a list of topics on alternative energy sources, e.g., tidal, geothermal, fuel cell, active solar heating, passive solar heating, photovoltaics, wind, hybrid, etc., from which they will later choose a research topic. Depending on location, some students may already be using alternative resources as their source of power in their homes. Some homes use solar power for their energy needs while others may use wind power or wood burning from a self-sustaining wood lot. Time should be set aside for those students to share their knowledge.

1.5.2. **Student Activity:** Fusion vs. Fission Case study: feasibility, costs and energy efficiencies. Students write an opinion essay including a concluding statement about whether fusion or fission should be the power-production technology of choice and some of the technical difficulties involved in both fusion and fission.

**Teacher Facilitation:** Have two articles, one on fusion and one on fission ready for students to read individually. Possible questions can include: Is fusion better than fission? Why? Can fusion ever replace fission? Is efficiency really an issue with either fusion or fission? Explain. Do the benefits of nuclear power outweigh the long-term health and environmental effects? The students should form an opinion based on the information presented in the articles. Background on the discovery of nuclear power and how it has evolved should be discussed as a whole class prior to beginning the task.

1.5.3. **Student Activity:** Students participate in a case study of the fuel cell/hybrid car. Information from various auto manufacturers is used to make students aware of what car manufacturers are doing to help reduce the environmental impact of using conventional energy sources. Students focus on how the technology works, the benefits of the technology as well as reasons why such technology was developed in the first place, how it has led to further scientific knowledge, and why large-scale use of the technology is not realized (SS1.06). In groups, students make summary notes and develop a timeline for constructing the fuel cell.
**Teacher Facilitation:** If library/resource centre time is not available, prepare handouts of various automobile manufacturers' initiatives on alternative power and on the history of fuel cell development.

1.5.4. **Student Activity:** After reviewing necessary safety procedures, students design and construct a system that uses an alternative energy source, e.g., a fuel cell powered miniature car, a windmill to generate electricity or lift a mass off the floor. Using provided fuel cell kits or other materials, students build an alternative energy powered device. Students should build several prototype models, establish a testing protocol, and determine through a series of tests, which design is the best.
**Teacher Facilitation:** After having looked briefly at several alternative energy sources in the previous three lessons, the teacher challenges the students to develop a simple system that uses one of these methods. Prior to beginning this activity, review all necessary procedures for safe and appropriate use of materials and equipment. Some scientific supply companies provide fuel cell kits; if appropriate, make these kits available to the students. Alternatively, encourage students to use wind or other renewable sources. Generators from Activity 1.3 can be used to help students in the design and construction of their device. It may be necessary to have a number of electric fans available for testing purposes as well as generators and multimeters for measuring current produced by the wind mills. Students may require a review lesson on the use of multimeters. To help students in their design process, set a specific goal (e.g., being able to light a 6 V light bulb, get a slight deflection on a galvanometer, lift a specific mass a given height, for the different devices). Some past/present alternative energy sources used in some cultures, e.g., burning of animal wastes, can be viewed as strange by students not of that culture. The teacher should be sensitive to this and emphasize how many of these uses have contributed significantly to developing technologies, e.g., use of methane and forms of biomass. Many students will likely need a review of the design process itself (initiate and plan; perform and record; analyse and interpret; communicate; or, alternatively, identify a need; develop a plan; execute and evaluate the plan; communicate the results).

1.5.5. **Student Activity:** Choosing an alternative power production technology, students prepare a report describing the benefits, drawbacks, efficiency, cost, savings in resources, the amount and type of waste eliminated and/or generated, and a brief history (origin – especially where inspired by traditional energy sources, development) (SSV.01, SS3.03). Students describe the prevalence of the method in Canada, and the sustainability of the alternate energy source in Canada. Given differing societal and cultural perspectives, they also consider the implications of developing such a technology on a more global scale (SSV.03). They offer reasons why alternative resources are not currently being used to their maximum capabilities. Students present/display their findings in a method that other students can refer to later when preparing for the End-of-Unit Task, e.g., a bulletin board display or electronic presentation.

**Teacher Facilitation:** The teacher reminds students to focus their research into alternate energy on such items as how the method they are researching can reduce pollution output, reduction to non-renewable resource consumption (giving specific numerical data where appropriate), appropriateness with respect to climate, initial cost, time needed to recoup initial costs, and any social or political ramifications to using or not using the alternative. Students will need time in the library/resource centre or to be supplied with prepared resources.

### Assessment & Evaluation of Student Achievement

The placemat activity can be used for formative assessment to provide students with initial feedback on their understanding of the concepts they might wish to consider for later research. The design process and device from Strategy1.5.4 can be assessed using an inquiry rubric (I, C). The presentation from Strategy 1.5.5 can be assessed using a rating scale (K/U, MC, C).

### Accommodations

- With the variety of student skill levels in building devices, teachers may wish to perform a diagnostic activity and then form groups so that there is a balance of skill levels within groups.
- Canadian companies are often at the forefront of scientific and technological progress, e.g., Ballard Power Systems. As an extension, students could be encouraged to find out more about a specific Canadian company in terms of how it is influencing alternative power production technology.

### Resources

Council of Ministers of Education, Canada 1997. *The Common Framework of Science Learning Outcomes K to 12: Pan-Canadian Protocol for Collaboration on School Curriculum*. Toronto: Council of Ministers of Education, Canada. ISBN 0-88987-111-6

Peel District School Board. 2001. *Science and Technology, K-10: enduring understandings – learning about the world around us.* Mississauga: Peel District School Board. ISBN 1-55038-164-4

Globaltoyota: Hybrid Technology – http://global.toyota.com/techenv/hybridtech/index.html
Fuel cell hybrid vehicle information

Hydrogen Fuel Cells: Innovations for the 21st Century
– http://inventors.about.com/library/weekly/aa090299.htm
Fuel cell timeline of development

Space Shuttle Orbiter System: Electrical Power System
– http://inventors.about.com/library/inventors/blfuelcells1.htm
Fuel cells on the space shuttle

Fuel Cell Store.com: Demonstration Fuel Cells
– http://www.fuelcellstore.com/products/index/demonstration_fuelcell_index.html
Fuel cell kits

Heliocentris – http://www.heliocentris.com
Fuel cell kits

Articles from the MAACIE Newsletter Archives: Article 12 The Extended Classroom Period: Elements for Success and Practical Ideas – http://www.geocities.com/athens/parthenon/6549/art12.html
Includes instructions for placemat group activity

## Activity 1.6: End-of-Unit Task – Energy Debate

**Time:** 6.5 hours

### Description

Using a debate forum, students compare, analyse and decide on an alternative power production technology for their own community or a fictitious one with specific parameters.

### Strand(s) & Learning Expectations

**Strand(s):** Energy Alternatives and Global Impact, Science and Contemporary Societal Issues

**Learning Expectations**

EAV.01 - demonstrate an understanding of the scientific principles of energy production from conventional and alternative sources;
EAV.02 - compare the practical value of a variety of alternative energy sources, through investigation and cost-benefit analysis;
EAV.03 - assess conventional and alternative energy sources in terms of their ability to satisfy societal demand and of their environmental impact.;
EA1.02 - compare and contrast conventional and alternative energy sources with respect to criteria such as availability, renewability, cost, and environmental impact;
EA2.04 - present an argument, based on research and scientific analysis, for the use of an alternative energy system;
EA3.05 - evaluate the suitability of alternative energy sources, using research into the regional availability of natural resources in Canada;
SSV.03 - evaluate the social and environmental implications and technological applications of contemporary scientific discoveries, and consider different cultural and societal perspectives on the discoveries;
SS3.01 - explain how a particular technological application of a scientific discovery is perceived by various interest groups in the community;
SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites;
SIS.06 - compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams;
SIS.08 - research and evaluate information on a specialized topic in science, and apply it to the world outside the school.

### Prior Knowledge & Skills

- Students draw on the knowledge and skills gained in previous activities to assist them in preparing for and participating in the debate.
- Experience from the ecology strand in Grade 10 Science should help in assessing environmental impacts.

### Planning Notes

- Students have already been introduced to the knowledge required to debate the issue. These materials from previous activities should be on display about the classroom.
- To help students in their debates, teachers may wish to review debate skills and emphasize key messages given earlier during previous feedback.
- Students have a variety of skills, e.g., good speakers, presenters, organizers, artists, and where possible, groups should be formed so that there is a balance of these skills in each group.
- Conducting a brief discussion prior to the written reflection in Strategy1.6.2 will benefit many students.

### Teaching/Learning Strategies

1.6.1. **Student Activity:** Students form up to six panels: the town council, two suppliers of alternate energy sources, two suppliers of conventional sources, and an environmentalist group. All students discuss/research the need for a new or supplemental power production technology for their actual or fictitious community. Students gather their research from what is displayed in the class, but may supplement it with other research done on their own time. Individual students synthesize their research onto one page to be used during the debate and submitted for evaluation following the debate. Students representing the energy suppliers research and prepare a short opening "sales pitch" presentation supporting the use of their respective technology. The environmentalist group researches and prepares arguments to support or refute each of the methods being considered given their particular societal or cultural perspective (SSV.03). The town council researches each of the technologies being considered sufficiently to be able to ask pertinent questions of each group. Prior to the debate, the four suppliers and the environmentalist group are each given an allotted time to make their opening statements (SS3.01). This is followed by a debate and questions from the town council. After the debate, the town council deliberates and makes a choice based on the presented information. The town council initially has to research all the positions to gather background on the energy panels to ensure accurate arguments are being presented to them. During the debate, they may ask questions. After the debate they deliberate in front of the other groups. Since the town council does not have to prepare a "sales pitch," an equal amount of work is distributed to each group.

**Teacher Facilitation:** The premise of the debate is the increased societal demand in energy requirements. The community may be growing. New industries may be moving in. More people may be purchasing more appliances and newer technology or using air conditioners or furnaces more. Perhaps the town itself has installed some major facility, e.g., new hospital, incinerator, water treatment plant. Needs and parameters identified by the students and/or teacher and specific to individual communities can replace or supplement this list. Guide the selection of criteria. Since students have already presented information on conventional and alternative energy sources and this material is on display in the classroom, minimal research time is required. The time allotted for this activity is used in reviewing debate procedures, questioning techniques, preparation for the debate, and the debate itself.

1.6.2. **Student Activity:** After the debate, students write a reflection journal (supported by data) on the debate process and the appropriateness of the decision by the town council. Included in the reflection is a discussion of the feasibility of this decision for other communities in Canada, e.g., to what extent is the decision universally appropriate and what limitations does it have for other communities.

**Teacher Facilitation:** The teacher may wish to lead a class discussion on issues such as: Is it feasible to have this power plant placed anywhere in Canada? Can the power production technologies, alternative or conventional, be placed anywhere or are there restrictions?

1.6.3. **Student Activity:** Written test.

**Teacher Facilitation:** Students should be allowed to have statistical data with them to answer longer questions. Allow them to use their notebooks or to prepare a fact sheet prior to the test.

### Assessment & Evaluation of Student Achievement

Evaluating the debate across all achievement categories while it is happening will prove too unwieldy. Use the debate itself to evaluate students' ability to Communicate ideas clearly and persuasively (C) and their ability to Make Connections (MC) to STSE issues. Have students submit their preparatory research notes to evaluate their Inquiry skills (I) and their ability to gather and synthesize important information (K/U). Individual Learning Skills could be assessed by circulating in the classroom during the preparation for the debate.
The written test can include Knowledge/Understanding questions or Making Connections questions and can be assessed using a marking scheme (K/U, MC).

### Resources

Discover Debate – www.discoverdebate.com
Debate skills and teaching strategies

## Appendix

### Informal Lab Reports

Formal lab reports usually include a title, purpose, hypothesis, theory, materials, procedure, data, calculations, analysis, discussion, sources of error, and a conclusion. Although teachers have their own requirements for these formal reports, these are some of the most common. Sometimes short activities require reports that are done on a lesser scale. This encourages the students to spend more time on the design or analysis components of the experiment. It is at the teacher's discretion to decide on the emphasis of the lab activity. Once this is arrived at, students can be informed as to what parts of a formal lab should be included in their informal lab report. Teachers are encouraged to assess these informal lab reports using appropriate checklists, marking scales, or lab report rubrics.

Informal lab reports need not be evaluated as formal labs would be. The primary purpose of an informal lab report is to determine if the student has indeed completed the lab and understands the conclusions.

## Appendix (Continued)

### Informal Lab Report Rubric

| Categories/ Criteria | Level 1 (50-59%) | Level 2 (60-69%) | Level 3 (70-79%) | Level 4 (80-100%) |
|---|---|---|---|---|
| **Knowledge/ Understanding** Problem Statement | - limited identification of problem, with limited relevant explanation | - problem is partially identified with a some relevant explanation | - problem is clearly identified with a considerable explanation | - problem is precisely identified with a high degree of relevant explanation |
| **Knowledge/ Understanding** Hypothesis | - limited association between problem and predicted results | - moderate association between problem and predicted results | - considerable association between problem and predicted results | - precise and thorough association between problem and predicted results |
| **Inquiry** Data | - data have limited accuracy;<br><br>- data are recorded with limited effectiveness | - data have some accuracy;<br><br>- data are recorded with some effectiveness | - data have considerable accuracy;<br><br>- data are recorded with considerable effectiveness | - data have a high degree of accuracy;<br><br>- data are recorded with a high degree of effectiveness |
| **Communication** Graphs | - constructed with limited accuracy<br><br>- format has limited effectiveness | - constructed with some accuracy<br><br>- format has some effectiveness | - constructed with considerable accuracy<br><br>- format has considerable effectiveness | - constructed with a high degree of accuracy<br><br>- format is highly effective |
| **Knowledge/ Understanding** Conclusion | - relates in a limited way to the hypothesis;<br><br>- limited substantiation by the data | - relates somewhat to the hypothesis;<br><br>- some substantiation by the data | - relates to the hypothesis;<br><br>- considerable substantiation by the data | - relates precisely to the hypothesis;<br><br>- thorough substantiation by the data |

**Note:** A student whose achievement is less than Level 1 (50%) has not met the expectations for this assignment of activity.