# Environmental Science, Grade 11

## University/College Preparation **SVN3M**

This course provides students with the fundamental knowledge of and skills relating to environmental science that will help them succeed in life after secondary school. Students will explore a range of topics, including the role of science in addressing contemporary environmental challenges; the impact of the environment on human health; sustainable agriculture and forestry; the reduction and management of waste; and the conservation of energy. Students will increase their scientific and environmental literacy and examine the interrelationships between science, the environment, and society in a variety of areas.

**Prerequisite:** Grade 10 Science, Applied or Academic

### Big Ideas

***Scientific Solutions to Contemporary Environmental Challenges***

- Current environmental issues are complex, and may involve conflicting interests or ideas.
- Scientific knowledge enables people to make informed decisions about effective ways to address environmental challenges.

***Human Health and the Environment***

- Environmental factors can have negative effects on human health.
- It is possible to minimize some of the negative health effects of environmental factors by making informed lifestyle choices and taking other precautions.

***Sustainable Agriculture and Forestry***

- Modern agricultural and forestry practices can have positive and negative consequences for the economy, human health, and the sustainability of ecosystems, both local and global.

***Reducing and Managing Waste***

- Well-thought-out waste management plans help to sustain ecosystems, locally and globally.
- By making informed choices, consumers can reduce the amount or alter the nature of the waste they produce.

***Conservation of Energy***

- The impact of energy production and consumption on environmental sustainability depends on which resources and energy production methods are used.

## Fundamental Concepts Covered in This Course (see also page 5)

| Fundamental Concepts | Scientific Solutions to Contemporary Environmental Challenges | Human Health and the Environment | Sustainable Agriculture and Forestry | Reducing and Managing Waste | Conservation of Energy |
|---|---|---|---|---|---|
| Matter | ✓ | ✓ | ✓ | ✓ | |
| Energy | ✓ | ✓ | ✓ | ✓ | ✓ |
| Systems and Interactions | ✓ | ✓ | | ✓ | |
| Structure and Function | | ✓ | | ✓ | ✓ |
| Sustainability and Stewardship | ✓ | ✓ | ✓ | ✓ | ✓ |
| Change and Continuity | ✓ | | | | |

# A. SCIENTIFIC INVESTIGATION SKILLS AND CAREER EXPLORATION

## OVERALL EXPECTATIONS

Throughout this course, students will:

**A1.** demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);

**A2.** identify and describe careers related to the fields of science under study, and describe the contributions of scientists, including Canadians, to those fields.

## SPECIFIC EXPECTATIONS

### A1. Scientific Investigation Skills

Throughout this course, students will:

#### Initiating and Planning [IP]*

**A1.1** formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research

**A1.2** select appropriate instruments (e.g., probes, moisture meters, rain gauges), and materials (e.g., water-sampling kits, soil-testing kits), and identify appropriate methods, techniques, and procedures, for each inquiry

**A1.3** identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately

**A1.4** apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory materials; and by using appropriate personal protection

#### Performing and Recording [PR]*

**A1.5** conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data

**A1.6** compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams

**A1.7** select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and/or human sources, using suitable formats and an accepted form of academic documentation

#### Analysing and Interpreting [AI]*

**A1.8** synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error

**A1.9** analyse the information gathered from research sources for logic, accuracy, reliability, adequacy, and bias

* The abbreviation(s) for the broad area(s) of investigation skills – IP, PR, AI, and/or C – are provided in square brackets at the end of the expectations in strands B–F to which the particular area(s) relate (see pp. 20–22 for information on scientific investigation skills).

**A1.10** draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge

### Communicating [C]*

**A1.11** communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

**A1.12** use appropriate numeric, symbolic, and graphic modes of representation, and appropriate units of measurement (e.g., SI and imperial units)

**A1.13** express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places or significant figures

## A2. Career Exploration

Throughout this course, students will:

**A2.1** identify and describe a variety of careers related to the fields of science under study (e.g., organic chemist, landscaper, conservationist, air quality technician, personal support worker, environmental lawyer) and the education and training necessary for these careers

**A2.2** describe the contributions of scientists, including Canadians (e.g., Pierre Dansereau, Margaret Newton, Johan F. Dormaar, Sheila Watt-Cloutier, Severn Cullis-Suzuki), to the fields under study

# B. SCIENTIFIC SOLUTIONS TO CONTEMPORARY ENVIRONMENTAL CHALLENGES

## OVERALL EXPECTATIONS

By the end of this course, students will:

**B1.** analyse social and economic issues related to an environmental challenge, and how societal needs influence scientific endeavours related to the environment;

**B2.** investigate a range of perspectives that have contributed to scientific knowledge about the environment, and how scientific knowledge and procedures are applied to address contemporary environmental problems;

**B3.** demonstrate an understanding of major contemporary environmental challenges and how we acquire knowledge about them.

## SPECIFIC EXPECTATIONS

### B1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

**B1.1** analyse, on the basis of research, social and economic issues related to a particular environmental challenge (e.g., overfishing, deforestation, acid rain, melting of the polar ice cap) and to efforts to address it [IP, PR, AI, C]

*Sample issue:* Greenhouse gas emissions from motor vehicles are a major contributor to global warming. The use of ethanol and other biofuels in motor vehicles reduces these emissions. However, diverting crops from food production to fuel production can increase prices and decrease the supply of food.

*Sample questions:* What are some of the social and economic challenges associated with cleaning up and conserving fresh water supplies? What are some alternative energy sources? What social and economic challenges are associated with their development? In what ways can consuming locally grown foods help the local economy, society, and the environment?

**B1.2** analyse ways in which societal needs or demands have influenced scientific endeavours related to the environment (e.g., the development of drought- and pest-resistant crops to address the rising global need for food; research into alternative energy sources in response to demands to address the impact on climate change of burning fossil fuels) [AI, C]

*Sample issue:* Because of unstable oil prices and the environmental damage caused by motor vehicle emissions, many consumers have been demanding more environmentally friendly vehicles. As a result, car companies are devoting greater resources towards the development of more fuel-efficient engines, hybrid vehicles, and cars powered by electricity or other types of energy.

*Sample questions:* How and why do demands by environmentally conscious consumers affect the types of products developed by corporations? What impact have the energy needs of remote communities had on innovations in the development of off-grid energy sources? What types of products have been developed in response to the health threats resulting from ozone depletion?

## B2. Developing Skills of Investigation and Communication

By the end of this course, students will:

**B2.1** use appropriate terminology related to the application of scientific knowledge and procedures to environmental issues, including, but not limited to: *fact, inference, paradigm, objectivity,* and *causality* [C]

**B2.2** plan and conduct a laboratory inquiry to test a scientific procedure used to address a contemporary environmental problem (e.g., an oil spill, acid precipitation) [IP, PR, AI]

**B2.3** investigate, through research or using case studies or computer simulation, how scientific knowledge and procedures are applied to address a particular contemporary environmental issue (e.g., scientific data on the needs and habits of endangered species are used to develop plans to protect threatened species; life-cycle assessments are conducted to determine the total environmental impact of a consumer product) [PR, AI]

**B2.4** use a research process to investigate how evidence, theories, and paradigms reflecting a range of perspectives have contributed to our scientific knowledge about the environment (e.g., with respect to debates about climate change; regarding the relationship between the cod moratorium and seal populations in Atlantic Canada), and communicate their findings [IP, PR, AI, C]

**B2.5** use a research process to locate a media report on a contemporary environmental issue (e.g., climate change, melting of the polar ice cap, deforestation), summarize its arguments, and assess their validity from a scientific perspective [IP, PR, AI, C]

## B3. Understanding Basic Concepts

By the end of this course, students will:

**B3.1** identify some major contemporary environmental challenges (e.g., global warming, acid precipitation), and explain their causes (e.g., deforestation, carbon and sulfur emissions) and effects (e.g., desertification, the creation of environmental refugees, the destruction of aquatic and terrestrial habitats)

**B3.2** describe how scientists use a variety of processes (e.g., environmental impact assessments, environmental scans) to solve problems and answer questions related to the environment

**B3.3** explain how new evidence affects scientific knowledge about the environment and leads to modifications of theory and/or shifts in paradigms (e.g., the impact of evidence of the effects of carbon dioxide emissions on theories of global warming)

**B3.4** explain how an environmental challenge has led to advances in science or technology (e.g., scrubbers on smokestacks to decrease sulfur dioxide emissions, hybrid cars)

**B3.5** describe a variety of human activities that have led to environmental problems (e.g., burning fossil fuels for transportation or power generation; waste disposal) and/or contributed to their solution (e.g., the development of renewable sources of energy; programs to reduce, reuse, and recycle)

# C. HUMAN HEALTH AND THE ENVIRONMENT

## OVERALL EXPECTATIONS

By the end of this course, students will:

**C1.** analyse initiatives, both governmental and non-governmental, that are intended to reduce the impact of environmental factors on human health;

**C2.** investigate environmental factors that can affect human health, and analyse related data;

**C3.** demonstrate an understanding of various environmental factors that can affect human health, and explain how the impact of these factors can be reduced.

## SPECIFIC EXPECTATIONS

### C1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

**C1.1** analyse grassroots initiatives that are intended to reduce the impact of environmental factors on human health (e.g., community cleanup of local aquatic or terrestrial environments; class action lawsuits against major polluters) [AI, C]

*Sample issue:* People from the Grassy Narrows Reserve in Northern Ontario were experiencing chronic health problems. They commissioned a study, which found that many animals and fish that were part of a traditional diet were contaminated with mercury and heavy metals. Guidelines were proposed to limit consumption of the affected animals, and thereby improve people's health.

*Sample questions:* Are there any grassroots groups in your community concerned with the state of the environment and its impact on human health? What types of actions do they take? What action has been taken by the Bulkley Valley and Lakes District Airshed Management Society to help reduce the impact of particulate matter in air on the health of local people? What is the Yellow Fish Road program, and how does it try to reduce the number of contaminants in local water sources?

**C1.2** evaluate the effectiveness of government initiatives that are intended to reduce the impact of environmental factors on human health (e.g., Ontario Ministry of the Environment smog advisories; provincial laws regulating drinking water; WHMIS regulations on hazardous material) [AI, C]

*Sample issue:* To protect the health of people who live on the street, the City of Toronto issues heat and cold alerts, opening cooling centres or heated shelters where people can escape extreme weather conditions. However, not everyone is aware of these services, and there are not always enough spaces to meet needs.

*Sample questions:* Why does the Ontario Ministry of the Environment issue smog advisories? Why are there concerns about the water quality in many First Nations communities in Canada? Why did the water treatment plant in Kashechewan, in Northern Ontario, fail to protect the community from contaminated water?

### C2. Developing Skills of Investigation and Communication

By the end of this course, students will:

**C2.1** use appropriate terminology related to human health and the environment, including, but not limited to: *contaminants, heavy metals, air pollution,* and *pesticide* [C]

**C2.2** analyse longitudinal data to determine the impact of various environmental factors that affect human health (e.g., air temperature, atmospheric greenhouse gases, contaminants in drinking water) [AI]

**C2.3** investigate, through laboratory inquiry or field study, water samples from natural and disturbed environments (e.g., tap water; pond, river, or lake water from disturbed and undisturbed areas; water from an outdoor pool), and analyse the resulting data [PR, AI]

**C2.4** analyse, on the basis of a laboratory inquiry, computer simulation, or field study, particulate matter in air (e.g., an air sample from an exhaust pipe or air vent, particles in a filter that cigarette smoke has passed through, particles caught on sticky paper set up in an open area) [PR, AI]

**C2.5** investigate health standards for buildings and methods to retrofit or otherwise improve structures to reduce their negative impact on human health (e.g., the use of materials that do not contain volatile organic compounds, the use of biological air and water filters), and communicate their findings [PR, C]

## C3. Understanding Basic Concepts

By the end of this course, students will:

**C3.1** identify the main pollutants and environmental contaminants that can affect human health (e.g., air pollutants such as sulfur dioxide, nitrous oxide, and particulates; noise pollution; heavy metals such as lead and mercury; DDT; PCBs; mould; volatile organic compounds such as acetone and chlorinated solvents)

**C3.2** describe the effects of a variety of environmental factors on human health (e.g., air pollutants are associated with disorders such as asthma; consumption of fish products from contaminated water may lead to increased levels of heavy metals in the human body; the thinning of the ozone layer may lead to increased incidence of skin cancer; noise pollution may impair hearing)

**C3.3** describe ways in which a variety of environmental contaminants (e.g., volatile organic compounds in paints, carpets, and cleaning products; mercury in fish; E. coli in the water at public beaches) can enter the human body (e.g., inhalation, ingestion, absorption)

**C3.4** describe measures that can reduce exposure to environmental contaminants (e.g., wearing protective clothing or sunscreen, or remaining indoors during peak UV hours, to prevent exposure to ultraviolet rays; avoiding the use of paints, solvents, and cleaning agents that contain volatile organic compounds)

**C3.5** identify a variety of populations who are particularly vulnerable to the effects of environmental factors, and explain why these populations are vulnerable (e.g., seniors are vulnerable to extreme temperatures because the ability to regulate body temperature diminishes as people age; Inuit who follow a traditional diet are vulnerable to contaminants that accumulate in the fatty tissue of sea mammals because these animals are their main food source)

# D. SUSTAINABLE AGRICULTURE AND FORESTRY

## OVERALL EXPECTATIONS

By the end of this course, students will:

**D1.** evaluate the impact of agricultural and forestry practices on human health, the economy, and the environment;

**D2.** investigate conditions necessary for plant growth, including the soil components most suitable for various species, and various environmentally sustainable methods that can be used to promote growth;

**D3.** demonstrate an understanding of conditions required for plant growth and of a variety of environmentally sustainable practices that can be used to promote growth.

## SPECIFIC EXPECTATIONS

### D1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

**D1.1** evaluate, on the basis of research, a variety of agricultural and forestry practices (e.g., companion planting, biological pest control, the use of genetically modified seed, forest fire control) with respect to their impact on the economy and the environment (e.g., the use of nematodes eliminates crop damage from grubs, thus contributing to better harvests, while reducing the use of toxic chemical pesticides; under some circumstances, forest thinning can help prevent or reduce the seriousness of forest fire, and its economic and environmental consequences) [IP, PR, AI, C]

*Sample issue:* The recycling of animal waste as fertilizer is economical and is generally considered an environmentally sustainable practice. However, care must be taken that the manure does not run off into water sources, as it can contaminate them with E. coli and other bacteria.

*Sample questions:* What are the economic and environmental pros and cons of growing crops that are genetically modified to be herbicide resistant? Why is organic produce more expensive than conventionally grown produce? What are the economic advantages of monoculture, both on farms and in forestry operations? How can monocultural practices lead to environmental degradation? What types of forestry practices can be implemented to maintain features of old-growth ecosystems while harvesting trees?

**D1.2** evaluate, on the basis of research, the impact, including the long-term impact, of agricultural and forestry practices on human health (e.g., the use of chemical fertilizers and pesticides; the use of growth hormones and antibiotics in livestock; the use of feed containing animal by-products; the clear-cutting of forests) [IP, PR, AI, C]

*Sample issue:* The toxins in pesticides can accumulate in the human body over the years. Although the immediate effects of exposure to pesticide may be unnoticeable, the chemicals build up in body fat and organs and can lead to a variety of cancers.

*Sample questions:* What was the source of contamination of well water in Walkerton, Ontario, in 2000? What are the immediate and long-term health effects of exposure to E. coli? What is known about the long-term effects of consuming genetically modified food? What impact could the spraying of forest canopies to prevent gypsy moth infestations have on human health?

## D2. Developing Skills of Investigation and Communication

By the end of this course, students will:

**D2.1** use appropriate terminology related to sustainable agriculture and forestry, including, but not limited to: *bioremediation, crop rotation, companion planting, organic product, humus, compost, mulch, silviculture,* and *naturalization* [C]

**D2.2** test samples of a variety of types of soil (e.g., clay, loam, commercial potting soil) to determine their nutrients and composition (e.g., pH; the percentage of nitrogen, phosphorus, and potassium; porosity; moisture) [PR, AI]

**D2.3** use an inquiry process to investigate the nutrients in and composition of a variety of compost samples (e.g., nutrients such as nitrogen, phosphorous, potassium; composition with respect to pH, porosity), and analyse the findings to determine appropriate uses for each sample [IP, PR, AI]

**D2.4** prepare a soil mixture (e.g., using compost, manure, vermiculite, black earth, top soil, peat moss, loam, and/or sand) for a selected plant species, based on analysis of the criteria for optimal growth for that species (e.g., cactus, tomato plants, wheat, jack pine) [PR, AI]

**D2.5** use a research process to investigate environmentally sustainable methods of managing and maintaining healthy and productive agricultural zones and forests (e.g., companion planting, crop rotation, selective tree-harvesting, planting a diverse canopy) [IP, PR]

**D2.6** design a landscaping project for their local area (e.g., a rooftop garden, a plot in a community garden, a riparian restoration), taking into account local conditions (e.g., zone hardiness, soil composition, amount of sunlight and rainfall), and propose a course of action to ensure the sustainability of the project and its healthy interaction with the surrounding environment (e.g., companion gardening, the use of compost to fertilize the soil, the use of native plants, the inclusion of plants that attract birds or butterflies) [IP, PR, AI]

## D3. Understanding Basic Concepts

By the end of this course, students will:

**D3.1** explain the basic principles of various agricultural and forestry practices (e.g., Integrated Pest Management), and identify regulations and regulatory bodies associated with these practices (e.g., Health Canada's Pest Management Regulatory Agency [PMRA], the Pest Control Products Act)

**D3.2** describe the basic requirements for plant growth (e.g., growing medium, light, moisture, nutrients)

**D3.3** describe the soil components (e.g., pH, moisture, the percentage of humus, porosity with respect to water and air) needed by a variety of plants for optimal growth

**D3.4** explain different ecologically sound practices for improving and maintaining soil structure and fertility (e.g., crop rotation, fallowing, adding compost or manure, inter-seeding grains and legumes, mulching, tree harvesting using a shelterwood system)

**D3.5** explain agricultural techniques and forestry practices that aim to maintain both biodiversity and long-term productivity (e.g., growing a variety of species, inter-planting crops, planting native and heritage varietals instead of hybrids or transgenic species, saving seeds, maintaining some older trees and snags for animal habitat)

**D3.6** describe sustainable water-management practices in agricultural and forestry settings (e.g., regulating the frequency of watering, planting species suited to local precipitation levels, limiting run-off and erosion)

# E. REDUCING AND MANAGING WASTE

## OVERALL EXPECTATIONS

By the end of this course, students will:

**E1.** analyse economic, political, and environmental considerations affecting waste management strategies;

**E2.** investigate the effectiveness of various waste management practices;

**E3.** demonstrate an understanding of the nature and types of waste and strategies for its management.

## SPECIFIC EXPECTATIONS

### E1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

**E1.1** analyse, on the basis of research, the impact of economic and political considerations on the development of waste management practices or strategies (e.g., incineration of hazardous waste; biological filtration and reuse of greywater; user fees for garbage disposal; vermicomposting) [IP, PR, AI, C]

*Sample issue:* The use of landfill sites has been a long-time strategy for disposal of garbage. As local sites fill up, some municipalities are shipping their garbage to distant sites. This strategy is often politically unpopular and, with high fuel prices, is increasingly expensive, so local politicians are under pressure to implement new strategies.

*Sample questions:* What are the costs of recycling compared to the costs of using landfill sites or incinerating garbage? Why is garbage incineration a controversial political issue? Why do municipal recycling programs recycle only a limited number of items?

**E1.2** evaluate the short- and long-term impact on the environment of a specific type of waste (e.g., waste products from animal farming; plastic shopping bags; tailings from mines) [AI, C]

*Sample issue:* Non-rechargeable batteries can be convenient, but their disposal presents problems. Batteries contain heavy metals and corrosive substances that can contaminate landfill sites and leach into surrounding soil or water. Ontario municipalities designate batteries as hazardous waste, yet some people continue to throw them in the garbage.

*Sample questions:* What impact do disposable diapers have on the environment? What effects does the dumping of solid waste into lakes, rivers, or oceans have on aquatic life? How long does it take polystyrene, widely used to make food and drink containers, to break down? What environmental challenges are associated with nuclear waste?

### E2. Developing Skills of Investigation and Communication

By the end of this course, students will:

**E2.1** use appropriate terminology related to waste management, including, but not limited to: *solid, liquid, and gaseous waste; toxic waste; heavy metal; chlorinated hydrocarbons;* and *polychlorinated biphenyls (PCBs)* [C]

**E2.2** plan and conduct an inquiry in a micro-environment to treat a solid, liquid, or gaseous waste (e.g., reduce the acidity in a closed bog system in an aquarium; use a vermicomposter to recycle solid organic matter) [IP, PR]

**E2.3** use a research process to investigate the waste generated throughout the life cycle of a product (e.g., the waste associated with all the materials and energy that go into the development and disposal of a computer or a running shoe) [IP, PR]

**E2.4** plan and conduct a waste audit within their school, and propose a plan of action for waste reduction based on their findings (e.g., review the school's policy regarding paper and plastic recycling, monitor actual practices, and propose strategies to improve them) [IP, PR, AI, C]

**E2.5** investigate a local, regional, national, or global waste management practice (e.g., local practices such as recycling or charging for residential and/or commercial garbage bags; shipping garbage to landfill sites in another region; disposal of nuclear waste; dumping raw sewage into rivers, lakes, oceans), and communicate their findings [PR, C]

## E3. Understanding Basic Concepts

By the end of this course, students will:

**E3.1** describe different categories of waste (e.g., biodegradable, recyclable, toxic, organic, inorganic)

**E3.2** explain some current waste remediation practices used with substances or products that are not environmentally friendly (e.g., "Toxic Taxi" for pick-up of household hazardous waste; the recycling of plastic to make furniture and "lumber")

**E3.3** describe the scientific principles involved in processing solid, liquid, and gaseous waste (e.g., combustion, decomposition, pyrolysis)

**E3.4** explain common strategies and technologies used in the collection and storage of waste (e.g., strategies such as recycling, composting, dumping in landfill sites; technologies such as compacters, enzyme digesters, flocculation tanks)

**E3.5** explain how scientific knowledge and technological processes have been applied in the development of environmentally sound waste management strategies (e.g., accelerated waste aeration, bioremediation)

# F. CONSERVATION OF ENERGY

## OVERALL EXPECTATIONS

By the end of this course, students will:

**F1.** assess the impact on society and the environment of the use of various renewable and non-renewable energy sources, and propose a plan to reduce energy consumption;

**F2.** investigate various methods of conserving energy and improving energy efficiency;

**F3.** demonstrate an understanding of energy production, consumption, and conservation with respect to a variety of renewable and non-renewable sources.

## SPECIFIC EXPECTATIONS

### F1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

**F1.1** evaluate the impact on the environment of renewable and non-renewable energy sources, and propose an environmentally friendly solution to reduce non-renewable energy consumption (e.g., a plan for broader use of hybrid cars or solar panels) [AI, C]

*Sample issue:* In some remote areas that are off the electrical grid, generators that run on fossil fuels are used to generate electricity. However, these devices are inefficient, and they produce carbon dioxide, which contributes to global warming, and noise pollution.

*Sample questions:* What impact can hydroelectric dams and generating stations have on the local environment? What effects do coal mining and the use of coal-burning power plants have on the local, regional, and global environment? How can the use of ethanol reduce the amount of petroleum needed to run cars?

**F1.2** assess the costs and benefits to society of the use of renewable and non-renewable energy sources, using a variety of criteria (e.g., associated health concerns, reliability, ability to meet demand, start-up and production costs) [AI, C]

*Sample issue:* The extraction, processing, and burning of fossil fuels damage the environment. However, some fossil fuels, such as coal, are plentiful and therefore a reliable source of energy. Some alternative energy sources, such as wind and solar power, are less reliable, and their unit costs are much higher.

*Sample questions:* How do the costs of coal and geothermal power compare? Do these costs change when environmental costs and benefits of the two sources are factored in? What are the health concerns associated with nuclear power? Why are wind and solar power less reliable than fossil fuel sources? How could that change?

### F2. Developing Skills of Investigation and Communication

By the end of this course, students will:

**F2.1** use appropriate terminology related to energy conservation, including, but not limited to: *renewable resource*, *non-renewable resource*, and *R-value*

**F2.2** investigate energy consumption and costs in their household over a given period of time, and suggest ways in which their household could conserve energy [PR, AI, C]

**F2.3** plan and conduct an energy audit of a home or business, and propose ways to improve its energy efficiency [IP, PR, AI, C]

**F2.4** design and construct a working model of a device that uses an alternative energy source (e.g., a wind generator, a solar-powered car, a "fan boat") [IP, PR]

**F2.5** plan and conduct an inquiry to evaluate the effectiveness of various insulation materials and/or techniques (e.g., straw, foam, fibreglass, blown cellulose) [IP, PR, AI]

## F3. Understanding Basic Concepts

By the end of this course, students will:

**F3.1** explain the historical significance of a variety of energy sources (e.g., whale oil, coal), and describe their long-term impact on the environment

**F3.2** describe the characteristics of a sustainable energy system (e.g., equitable access to the source, long-term availability, limited environmental impact)

**F3.3** explain the basic principles and characteristics of various types of renewable (e.g., tidal, geothermal, solar, wind) and non-renewable (e.g., coal, oil, gas) energy production and their impact on the environment

**F3.4** describe methods of energy production and conservation intended to reduce greenhouse gas emissions (e.g., energy production methods at the Prince Edward Island Wind-Hydrogen Village; charging higher prices for energy used during peak hours)

**F3.5** describe technological advances aimed at reducing energy consumption (e.g., programmable thermostats, improved R-value in insulation, compact fluorescent light bulbs, rechargeable batteries, "smart meters")