2008

REVISED

The Ontario Curriculum
Grades 9 and 10

Science

reach every student

Ontario

Science, Grade 9

Academic SNC1D

This course enables students to develop their understanding of basic concepts in biology, chemistry, earth and space science, and physics, and to relate science to technology, society, and the environment. Throughout the course, students will develop their skills in the processes of scientific investigation. Students will acquire an understanding of scientific theories and conduct investigations related to sustainable ecosystems; atomic and molecular structures and the properties of elements and compounds; the study of the universe and its properties and components; and the principles of electricity.

Prerequisite: None

Big Ideas

Biology

- Ecosystems are dynamic and have the ability to respond to change, within limits, while maintaining their ecological balance.
- People have the responsibility to regulate their impact on the sustainability of ecosystems in order to preserve them for future generations.

Chemistry

- Elements and compounds have specific physical and chemical properties that determine their practical uses.
- The use of elements and compounds has both positive and negative effects on society and the environment.

Earth and Space Science

- Different types of celestial objects in the solar system and universe have distinct properties that can be investigated and quantified.
- People use observational evidence of the properties of the solar system and the universe to develop theories to explain their formation and evolution.
- Space exploration has generated valuable knowledge but at enormous cost.

Physics

- Electricity is a form of energy produced from a variety of non-renewable and renewable sources.
- The production and consumption of electrical energy has social, economic, and environmental implications.
- Static and current electricity have distinct properties that determine how they are used.

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

Fundamental Concepts	Biology	Chemistry	Earth and Space Science	Physics
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 a variety of careers related to the fields of science under study, and identify scientists, including Canadians, who have made contributions to those fields.

SPECIFIC EXPECTATIONS

A1. Scientific Investigation Skills

Throughout this course, students will:

Initiating and Planning [IP]*

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

A1.2 select appropriate instruments (e.g., sampling instruments, laboratory glassware, magnifying lenses, an electroscope) and materials (e.g., ebonite rods, star charts, a ball and spring apparatus, pH paper) for particular inquiries

A1.3 identify and locate print, electronic, and human sources that are relevant to research questions

A1.4 apply knowledge and understanding of safe practices and procedures when planning investigations (e.g., appropriate techniques for handling, storing, and disposing of laboratory materials [following the Workplace Hazardous Materials Information System–WHMIS]; safe operation of electrical equipment; safe handling of biological materials), with the aid of appropriate support materials (e.g., the Reference Manual on the WHMIS website; the Live Safe! Work Smart! website)

Performing and Recording [PR]*

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

A1.6 gather 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 various sources, including electronic, print, and/or human sources (e.g., Statistics Canada publications, NASA or EnerGuide websites, personal interviews), using recommended formats and an accepted form of academic documentation

Analysing and Interpreting [AI]*

A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty

A1.9 analyse the information gathered from research sources for reliability and bias

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

* 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–E to which the particular area(s) relate (see pp. 19–21 for information on scientific investigation skills).

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

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., astrophysicist, geophysicist, conservation officer, park warden, fire protection engineer, hydrologist, electrician) and the education and training necessary for these careers

A2.2 identify scientists, including Canadians (e.g., David Suzuki, Howard Alper, Roberta Bondar, Kenneth Hill), who have made a contribution to the fields of science under study

B. BIOLOGY: SUSTAINABLE ECOSYSTEMS

OVERALL EXPECTATIONS

By the end of this course, students will:

B1. assess the impact of human activities on the sustainability of terrestrial and/or aquatic ecosystems, and evaluate the effectiveness of courses of action intended to remedy or mitigate negative impacts;

B2. investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems;

B3. demonstrate an understanding of the dynamic nature of ecosystems, particularly in terms of ecological balance and the impact of human activity on the sustainability of terrestrial and aquatic ecosystems.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

B1.1 assess, on the basis of research, the impact of a factor related to human activity (e.g., urban sprawl, introduction of invasive species, overhunting/overfishing) that threatens the sustainability of a terrestrial or aquatic ecosystem [IP, PR, AI, C]

Sample issue: The Great Lakes constitute an important shipping route. Foreign ships often empty their ballast water, which can contain invasive species, directly into the lakes. The goby, which was likely imported in ballast water, is an aggressive fish that has taken over the spawning grounds of some native species, threatening the balance of the ecosystem.

Sample questions: How has suburban development on the Niagara Escarpment or the Oak Ridges Moraine affected local ecosystems? How has the zebra mussel population in Lake Erie affected aquatic species and water quality? How has commercial logging affected the sustainability of forests in Northern Ontario?

B1.2 evaluate the effectiveness of government initiatives in Canada (federal, provincial, municipal), and/or the efforts of societal groups or non-governmental organizations, such as Aboriginal communities, environmental groups, or student organizations, with respect to an environmental issue that affects the sustainability of terrestrial or aquatic ecosystems (e.g., wetland restoration, recycling programs, Canada–Ontario Environmental Farm Plans, stewardship of national and provincial parks) [AI, C]

Sample issue: Landfill sites can have negative effects on adjacent ecosystems, attracting pests, leaching toxic chemicals, and producing greenhouse gases. Municipal recycling and composting programs divert garbage, reducing the need for new landfill sites. However, many people, particularly rural residents and those in apartment buildings, may not be included in these programs.

Sample questions: What provincial or federal legislation attempts to protect special features or sensitive elements of terrestrial or freshwater ecosystems? How could such legislation be more effective? How have the actions of local wetland-reclamation, municipal tree-planting, Aboriginal fisheries-management, Great Lakes–rehabilitation, organic farming, or other groups helped to ensure ecological sustainability? What further action could such groups take?

B2. Developing Skills of Investigation and Communication

By the end of this course, students will:

B2.1 use appropriate terminology related to sustainable ecosystems, including, but not limited to: *bioaccumulation, biosphere, diversity, ecosystem, equilibrium, sustainability, sustainable use, protection,* and *watershed* [C]

B2.2 interpret qualitative and quantitative data from undisturbed and disturbed ecosystems (terrestrial and/or aquatic), communicate the results graphically, and, extrapolating from the data, explain the importance of biodiversity for all sustainable ecosystems [PR, AI, C]

B2.3 plan and conduct an investigation, involving both inquiry and research, into how a human activity affects soil composition or soil fertility (e.g., changes to soil composition resulting from the use of different compostable materials, organic or inorganic fertilizers, or pesticides), and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of terrestrial ecosystems [IP, PR, AI, C]

B2.4 plan and conduct an investigation, involving both inquiry and research, into how a human activity affects water quality (e.g., leaching of organic or inorganic fertilizers or pesticides into water systems, changes to watersheds resulting from deforestation or land development, diversion of ground water for industrial uses), and, extrapolating from the data and information gathered, explain the impact of this activity on the sustainability of aquatic ecosystems [IP, PR, AI, C]

B2.5 analyse the effect of human activity on the populations of terrestrial and aquatic ecosystems by interpreting data and generating graphs (e.g., data from Statistics Canada, Parks Canada, and other websites on: the concentration in water of chemicals from fertilizer run-off and their effect on the growth of algae; stressors associated with human use of natural areas, such as trampled vegetation, wildlife mortality from motor vehicles, and the removal of plants, animals, and/or natural objects; suburban developments and their impact on the food supply for animals such as foxes and racoons) [PR, AI, C]

B3. Understanding Basic Concepts

By the end of this course, students will:

B3.1 compare and contrast biotic and abiotic characteristics of sustainable and unsustainable terrestrial and aquatic ecosystems

B3.2 describe the complementary processes of cellular respiration and photosynthesis with respect to the flow of energy and the cycling of matter within ecosystems (i.e., carbon dioxide is a by-product of cellular respiration and is used for photosynthesis, which produces oxygen needed for cellular respiration), and explain how human activities can disrupt the balance achieved by these processes (e.g., automobile use increases the amount of carbon dioxide in the atmosphere; planting more trees decreases the amount of carbon dioxide in the atmosphere)

B3.3 describe the limiting factors of ecosystems (e.g., nutrients, space, water, energy, predators), and explain how these factors affect the carrying capacity of an ecosystem (e.g., the effect of an increase in the moose population on the wolf population in the same ecosystem)

B3.4 identify the earth's four spheres (biosphere, hydrosphere, lithosphere, atmosphere), and describe the relationship that must exist between these spheres if diversity and sustainability are to be maintained

B3.5 identify various factors related to human activity that have an impact on ecosystems (e.g., the introduction of invasive species; shoreline development; industrial emissions that result in acid rain), and explain how these factors affect the equilibrium and survival of ecosystems (e.g., invasive species push out native species and upset the equilibrium in an ecosystem; shoreline development affects the types of terrestrial and aquatic life that can live near lake shores or river banks; acid rain changes the pH of water, which affects the type of aquatic life that can survive in a lake)

Science, Grade 10

Applied SNC2P

This course enables students to develop a deeper understanding of concepts in biology, chemistry, earth and space science, and physics, and to apply their knowledge of science in real-world situations. Students are given opportunities to develop further practical skills in scientific investigation. Students will plan and conduct investigations into everyday problems and issues related to human cells and body systems; chemical reactions; factors affecting climate change; and the interaction of light and matter.

Prerequisite: Science, Grade 9, Academic or Applied

Big Ideas

Biology

- All animals are made of specialized cells, tissues, and organs that are organized into systems.
- Although technology and chemicals can be used to improve human health, they can also constitute a health hazard.

Chemistry

- Chemicals react with one another in predictable ways.
- Chemical reactions are a necessary component of chemical products and processes used in the home and workplace.

Earth and Space Science

- Global climate change is affected by both natural and human factors.
- Climate change affects living things and natural systems in a variety of ways.

Physics

- A wide range of technologies utilize the properties of light and colour.
- The behaviour of light depends on the materials with which it interacts.
- Light is a form of energy, produced from a variety of sources, and can be transformed into other useful forms of energy.

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

Fundamental Concepts	Biology	Chemistry	Earth and Space Science	Physics
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 a variety of careers related to the fields of science under study, and identify scientists, including Canadians, who have made contributions to those fields.

SPECIFIC EXPECTATIONS

A1. Scientific Investigation Skills

Throughout this course, students will:

Initiating and Planning [IP]*

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

A1.2 select appropriate instruments (e.g., a microscope, laboratory glassware, an optical bench) and materials (e.g., prepared slides, an aquarium, lenses, acid–base indicators) for particular inquiries

A1.3 identify and locate print, electronic, and human sources that are relevant to research questions

A1.4 apply knowledge and understanding of safe practices and procedures when planning investigations (e.g., appropriate techniques for handling, storing, and disposing of laboratory materials [following the Workplace Hazardous Materials Information System–WHMIS]; safe operation of optical equipment; safe handling and disposal of biological materials), with the aid of appropriate support materials (e.g., the Reference Manual on the WHMIS website; the Live Safe! Work Smart! website)

Performing and Recording [PR]*

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

A1.6 gather 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 various sources, including electronic, print, and/or human sources (e.g., a website for a public health organization, federal and provincial government publications, reference books, personal interviews), using recommended formats and an accepted form of academic documentation

Analysing and Interpreting [AI]*

A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty

A1.9 analyse the information gathered from research sources for reliability and bias

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

* 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–E to which the particular area(s) relate (see pp. 19–21 for information on scientific investigation skills).

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

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., veterinarian assistant, quality control technician, conservation officer, sound and light technician) and the education and training necessary for these careers

A2.2 identify scientists, including Canadians (e.g., Maude Abbott, Paul Kebarle, Reginald Fessenden, James Hillier), who have made a contribution to the fields of science under study

B. BIOLOGY: TISSUES, ORGANS, AND SYSTEMS

OVERALL EXPECTATIONS

By the end of this course, students will:

B1. analyse some current technologies or substances that have an impact on human tissues, organs, or systems, and evaluate their effects on human health;

B2. investigate cell division, cell specialization, and the organization of systems in animals, including humans, using various laboratory techniques;

B3. demonstrate an understanding of the hierarchical organization of cells, from tissues, to organs, to systems in animals, including humans.

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, medical imaging technologies (e.g., ultrasound, X-rays, computerized axial tomography [CT or CAT] scan, magnetic resonance imaging [MRI], microscopy, biophotonics) used in Canada to explore, diagnose, or treat the human body, and communicate their findings [PR, AI, C]

Sample issue: The diagnostic use of nuclear isotopes has saved lives by providing more reliable diagnoses of certain diseases. However, in the longer term, nuclear medicine could have harmful effects on the human body.

Sample questions: How have today's X-rays improved over those in the past? How is ultrasound used to monitor fetal development? How has the development of imaging technologies improved the diagnosing of diseases not visible to the human eye?

B1.2 evaluate the effects that use of or exposure to a technology, substance, or environmental factor (e.g., cellphones, X-rays, UV radiation, personal audio players, cigarette smoke, pesticides, food additives/preservatives, vitamins, gene therapy) may have on the function of human tissues, organs, or systems [AI, C]

Sample issue: Cellphones are widely used in Canada. However, some studies have suggested that radiation emitted from cellphones may cause damage to the brain, particularly in children.

Sample questions: What impact does the ingestion of food additives have on the cells of the digestive system? What impact does smoking have on lung tissue? What effects does exposure to UV radiation have on skin? How can using a personal audio player affect a person's auditory system?

B2. Developing Skills of Investigation and Communication

By the end of this course, students will:

B2.1 use appropriate terminology related to human cells, tissues, organs, and systems, including, but not limited to: *absorption, anaphase, capillaries, concentration, differentiation, diffusion, interphase, metaphase, osmosis, prophase, red blood cells, regeneration,* and *telophase* [C]

B2.2 examine cells under a microscope or similar instrument to identify the various stages of mitosis in animals [PR, AI]

B2.3 investigate, using a microscope or similar instrument, cell specialization in the human body, focusing on different types of human cells (e.g., muscle cells, epithelial cells, nerve cells), and draw labelled biological diagrams of each type of cell [PR, C]

B2.4 compare, on the basis of observation (e.g., using pictures, videos, or images), the division of cancerous cells and non-cancerous cells, and describe the impact of cancerous cells on the human body [PR, AI]

B2.5 locate, through a laboratory or computer-simulated dissection, the organs of a specific system of an animal (e.g., a worm, a frog, a fish), and describe their interrelationship [PR, AI, C]

B2.6 use scientific investigation skills to research health problems related to tissues, organs, or systems in humans (e.g., asthma, sickle-cell anemia, heart disease, Crohn's disease), and communicate their findings [IP, PR, C]

B3. Understanding Basic Concepts

By the end of this course, students will:

B3.1 describe the cell cycle in animals, and explain its importance for the growth of cells and repair of tissues

B3.2 describe the structure, function, and importance of specialized cells and tissues in multi-cellular organisms (e.g., neurons have many branching dendrites and long axons to receive and transmit messages; muscle cells have a higher concentration of mitochondria, which produce energy)

B3.3 explain cell organization by describing the link between cells, tissues, organs, and systems in the human body

B3.4 explain the general function of some of the systems in the human body (e.g., the function of the circulatory system is to transport materials through the body; the function of the digestive system is to absorb nutrients; the function of the respiratory system is to bring oxygen into and remove carbon dioxide from the body)

B3.5 describe the interaction of systems in the human body (e.g., the respiratory system brings oxygen into the body, and the circulatory system transports the oxygen to cells), and explain why these interactions are necessary for survival

C. CHEMISTRY: CHEMICAL REACTIONS AND THEIR PRACTICAL APPLICATIONS

OVERALL EXPECTATIONS

By the end of this course, students will:

C1. analyse how chemical reactions are employed in common products and processes, and assess the safety and environmental hazards associated with them;

C2. investigate, through inquiry, the characteristics of simple chemical reactions;

C3. demonstrate an understanding of simple chemical reactions and the language and ways to represent them.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

C1.1 analyse, on the basis of research, the function of chemical reactions in the production of selected products and/or in processes commonly encountered at home or in the workplace (e.g., carbonation of soft drinks; rust proofing), and communicate their findings [IP, PR, AI, C]

Sample questions: How does the addition of ethanol to gasoline result in cleaner engine emissions? What chemical reactions are used in the rust-proofing process? How can chemical reactions affect the decomposition of important nutrients in food?

C1.2 identify practical applications of chemical reactions in a particular profession (e.g., ceramics, cosmetology, firefighting, heating and cooling system technology, food preparation, plumbing, custodial services), and assess the associated hazards, including hazards associated with the handling and disposal of chemicals [PR, AI, C]

Sample issue: Class B fire extinguishers containing ammonium phosphate, sodium bicarbonate, or potassium bicarbonate are effective in smothering fires involving flammable liquids. However, some of these chemicals are corrosive and can cause damage if introduced to an ecosystem.

Sample questions: How do lab technicians protect themselves from chemical reactions in their work environment? What applications of chemical reactions are used by hair stylists? What precautions can they take in using and disposing of the chemicals? What types of chemical reactions do chefs need to be aware of when they process or store food? What precautions should an auto mechanic take when changing the fluids in a car?

C2. Developing Skills of Investigation and Communication

By the end of this course, students will:

C2.1 use appropriate terminology related to chemical reactions, including, but not limited to: *antacid, dilute, neutralization, product, reactant,* and *word equation* [C]

C2.2 construct molecular models of simple chemical reactions (e.g., $C + O_2 \rightarrow CO_2$; $2H_2 + O_2 \rightarrow 2H_2O$), and produce diagrams of these models [PR, C]

C2.3 conduct and observe inquiries related to simple chemical reactions, including synthesis, decomposition, and displacement reactions, and represent them using a variety of formats (e.g., word equations, balanced chemical equations, molecular models) [PR, AI, C]

C2.4 use an inquiry process to investigate the law of conservation of mass in a chemical reaction (e.g., compare the values before and after the reaction), and account for any discrepancies [PR, AI]

C2.5 use an inquiry process to investigate acid–base neutralization reactions (e.g., neutralize a dilute solution of sodium hydroxide with dilute hydrochloric acid and extract the sodium chloride produced) [PR, AI]

C2.6 conduct an inquiry to classify some common substances as acidic, basic, or neutral (e.g., use acid–base indicators or pH strips to classify common household substances) [PR, AI]

C2.7 investigate applications of acid–base reactions in common products and processes (e.g., compare the effectiveness of different brands of antacid tablets, using quantitative analysis) [PR, AI]

C3. Understanding Basic Concepts

By the end of this course, students will:

C3.1 describe the relationships between chemical formulae, composition, and names of simple compounds (e.g., carbon dioxide, CO_2, has one more oxygen atom than carbon monoxide, CO)

C3.2 name and write the formulae for simple ionic and molecular compounds (e.g., NaCl, NaOH, H_2O, CO_2)

C3.3 write word equations and balanced chemical equations for simple chemical reactions (e.g., $2H_2 + O_2 \rightarrow 2H_2O$)

C3.4 describe the process of neutralization for simple acid–base reactions (i.e., an acid reacts with a base to form a salt and often water)

C3.5 describe how the pH scale is used to identify the concentration of acids and bases

D. EARTH AND SPACE SCIENCE: EARTH'S DYNAMIC CLIMATE

OVERALL EXPECTATIONS

By the end of this course, students will:

D1. analyse effects of human activity on climate change, and effects of climate change on living things and natural systems;

D2. investigate various natural and human factors that have an impact on climate change and global warming;

D3. demonstrate an understanding of various natural and human factors that contribute to climate change and global warming.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

D1.1 analyse, on the basis of research, various ways in which living things and natural systems have been affected by climate change (e.g., the effect of loss of permafrost on northern roads and housing; the effect of longer growing seasons in some regions on farmers; the effect of warming oceans on coral reefs), and communicate their findings [IP, PR, AI, C]

Sample issue: Some areas of Canada have been experiencing hotter and drier summers, resulting in poor harvests, loss of wetland habitat, and increased incidence of forest fires. However, in other areas, an increase in the number of frost-free days has extended the agricultural growing season.

Sample questions: What effect does climate change have on air quality and extreme weather phenomena? How does global warming increase the vulnerability of Canadian forests to fire and pests? How does the destruction of forests affect animals and humans?

D1.2 analyse ways in which human actions (e.g., burning fossil fuels, implementing tree-planting programs) have increased or decreased the production of greenhouse gases [AI, C]

Sample issue: Motor vehicle emissions are a major contributor to greenhouse gases. People can reduce such emissions by walking, biking, or using public transportation instead of driving; by keeping their vehicle in good operating condition; or by driving a hybrid vehicle.

Sample questions: Why do government and/or industry offer rebates to consumers buying programmable thermostats and compact fluorescent light bulbs? How does the production of oil from the Alberta oil sands contribute to greenhouse gas emissions? What is the difference in greenhouse gas emissions between a traditional SUV and a hybrid vehicle? What is "clean coal", and what is its impact on greenhouse gas emissions? How does large-scale livestock farming increase the production of greenhouse gases? What actions have you and/or your community taken to help reduce levels of greenhouse gases?

D2. Developing Skills of Investigation and Communication

By the end of this course, students will:

D2.1 use appropriate terminology related to Earth's dynamic climate, including, but not limited to: *anthropogenic, atmosphere, carbon footprint, carbon sink, climate, greenhouse gases, hydrosphere,* and *weather* [C]

D2.2 investigate the principles of the natural greenhouse effect, using simulations, diagrams, and/or models, and compare these principles to those of an actual greenhouse [PR, AI]

D2.3 use a research process to investigate a source of greenhouse gases (e.g., decaying garbage, animal digestive processes, burning biomass)

and its effect on a region of Canada (e.g., melting of the polar ice cap in the Arctic, shrinking of glaciers in the Rockies) [IP, PR, AI]

D2.4 conduct an inquiry to determine how different factors (e.g., an increase in surface temperature, an increase in water temperature) affect global warming and climate change [PR]

D2.5 investigate their personal carbon footprint, using a computer simulation or numerical data (e.g., determine carbon emissions that result from their travelling to school, work, and recreation venues; from vacation travelling; from buying products imported from distant countries), and plan a course of action to reduce their footprint (e.g., a plan to increase their use of bicycles or public transit; to eat more local foods) [PR, AI, C]

D2.6 compare different tools or systems used by scientists to make informed decisions on global climate change (e.g., Ecoregions of Canada, bioclimate profiles) [PR, AI]

D2.7 compare different perspectives and/or biases evident in discussions of climate change in scientific and non-scientific media (e.g., with reference to knowledge, beliefs, and/or values) [PR, AI]

D3. Understanding Basic Concepts

By the end of this course, students will:

D3.1 describe the principal components of Earth's climate system (e.g., the sun, oceans, and the atmosphere; the topography and configuration of land masses)

D3.2 describe the natural greenhouse effect, its importance for life, and the difference between it and the anthropogenic greenhouse effect

D3.3 describe how heat is transferred and stored in both hydrospheric and atmospheric heat sinks

D3.4 identify different greenhouse gases (e.g., carbon dioxide, methane, water vapour, nitrous oxide), and explain how they are produced naturally in the environment

D3.5 describe methods by which greenhouse gases are produced by humans (e.g., burning of biomass, chemical reactions involving pollutants)

D3.6 identify the natural and human causes of climate change in the world and, in particular, how Canada contributes to climate change

D3.7 identify indicators of global climate change (e.g., changes in: the mass of glacial and polar ice, sea levels, wind patterns, global carbon budget assessments, migratory patterns of birds)

E. PHYSICS: LIGHT AND APPLICATIONS OF OPTICS

OVERALL EXPECTATIONS

By the end of this course, students will:

E1. analyse how properties of light and colour are applied in technology and the impact of these technologies on society;

E2. investigate, through inquiry, properties of light, and predict its behaviour in mirrors and as it passes through different media;

E3. demonstrate an understanding of characteristics and properties of light, particularly with respect to reflection and refraction and the addition and subtraction of colour.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

E1.1 analyse how additive and/or subtractive colour theory are applied in technologies used in everyday life (e.g., stop lights, high-definition television, colour monitors, coloured spotlights) [AI, C]

Sample issue: Colour monitors, developed through the application of additive colour theory, enable computers to be used for a range of scientific, medical, and artistic functions that were not possible with old black-and-white monitors.

Sample questions: What are some of the safety uses of lights that employ colour filters? How do the advantages and disadvantages of liquid-crystal displays (LCDs) affect their uses? How can colour filters on glasses assist people with dyslexia? What role do additive and subtractive colour theories play in theatre productions and in movies?

E1.2 describe the role of selected optical technologies in the transmission of information, and analyse their impact on society (e.g., cellphones, optical fibre cables, satellite dishes) [AI, C]

Sample issue: Text messaging on cellphones has become a standard mode of communication, particularly among young people. Some experts are concerned that text messaging has a negative influence on the way we communicate with each other, as it reduces verbal communication and the use of conventional written language.

Sample questions: How does virtual reality technology attempt to decrease pain and anxiety during medical procedures? What impact has the use of optical fibre cables had on the way we receive and communicate information? How has it made telecommuting possible for some types of workers?

E2. Developing Skills of Investigation and Communication

By the end of this course, students will:

E2.1 use appropriate terminology related to light and optics, including, but not limited to: *angle of incidence, angle of reflection, angle of refraction, centre of curvature, focal length, luminescence, magnification, principal axis, radius of curvature,* and *vertex* [C]

E2.2 use an inquiry process to investigate the laws of reflection; use these laws to explain the characteristics of images formed by plane, converging (concave), and diverging (convex) mirrors; and draw ray diagrams to illustrate their observations [PR, AI, C]

E2.3 use an inquiry process to investigate the refraction of light as it passes through a variety of media (e.g., the angles of incidence and refraction as light passes through a clear acrylic block) [PR]

E2.4 predict the qualitative characteristics of images (e.g., location, orientation, size, type) formed by converging lenses, test their predictions through inquiry, and draw ray diagrams to record their observations [IP, PR, AI, C]

E2.5 investigate how various objects or media (e.g., opaque, translucent, and transparent materials; black-and-white surfaces) reflect, transmit, or absorb light, and record their observations using ray diagrams [PR, C]

E2.6 predict the effect of shining a coloured light on objects of different colours, and test their predictions through inquiry [IP, PR, AI, C]

E2.7 construct an optical device (e.g., a funhouse mirror, a device that produces an optical illusion, a solar oven) that uses a variety of mirrors [PR]

E3. Understanding Basic Concepts

By the end of this course, students will:

E3.1 describe various types of light emissions (e.g., chemiluminescence, bioluminescence, incandescence, electric discharge) and how they produce light

E3.2 identify and label the visible and invisible regions of the electromagnetic spectrum, and identify the colours that make up visible white light

E3.3 explain the laws of reflection of light, and identify ways in which light reflects from various types of mirrors (e.g., plane, converging, diverging)

E3.4 describe qualitatively how visible light is refracted at the interface between two different media

E3.5 use additive colour theory to predict the results of combining primary and secondary light colours

E3.6 use subtractive colour theory to describe the effect of colour filters on white light

E3.7 explain how the colour of an object is determined by reflection, absorption, and transmission of colour

E3.8 explain how the properties of light or colour are applied in the operation of an optical device (e.g., a reflecting telescope, stop lights, stage lights)

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