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)

C. CHEMISTRY: ATOMS, ELEMENTS, AND COMPOUNDS

OVERALL EXPECTATIONS

By the end of this course, students will:

C1. assess social, environmental, and economic impacts of the use of common elements and compounds, with reference to their physical and chemical properties;

C2. investigate, through inquiry, the physical and chemical properties of common elements and compounds;

C3. demonstrate an understanding of the properties of common elements and compounds, and of the organization of elements in the periodic table.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

C1.1 assess the usefulness of and/or the hazards associated with common elements or compounds in terms of their physical and chemical properties [AI, C]

Sample issue: Polyethylene is a versatile, flexible, and durable compound that is used in a range of products, including toys, plastic bottles, bullet-proof vests, and plastic bags. However, its durability poses problems for the environment because products made from polyethylene are not biodegradable.

Sample questions: What properties of diamonds make them useful in a variety of applications? What property of DDT allows it to continue to accumulate in the fatty tissue of mammals despite its ban by the Canadian government in the 1980s? How do the chemical properties of peroxide make it suitable for use in hair dye? What are the hazards associated with this use?

C1.2 assess social, environmental, and economic impacts of the use of common elements or compounds [AI, C]

Sample issue: By reducing the accumulation of ice on roads, road salt makes winter driving safer, decreasing medical and insurance costs associated with motor vehicle accidents. But the compounds in road salt damage roads and vehicles, pollute water systems, and harm animals and vegetation.

Sample questions: How has the presence of mercury in water bodies in Northern Ontario affected the environment and the lives of Aboriginal people? How does the widespread use of agricultural chemicals in Canada or elsewhere affect the economy, society, and the environment? What are the economic benefits and environmental costs of diamond mining for Northern Canadian communities?

C2. Developing Skills of Investigation and Communication

By the end of this course, students will:

C2.1 use appropriate terminology related to atoms, elements, and compounds, including, but not limited to: *boiling point, mixtures, particle theory, pure substances,* and *viscosity* [C]

C2.2 conduct an inquiry to identify the physical and chemical properties of common elements and compounds (e.g., magnesium sulfate, water, carbon, copper II) [PR]

C2.3 plan and conduct an inquiry into the properties of common substances found in the laboratory or used in everyday life (e.g., starch, table salt, wax, toothpaste), and distinguish the substances by their physical and chemical properties (e.g., *physical properties:* hardness, conductivity,

colour, melting point, solubility, density; *chemical properties:* combustibility, reaction with water) [IP, PR, AI]

C2.4 conduct appropriate chemical tests to identify some common gases (e.g., oxygen, hydrogen, carbon dioxide) on the basis of their chemical properties, and record their observations [PR, C]

C2.5 construct molecular models to represent simple molecules (e.g., O_2, CO_2, H_2O, NH_3, CH_4) [PR]

C3. Understanding Basic Concepts

By the end of this course, students will:

C3.1 explain how different atomic models evolved as a result of experimental evidence (e.g., how the Thomson model of the atom changed as a result of the Rutherford gold-foil experiment)

C3.2 describe the characteristics of neutrons, protons, and electrons, including charge, location, and relative mass

C3.3 distinguish between elements and compounds (e.g., compounds are pure substances that can be broken down into elements by chemical means)

C3.4 describe the characteristic physical and chemical properties of common elements and compounds (e.g., aluminum is a good conductor of heat; copper reacts to moist air by developing a greenish surface of copper carbonate; sodium carbonate is a white, odourless powder that dissolves in water; water has unique physical properties that allow it to support life)

C3.5 describe patterns in the arrangements of electrons in the first 20 elements of the periodic table, using the Bohr-Rutherford model

C3.6 explain the relationship between the atomic structure of an element and the position of that element in the periodic table

C3.7 compare and contrast the physical properties of elements within a group (e.g., alkali metals) and between groups (e.g., the carbon group and noble gases) in the periodic table

C3.8 identify and use the symbols for common elements (e.g., C, Cl, S, N) and the formulae for common compounds (e.g., H_2O, CO_2, NaCl, O_2)

D. EARTH AND SPACE SCIENCE: THE STUDY OF THE UNIVERSE

OVERALL EXPECTATIONS

By the end of this course, students will:

D1. assess some of the costs, hazards, and benefits of space exploration and the contributions of Canadians to space research and technology;

D2. investigate the characteristics and properties of a variety of celestial objects visible from Earth in the night sky;

D3. demonstrate an understanding of the major scientific theories about the structure, formation, and evolution of the universe and its components and of the evidence that supports these theories.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

D1.1 assess, on the basis of research, and report on the contributions of Canadian governments, organizations, businesses, and/or individuals to space technology, research, and/or exploration (e.g., as part of the International Space Station mission; in the fields of telecommunications and satellite technology) [IP, PR, AI, C]

Sample issue: The Canadarm was developed by a Canadian company with financial support from the federal government to offset its high costs. It is an important component of the International Space Station, a unique facility that provides many innovative opportunities for space exploration and research.

Sample questions: What contributions have Canadian researchers made to space exploration? How have Canadians contributed to the development and use of satellite technology? How have partnerships between the public and private sectors in Canada contributed to the development of technology used in space research and exploration?

D1.2 assess some of the costs, hazards, and benefits of space exploration (e.g., the expense of developing new technologies, accidents resulting in loss of life, contributions to our knowledge of the universe), taking into account the benefits of technologies that were developed for the space program but that can be used to address environmental and other practical challenges on Earth (e.g., radiation monitors and barriers, sensors to monitor air and water quality, remote sensing technology, fire-resistant materials) [AI, C]

Sample issue: Technologies that were originally developed for space exploration now have a range of environmental, medical, business, and domestic uses. However, these technologies were developed at great cost, using funds that might have been directed to other types of research and development.

Sample questions: What hazards do humans face when they are in space? What technologies have been developed in response to these hazards? How have these technologies been adapted for use on Earth? How much money was spent to develop the Canadarm? How is Canadarm technology now used in other sectors such as medicine and the environment?

D2. Developing Skills of Investigation and Communication

By the end of this course, students will:

D2.1 use appropriate terminology related to the study of the universe, including, but not limited to: *celestial objects, orbital radius, retrograde motion,* and *satellite* [C]

D2.2 use direct observation, computer simulation, or star charts to determine the location, appearance, and motion of well-known stars and other celestial objects that are visible in the night sky (e.g., the stars Polaris, Sirius, Betelgeuse; the planet Venus) [PR, AI]

D2.3 plan and conduct a simulation that illustrates the interrelationships between various properties of celestial objects visible in the night sky (e.g., set up flashlights of various intensities at different distances from an observation point to help illustrate why the brightness of a star viewed from Earth is a function of both its actual brightness and its distance from Earth) [IP, PR, AI]

D2.4 gather and record data, using an inquiry or research process, on the properties of specific celestial objects within the solar system (e.g., the composition of their atmosphere, if any; the composition of their surface; the strength of their gravitational pull) [IP, PR, C]

D2.5 compare and contrast properties of celestial objects visible in the night sky, drawing on information gathered through research and using an appropriate format (e.g., compare the size of planets; represent the distance of stars from Earth using scientific notation; compare star temperatures and colour) [PR, AI, C]

D3. Understanding Basic Concepts

By the end of this course, students will:

D3.1 describe observational and theoretical evidence relating to the origin and evolution of the universe (e.g., evidence supporting the big bang theory)

D3.2 describe observational and theoretical evidence relating to the formation of the solar system (e.g., evidence that supports the theory that the solar system was formed from a contracting, spinning disc of dust and gas)

D3.3 describe the major components of the solar system and the universe (e.g., planets, stars, galaxies), using appropriate scientific terminology and units (e.g., astronomical units, scientific notation, light years)

D3.4 describe the sun's composition and energy source, and explain how its energy warms Earth and supports life on the planet (e.g., with reference to the types of radiation the sun emits and the interaction of the sun's energy with Earth's atmosphere)

D3.5 explain the causes of astronomical phenomena (e.g., the aurora borealis, solar eclipses, phases of the moon, comets) and how various phenomena can best be observed from Earth (e.g., solar eclipses should be viewed through a suitable solar filter or by projection, not with the naked eye)

D3.6 describe various reasons that humankind has had for studying space (e.g., to develop calendars for agricultural purposes, to forecast weather, for celestial navigation, for religious inspiration) and the conceptions of the universe held by various cultures and civilizations (e.g., Aboriginal peoples; ancient Greek, Mayan civilizations)

E. PHYSICS: THE CHARACTERISTICS OF ELECTRICITY

OVERALL EXPECTATIONS

By the end of this course, students will:

E1. assess some of the costs and benefits associated with the production of electrical energy from renewable and non-renewable sources, and analyse how electrical efficiencies and savings can be achieved, through both the design of technological devices and practices in the home;

E2. investigate, through inquiry, various aspects of electricity, including the properties of static and current electricity, and the quantitative relationships between potential difference, current, and resistance in electrical circuits;

E3. demonstrate an understanding of the principles of static and current electricity.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

E1.1 analyse the design of a technological device that improves its electrical efficiency or protects other devices by using or controlling static electricity (e.g., paint sprayers, photocopiers, lightning rods, grounding wires) [AI, C]

Sample questions: How does eliminating static electricity help or hinder the performance of a device? How have static electricity controls helped in developing new technologies?

E1.2 assess some of the social, economic, and environmental implications of the production of electrical energy in Canada from renewable and non-renewable sources (e.g., wind, solar, hydro, coal, oil, natural gas, nuclear) [AI, C]

Sample issue: The operation of wind farms along Lake Huron produces electricity from a renewable source, reducing dependence on non-renewable sources of electricity. However, the wind farms produce noise and visual pollution, affect local animal life, and reduce the amount of land available for agriculture.

Sample questions: What is the price difference between electricity produced from solar power and by coal-burning plants? What effects do coal mining, oil production, wind farms, and hydroelectric dams have on surrounding ecosystems? What types of hazardous substances are used or created in the production of solar power and nuclear power? What types of emissions are produced by coal-burning and hydroelectric power plants? What are the effects of these emissions on human health and the environment?

E1.3 produce a plan of action to reduce electrical energy consumption at home (e.g., using EnerGuide information when purchasing appliances), and outline the roles and responsibilities of various groups (e.g., government, business, family members) in this endeavour [IP, AI, C]

Sample issue: Replacing incandescent light bulbs with compact fluorescent bulbs can reduce the energy needed to light a home by 75%. Although the bulbs are more expensive than incandescent bulbs, electrical companies sometimes provide coupons to reduce the price. Also, the Ontario government is phasing out incandescent bulbs, which will further reduce energy consumption.

Sample questions: What are EnerGuide and ENERGY STAR, and how can they be used when purchasing appliances or electronics? What is the difference in energy consumption between a conventional and a front-loading washing machine? What appliances consume electrical energy even when they are not in use?

E2. Developing Skills of Investigation and Communication

By the end of this course, students will:

E2.1 use appropriate terminology related to electricity, including, but not limited to: *ammeter, amperes, battery, current, fuse, kilowatt hours, load, ohms, potential difference, resistance, switch, voltmeter,* and *volts* [C]

E2.2 conduct investigations into the transfer of static electric charges by friction, contact, and induction, and produce labelled diagrams to explain the results [PR, AI, C]

E2.3 predict the ability of different materials to hold or transfer electric charges (i.e., to act as insulators or conductors), and test their predictions through inquiry [IP, PR]

E2.4 plan and carry out inquiries to determine and compare the conductivity of various materials (e.g., metals, plastics, glass, water) [IP, PR, AI, C]

E2.5 design, draw circuit diagrams of, and construct series and parallel circuits (e.g., a circuit where all light bulbs go out when one light bulb is removed; a circuit that allows one of several light bulbs to be switched on and off independently of the others), and measure electric current I, potential difference V, and resistance R at various points in the circuits, using appropriate instruments and SI units [IP, PR, AI, C]

E2.6 analyse and interpret the effects of adding an identical load in series and in parallel in a simple circuit [AI, C]

E2.7 investigate the quantitative relationships between current, potential difference, and resistance in a simple series circuit [PR, AI]

E2.8 solve simple problems involving potential difference V, electric current I, and resistance R, using the quantitative relationship $V = IR$ [AI, C]

E2.9 determine the energy consumption of various appliances, and calculate their operating costs (e.g., using the kilowatt hour rate from a utility bill) [AI, C]

E2.10 calculate the efficiency of an energy converter, using the following equation: percent efficiency = $(E_{out}/E_{in}) \times 100\%$ [AI, C]

E3. Understanding Basic Concepts

By the end of this course, students will:

E3.1 identify electrical quantities (i.e., current, potential difference, resistance, and electrical energy), and list their symbols and their corresponding SI units (e.g., electric current: I, ampere)

E3.2 explain the characteristics of conductors and insulators and how materials allow static charge to build up or be discharged

E3.3 compare and contrast static electricity with alternating current (AC) and direct current (DC) (e.g., the charge on a charged electroscope, the charge in a functioning circuit)

E3.4 identify the components of a simple DC circuit (e.g., electrical source, load, connecting wires, switch, fuse), and explain their functions

E3.5 explain the characteristics of electric current, potential difference, and resistance in simple series and parallel circuits, noting how the quantities differ in the two circuits

E3.6 describe, qualitatively, the interrelationships between resistance, potential difference, and electric current (e.g., the effect on current when potential difference is changed and resistance is constant)

E3.7 explain what different meters (e.g., ammeters, voltmeters, multimeters) measure and how they are connected within an electrical circuit to measure electrical quantities

E3.8 explain how various factors (e.g., wire length, wire material, cross-sectional area of wire) influence the resistance of an electrical circuit