Science, Grade 10

Academic SNC2D

This course enables students to enhance their understanding of concepts in biology, chemistry, earth and space science, and physics, and of the interrelationships between science, technology, society, and the environment. Students are also given opportunities to further develop their scientific investigation skills. Students will plan and conduct investigations and develop their understanding of scientific theories related to the connections between cells and systems in animals and plants; chemical reactions, with a particular focus on acid–base reactions; forces that affect climate and climate change; and the interaction of light and matter.

Prerequisite: Science, Grade 9, Academic or Applied

Big Ideas

Biology

- Plants and animals, including humans, are made of specialized cells, tissues, and organs that are organized into systems.
- Developments in medicine and medical technology can have social and ethical implications.

Chemistry

- Chemicals react with each other in predictable ways.
- Chemical reactions may have a negative impact on the environment, but they can also be used to address environmental challenges.

Earth and Space Science

- Earth's climate is dynamic and is the result of interacting systems and processes.
- Global climate change is influenced by both natural and human factors.
- Climate change affects living things and natural systems in a variety of ways.
- People have the responsibility to assess their impact on climate change and to identify effective courses of action to reduce this impact.

Physics

- Light has characteristics and properties that can be manipulated with mirrors and lenses for a range of uses.
- Society has benefited from the development of a range of optical devices and technologies.

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, 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 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., websites for public health organizations, 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., meteorologist, medical illustrator, geochemist, optical physicist) and the education and training necessary for these careers

A2.2 identify scientists, including Canadians (e.g., Sheela Basrur, William Richard Peltier, Alice Wilson, Willard Doyle), who have made a contribution to the fields of science under study

B. BIOLOGY: TISSUES, ORGANS, AND SYSTEMS OF LIVING THINGS

OVERALL EXPECTATIONS

By the end of this course, students will:

B1. evaluate the importance of medical and other technological developments related to systems biology, and analyse their societal and ethical implications;

B2. investigate cell division, cell specialization, organs, and systems in animals and plants, using research and inquiry skills, including various laboratory techniques;

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

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, ethical issues related to a technological development in the field of systems biology (e.g., cloning, stem-cell research, live organ transplants, transgenic transplants), and communicate their findings [IP, PR, AI, C]

Sample issue: DNA screening is a valuable tool for determining whether a person is genetically predisposed to certain diseases. However, it raises ethical issues related to privacy, choice, access, treatment, and discrimination. It also raises questions about how far society should go in using available technologies, who funds research, and who owns or manages the resulting product or technology.

Sample questions: What are the ethical arguments for and against stem-cell research? What ethical issues might arise when a drug company funds trials of a new drug it has developed to treat a genetic disorder? Who should determine how the results of transgenic research in plants and animals will be applied?

B1.2 assess the importance to human health and/or society of medical imaging technologies (e.g., ultrasound, X-rays, computerized axial tomography [CT or CAT] scan, magnetic resonance imaging [MRI], microscopy, biophotonics) used in Canada in diagnosing or treating abnormalities in tissues, organs, and/or systems [AI, C]

Sample issue: Ultrasound is routinely used during pregnancy to monitor the development of the fetus. It is also used to perform amniocentesis, which screens for genetic disorders, and allows doctors to perform surgery on the fetus before birth to correct some abnormalities. However, there have been few studies on the long-term effects of the use of ultrasound.

Sample questions: How are medical imaging technologies used in the diagnosis and treatment of heart disease and stroke? What types of imaging technologies are used in ophthalmology? How have they benefited people who have eye disease? How have developments in biophotonics advanced a range of surgical procedures?

B1.3 describe public health strategies related to systems biology (e.g., cancer screening and prevention programs; vaccines against the human papillomavirus [HPV] and measles, mumps, and rubella [MMR]; AIDS education), and assess their impact on society [AI, C]

Sample issue: Early-childhood vaccination programs have greatly reduced the incidence of certain diseases and the social and medical costs associated with them. Influenced by controversial studies arguing that there may be health risks associated with such vaccines, some parents have chosen not to vaccinate their children, which could lead to a resurgence of these potentially deadly diseases.

Sample questions: What strategies are included in public health initiatives aimed at reducing the incidence of smoking-related diseases? What impact have these initiatives had on smoking rates and associated medical costs? How have health authorities responded to the threat of West Nile virus? What effect does this response have on people's lifestyles? How did various cultures attempt to prevent disease before vaccines were available? What impact have vaccines had on global health?

B2. Developing Skills of Investigation and Communication

By the end of this course, students will:

B2.1 use appropriate terminology related to cells, tissues, organs, and systems of living things, including, but not limited to: *absorption, anaphase, capillaries, concentration, differentiation, diffusion, meristematic, mesophyll, phloem, prophase, red blood cells, regeneration, stomate,* and *xylem* [C]

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

B2.3 examine different plant and animal cells (e.g., cheek cells, onion cells) under a microscope or similar instrument, and draw labelled biological diagrams to show how the cells' organelles differ [PR, C]

B2.4 investigate, using a microscope or similar instrument, specialized cells in the human body or in plants, focusing on different types of cells (e.g., bone, muscle, leaf, root cells), and draw labelled biological diagrams to show the cells' structural differences [PR, C]

B2.5 investigate the rate of cell division in cancerous and non-cancerous cells, using pictures, videos, or images, and predict the impact of this rate of cell division on an organism [PR, AI]

B2.6 investigate, through a laboratory or computer-simulated dissection of a plant, worm, fish, or frog, the interrelationships between organ systems of a plant or an animal (e.g., between the root system and leaf system in a plant; between the digestive system and circulatory system in an animal) [PR, AI]

B2.7 use a research process to investigate a disease or abnormality related to tissues, organs, or systems of humans or plants (e.g., heart disease, tobacco mosaic virus, wheat rust) [IP, PR, C]

B3. Understanding Basic Concepts

By the end of this course, students will:

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

B3.2 explain the importance of cell division and cell specialization in generating new tissues and organs (e.g., the division of stem cells into specialized cells such as muscle cells or nerve cells in humans; the division of meristematic cells to expand and differentiate plant tissue)

B3.3 explain the links between specialized cells, tissues, organs, and systems in plants and animals (e.g., muscle cells and nerve cells form the tissue found in the heart, which is a component of the circulatory system; granum and thylakoid structures act as solar collectors in the chloroplast to produce carbohydrates for plant growth)

B3.4 explain the primary functions of a variety of systems in animals (e.g., the circulatory system transports materials through the organism; the respiratory system supplies oxygen to and removes carbon dioxide from the body)

B3.5 explain the interaction of different systems within an organism (e.g., the respiratory system brings oxygen into the body, and the circulatory system transports the oxygen to cells) and why such interactions are necessary for the organism's survival

C. CHEMISTRY: CHEMICAL REACTIONS

OVERALL EXPECTATIONS

By the end of this course, students will:

C1. analyse a variety of safety and environmental issues associated with chemical reactions, including the ways in which chemical reactions can be applied to address environmental challenges;

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

C3. demonstrate an understanding of the general principles of chemical reactions, and various 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, various safety and environmental issues associated with chemical reactions and their reactants and/or product(s) (e.g., chemical reactions related to the use of cyanide in gold mining, the corrosion of metal supports on bridges, the use of different antibacterial agents such as chlorine and bromine in recreational pools) [IP, PR, AI, C]

Sample issue: Ammonia and chlorine bleach are two common household cleaning agents. However, when these two substances are mixed, the chemical reaction produces chlorine gas, which is highly toxic.

Sample questions: Why is it important to understand the chemical composition of chlorinating agents used in swimming pools before using them? What chemical reactions result in acid precipitation? What impact does it have on the environment? What sources of information are available on the safety or environmental implications of chemicals and chemical reactions? Why is it important to ensure that these sources are up to date? Why is it important to understand WHMIS information, including Material Safety Data Sheets, before using any chemicals?

C1.2 analyse how an understanding of the properties of chemical substances and their reactions can be applied to solve environmental challenges (e.g., renewing the Great Lakes, neutralizing acid spills, scrubbing smokestack emissions) [AI, C]

Sample issue: Spills from oil tankers damage the environment by contaminating water and shorelines, killing birds and aquatic life. Biological oil agents help break down the oil so it degrades faster and does less damage to the environment.

Sample questions: How does the addition of lime reduce the acidification of water? How can this reaction be applied to renew lakes that have been affected by acid precipitation? Why is acid leaching used in soil contaminated with heavy metals?

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: *compounds, product,* and *reactant* [C]

C2.2 construct molecular models to illustrate the structure of molecules in 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 investigate simple chemical reactions, including synthesis, decomposition, and displacement reactions, and represent them using a variety of formats (e.g., molecular models, word equations, balanced chemical equations) [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 plan and conduct an inquiry to identify the evidence of chemical change (e.g., the formation of a gas or precipitate, a change in colour or odour, a change in temperature) [IP, PR, AI]

C2.6 plan and conduct an inquiry to classify some common substances as acidic, basic, or neutral (e.g., use acid–base indicators or pH test strips to classify common household substances) [IP, 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 binary compounds (e.g., carbon dioxide, CO_2, has two oxygen atoms and one carbon atom)

C3.2 explain, using the law of conservation of mass and atomic theory, the rationale for balancing chemical equations

C3.3 describe the types of evidence that indicate chemical change (e.g., changes in colour, the production of a gas, the formation of a precipitate, the production or absorption of heat, the production of light)

C3.4 write word equations and balanced chemical equations for simple chemical reactions (e.g., $2H_2 + O_2 \rightarrow 2H_2O$)

C3.5 describe, on the basis of observation, the reactants in and products of a variety of chemical reactions, including synthesis, decomposition, and displacement reactions (e.g., reactions occurring when magnesium burns or in the production of oxygen from hydrogen peroxide; the reaction of iron and copper sulphate; reactions occurring when fossil fuels burn)

C3.6 describe the process of acid–base neutralization (i.e., an acid reacts with a base to form a salt and often water)

C3.7 describe how the pH scale is used to classify solutions as acidic, basic, or neutral (e.g., a solution with a pH of 1 is highly acidic; a solution with a pH of 7 is neutral)

C3.8 identify simple ionic compounds (e.g., NaCl), simple compounds involving polyatomic ions (e.g., KNO_3, NaOH), molecular compounds (e.g., CO_2, H_2O, NH_3), and acids (e.g., HCl(aq), H_2SO_4(aq)), using the periodic table and a list of the most common polyatomic ions (e.g., OH^-, SO_4^{-2}), and write the formulae

D. EARTH AND SPACE SCIENCE: CLIMATE CHANGE

OVERALL EXPECTATIONS

By the end of this course, students will:

D1. analyse some of the effects of climate change around the world, and assess the effectiveness of initiatives that attempt to address the issue of climate change;

D2. investigate various natural and human factors that influence Earth's climate and climate change;

D3. demonstrate an understanding of natural and human factors, including the greenhouse effect, that influence Earth's climate and contribute to climate change.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

D1.1 analyse current and/or potential effects, both positive and negative, of climate change on human activity and natural systems (e.g., loss of habitat for Arctic mammals such as polar bears and loss of traditional lifestyles for Inuit as Arctic ice shrinks; famine as arable land is lost to desertification; an increase in water-borne disease and human resettlement as coastal lands are flooded; expansion of the growing season in some regions) [AI, C]

Sample issue: Scientists are researching changes in climate patterns as possible contributing factors to an increase in the number of smog days in Ontario and elsewhere in Canada. As the air quality worsens, people may curtail their outdoor activities, and those with respiratory problems may require medical attention, increasing health care costs.

Sample questions: How have recent extreme weather events such as heat waves in Europe or drought in southern Africa affected habitats in these regions? How might predicted changes to global temperature and precipitation affect agriculture in Ontario, Canada, or different areas around the world? How might the continuing reduction of the polar ice cap influence domestic and international transportation and shipping?

D1.2 assess, on the basis of research, the effectiveness of some current individual, regional, national, or international initiatives that address the issue of climate change (e.g., Drive Clean, ENERGY STAR, federal and provincial government rebates for retrofitting older buildings to be more energy efficient, carbon offset programs, community tree-planting programs, municipal recycling programs, Intergovernmental Panel on Climate Change [IPCC]), and propose a further course of action related to one of these initiatives [PR, AI, C]

Sample issue: Governments and industry have created rebates or tax cuts to encourage consumers to replace their old appliances with efficient ENERGY STAR appliances. However, such initiatives do not take into account the resources used to create the new products or the problems associated with the disposal of old appliances.

Sample questions: What type of recycling and composting programs are in place in your community? What proportion of locally generated garbage do they divert from landfill sites? How could they be improved? What is the purpose of carbon offset credits? Do they achieve that purpose? Why or why not?

D2. Developing Skills of Investigation and Communication

By the end of this course, students will:

D2.1 use appropriate terminology related to climate change, including, but not limited to: *albedo*, *anthropogenic*, *atmosphere*, *cycles*, *heat sinks*, and *hydrosphere* [C]

D2.2 design and build a model to illustrate the natural greenhouse effect, and use the model to explain the anthropogenic greenhouse effect [IP, PR, C]

D2.3 analyse different sources of scientific data (e.g., lake cores, tree rings, fossils and preserved organisms, ice cores) for evidence of natural climate change and climate change influenced by human activity [PR, AI, C]

D2.4 investigate a popular hypothesis on a cause-and-effect relationship having to do with climate change (e.g., the combustion of fossil fuels is responsible for rising global temperatures; the concentration of atmospheric CO_2 is responsible for rising global temperatures; global temperatures have been on the increase since the industrial revolution; the severity of cyclones, hurricanes, and tornadoes increases as atmospheric temperatures increase), using simulations and/or time-trend data that model climate profiles (e.g., data from Statistics Canada and Environment Canada) [PR, AI, C]

D2.5 investigate, through laboratory inquiry or simulations, the effects of heat transfer within the hydrosphere and atmosphere [PR, AI]

D2.6 investigate, through laboratory inquiry or simulations, how water in its various states influences climate patterns (e.g., water bodies moderate climate, water vapour is a greenhouse gas, ice increases the albedo of Earth's surface) [PR, AI]

D2.7 investigate, through research or simulations, the influence of ocean currents on local and global heat transfer and precipitation patterns [PR, AI]

D2.8 classify the climate of their local region using various tools or systems (e.g., Ecoregions of Canada, bioclimate profiles), and compare their region to other regions in Ontario, Canada, and the world [AI, C]

D2.9 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 values) [AI, C]

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 atmosphere; the topography and configuration of land masses) and how the system works

D3.2 describe and explain heat transfer in the hydrosphere and atmosphere and its effects on air and water currents

D3.3 describe the natural greenhouse effect, explain its importance for life, and distinguish it from the anthropogenic greenhouse effect

D3.4 identify natural phenomena (e.g., plate tectonics, uplift and weathering, solar radiance, cosmic ray cycles) and human activities (e.g., forest fires, deforestation, the burning of fossil fuels, industrial emissions) known to affect climate, and describe the role of both in Canada's contribution to climate change

D3.5 describe the principal sources and sinks, both natural and/or anthropogenic, of greenhouse gases (e.g., carbon dioxide, methane, nitrous oxide, halocarbons, water vapour)

D3.6 describe how different carbon and nitrogen compounds (e.g., carbon dioxide, methane, nitrous oxide) influence the trapping of heat in the atmosphere and hydrosphere

D3.7 describe, in general terms, the causes and effects of the anthropogenic greenhouse effect, the depletion of stratospheric and tropospheric ozone, and the formation of ground-level ozone and smog

D3.8 identify and describe indicators of global climate change (e.g., changes in: glacial and polar ice, sea levels, wind patterns, global carbon budget assessments)

E. PHYSICS: LIGHT AND GEOMETRIC OPTICS

OVERALL EXPECTATIONS

By the end of this course, students will:

E1. evaluate the effectiveness of technological devices and procedures designed to make use of light, and assess their social benefits;

E2. investigate, through inquiry, the properties of light, and predict its behaviour, particularly with respect to reflection in plane and curved mirrors and refraction in converging lenses;

E3. demonstrate an understanding of various characteristics and properties of light, particularly with respect to reflection in mirrors and reflection and refraction in lenses.

SPECIFIC EXPECTATIONS

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

By the end of this course, students will:

E1.1 analyse a technological device or procedure related to human perception of light (e.g., eyeglasses, contact lenses, infrared or low light vision sensors, laser surgery), and evaluate its effectiveness [AI, C]

Sample issue: Laser surgery corrects vision by surgically reshaping the cornea to correct refractive defects in the eye. While the procedure is effective in most cases, it poses risks and can in some cases lead to poor night vision.

Sample questions: How do anti-glare night vision glasses help people who have difficulty driving at night? How do eyeglasses with colour filters help people with dyslexia to read?

E1.2 analyse a technological device that uses the properties of light (e.g., microscope, retroreflector, solar oven, camera), and explain how it has enhanced society [AI, C]

Sample issue: Cameras can produce a range of optical effects, from highly detailed and realistic to manipulated and abstract. Photographic images are used for a wide range of purposes that benefit society, including in the areas of culture, education, security, policing, entertainment, and the environment. However, the widespread use of cameras raises privacy concerns.

Sample questions: How do vision sensors help the Canadian Food Inspection Agency improve food safety? How are photonics used in the early diagnosis of diseases such as cancer? How have optical fibres enhanced our ability to communicate information? How do all of these technologies benefit society? How are outdoor lights such as street or stadium lights designed to limit light pollution in surrounding areas?

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, focal point, luminescence, magnification, mirage,* and *virtual image* [C]

E2.2 use an inquiry process to investigate the laws of reflection, using plane and curved mirrors, and draw ray diagrams to summarize their findings [PR, C]

E2.3 predict the qualitative characteristics of images formed by plane and curved mirrors (e.g., location, relative distance, orientation, and size in plane mirrors; location, orientation, size, type in curved mirrors), test their predictions through inquiry, and summarize their findings [PR, AI, C]

E2.4 use an inquiry process to investigate the refraction of light as it passes through media of different refractive indices, compile data on their findings, and analyse the data to determine if there is a trend (e.g., the amount by which the angle of refraction changes as the angle of incidence increases varies for media of different refractive indices) [PR, AI, C]

E2.5 predict, using ray diagrams and algebraic equations, the position and characteristics of an image produced by a converging lens, and test their predictions through inquiry [PR, AI, C]

E2.6 calculate, using the indices of refraction, the velocity of light as it passes through a variety of media, and explain the angles of refraction with reference to the variations in velocity [PR, C]

E3. Understanding Basic Concepts

By the end of this course, students will:

E3.1 describe and explain various types of light emissions (e.g., chemiluminescence, bioluminescence, incandescence, fluorescence, phosphorescence, triboluminescence; from an electric discharge or light-emitting diode [LED])

E3.2 identify and label the visible and invisible regions of the electromagnetic spectrum

E3.3 describe, on the basis of observation, the characteristics and positions of images formed by plane and curved mirrors (e.g., location, orientation, size, type), with the aid of ray diagrams and algebraic equations, where appropriate

E3.4 explain the conditions required for partial reflection/refraction and for total internal reflection in lenses, and describe the reflection/refraction using labelled ray diagrams

E3.5 describe the characteristics and positions of images formed by converging lenses (e.g., orientation, size, type), with the aid of ray diagrams

E3.6 identify ways in which the properties of mirrors and lenses (both converging and diverging) determine their use in optical instruments (e.g., cameras, telescopes, binoculars, microscopes)

E3.7 identify the factors, in qualitative and quantitative terms, that affect the refraction of light as it passes from one medium to another

E3.8 describe properties of light, and use them to explain naturally occurring optical phenomena (e.g., apparent depth, shimmering, a mirage, a rainbow)