GRADE 9

Processes of Science

It is expected that students will:

A1 demonstrate safe procedures
A2 perform experiments using the scientific method
A3 represent and interpret information in graphic form
A4 demonstrate scientific literacy
A5 demonstrate ethical, responsible, cooperative behaviour
A6 describe the relationship between scientific principles and technology
A7 demonstrate competence in the use of technologies specific to investigative procedures and research

Life Science: Reproduction

It is expected that students will:

B1 explain the process of cell division
B1 relate the processes of cell division and emerging reproductive technologies to embryonic development
B3 compare sexual and asexual reproduction in terms of advantages and disadvantages

Physical Science: Atoms, Elements, and Compounds

It is expected that students will:

C1 use modern atomic theory to describe the structure and components of atoms and molecules
C2 use the periodic table to compare the characteristics and atomic structure of elements
C3 write and interpret chemical symbols of elements and formulae of ionic compounds
C4 describe changes in the properties of matter

Physical Science: Characteristics of Electricity

C5 explain the production, transfer, and interaction of static electrical charges in various materials
C6 explain how electric current results from separation of charge and the movement of electrons
C7 compare series and parallel circuits involving varying resistances, voltages, and currents
C8 relate electrical energy to power consumption

Earth and Space Science: Space Exploration

It is expected that students will:

D1 explain how a variety of technologies have advanced understanding of the universe and solar system
D2 describe the major components and characteristics of the universe and solar system
D3 describe traditional perspectives of a range of Aboriginal peoples in BC on the relationship between the Earth and celestial bodies
D4 explain astronomical phenomena with reference to the Earth/moon system
D5 analyse the implications of space travel

GRADE 9

KEY ELEMENTS: PROCESSES OF SCIENCE

Estimated Time: integrate with other curriculum organizers

The prescribed learning outcomes related to Processes of Science support the development of attitudes, skills, and knowledge essential for an understanding of science. These learning outcomes should not be taught in isolation, but should be integrated with activities related to the other three curriculum organizers.

Vocabulary

accuracy, conclusion, control, controlled experiment, dependent variables, hypothesis, independent variables, observation, precision, prediction, procedure, principle, scientific literacy, validity, variable

Knowledge

- metric system (SI units)
- elements of a valid experiment
- dependent and independent variables
- appropriate scale
- application of scientific principles in the development of technologies

Skills and Attitudes

- recognize dangers
- demonstrate emergency response procedures
- use personal protective equipment
- use proper techniques for handling and disposing of lab materials
- use electroscope, voltmeter, ammeter, Van de Graaff generator, Bunsen burner, hotplate
- make accurate measurements using a variety of instruments (e.g., rulers, balances, graduated cylinders
- use the Internet as a research tool
- communicate results
- use appropriate types of graphic models and/or formulae to represent a given type of data, including Bohr models
- use bar graphs, line graphs, pie charts, tables, and diagrams to extract and convey information
- deduce relationships between variables use models to demonstrate how systems operate
- apply given criteria for evaluating evidence and sources of information
- identify main points, supporting or refuting information, and bias in a science-related article or illustration
- demonstrate ethical, responsible, cooperative behaviour
- acquire and apply scientific and technological knowledge to the benefit of self, society, and the environment

GRADE 9 PROCESSES OF SCIENCE

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.* *Students who have fully met the prescribed learning outcome are able to:*
A1 demonstrate safe procedures	❑ identify a variety of dangers in procedures (e.g., cuts from sharp objects; burns from heating devices; overloading a circuit; shocks from misuse of electrical equipment) ❑ identify appropriate equipment for an lab activity (e.g., Bunsen burner vs. hotplate) ❑ identify and use appropriate personal protective equipment (e.g., hand and eye protection) and procedures (e.g., hair tied back, clear work area, no loose clothing, no horseplay) ❑ use proper techniques for handling and disposing of lab materials (e.g., using tongs, waste receptacles to handle and dispose of chemicals) ❑ with teacher support, describe appropriate emergency response procedures (e.g., how to use a fire extinguisher/blanket, eye wash station, first aid for cuts, knowing who to contact and how)
A2 perform experiments using the scientific method	❑ describe the elements of a valid experiment: - formulate an hypothesis - make a prediction - identify controlled versus experimental variables - observe, measure, and record, using appropriate units - interpret data - draw conclusions ❑ use information and conclusions as a basis for further comparisons, investigations, or analyses ❑ communicate results using a variety of methods
A3 represent and interpret information in graphic form	❑ identify and use the most appropriate type of graphic, model, or formula to convey information, including - Bohr model - solar system model - star map or celestial sphere - simple chemical formulae - diagrams of a cell in stages of mitosis ❑ distinguish between dependent and independent variables in a graph ❑ use appropriate scale and axis to create a graph ❑ extrapolate and interpolate points on a graph ❑ extract information from bar graphs, line graphs, and tables, and diagrams (e.g., periodic table)

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
A4 demonstrate scientific literacy	❑ identify the main points in a science-related article or illustration ❑ describe the qualities of the scientifically literate person, such as - awareness of assumptions (their own and authors') - respect for precision - ability to separate fundamental concepts from the irrelevant or unimportant - recognizing that scientific knowledge is continually developing and often builds upon previous theories - recognizing cause and effect ❑ use given criteria for evaluating evidence and sources of information (e.g., identify supporting or refuting information and bias) ❑ explain how science and technology affect individuals, society, and the environment
A5 demonstrate ethical, responsible, cooperative behaviour	❑ describe and demonstrate - ethical behaviour (e.g., honesty, fairness, reliability) - open-mindedness (e.g., ongoing examination and reassessment of own beliefs) - willingness to question and promote discussion - skills of collaboration and co-operation - respect for the contributions of others
A6 describe the relationship between scientific principles and technology	❑ give examples of scientific principles that have resulted in the development of technologies (e.g., cell division—reproductive technologies; electrical energy—appliances; properties of matter—semiconductors) ❑ identify a variety of technologies and explain how they have advanced our understanding of science (e.g., microscopes for observing cell structure; instruments for observing astronomical phenomena)
A7 demonstrate competence in the use of technologies specific to investigative procedures and research	❑ select and carefully use appropriate technologies, including - microscope - balances and other measurement tools (e.g., thermometers, voltmeter, ammeter, Van de Graaff generator) - electrical circuitry devices (e.g., batteries, power supplies, switches, lamps, resistors) ❑ proficiently use the Internet as a research tool

GRADE 9

KEY ELEMENTS: LIFE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have developed understanding of the processes of cell division as they pertain to reproduction.

Vocabulary

binary fission, budding, cancer, cell cycle, chromosomes, DNA, embryonic development, fertilization, fragmentation, gametes, genes, meiosis, mitosis, nucleolus, sexual and asexual reproduction, stem cells, vegetative reproduction, zygote

Knowledge

- contents of the nucleus
- relationship between genes and proteins
- changes to cell membrane and nucleus during the cell cycle
- cancer
- sexual and asexual reproduction
- type(s) of reproduction
- adaptability of organisms
- zygote formation (fertilization)
- stem cells in embryonic development

Skills and Attitudes

- use microscopes
- apply the relationship between scientific principles and technology
- respect diverse opinions

GRADE 9 LIFE SCIENCE: REPRODUCTION

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.* *Students who have fully met the prescribed learning outcome are able to:*
B1 explain the process of cell division	❑ identify the contents of the nucleus: chromosomes, DNA, genes, and nucleolus ❑ explain the significance of cell division, with reference to the basic relationship between genes and proteins (i.e., genes code for proteins) ❑ describe factors that may lead to changes in a cell's genetic information ❑ describe, in sequence, the stages and features of the cell cycle, including mitosis and cytokinesis ❑ describe cancer as abnormal cell division ❑ distinguish meiosis from mitosis in terms of outcomes (i.e., number of chromosomes and number of daughter cells)
B2 relate the processes of cell division and emerging reproductive technologies to embryonic development	❑ distinguish between male and female gametes ❑ describe the process by which a single zygote forms (fertilization) and develops ❑ describe and assess the impact of one or more emerging reproductive technologies (e.g., in vitro, cloning) ❑ explain the role of stem cells in embryonic development
B3 compare sexual and asexual reproduction in terms of advantages and disadvantages	❑ distinguish between sexual reproduction (e.g., human) and asexual reproduction (e.g., binary fission, budding, vegetative, fragmentation) in representative organisms ❑ relate sexual and asexual reproduction to adaptability of organisms

GRADE 9

KEY ELEMENTS: PHYSICAL SCIENCE

Estimated Time: 40-45 hours

By the end of this grade, students will have demonstrated understanding of how the nature of the atom relates to chemistry and electricity.

Atoms, Elements, and Compounds (18-20 hours)

Vocabulary

alkali metal, alkaline earth metal, atom, atomic mass, atomic number, Bohr model, conductivity, covalent compounds, density, electron, element, halogens, ionic compounds, mass, melting/boiling point, molecule, multiple ion charge, metal, metalloid, neutron, noble gases, non-metal, polyatomic ions, proton, state, subatomic particles, volume

Knowledge

- properties and states of matter
- physical and chemical change
- subatomic particles, properties, and location
- Bohr model
- atomic theory
- the structure and components of atoms and molecules
- metals, non-metals, and metalloids
- periodic table
- chemical symbols for elements
- chemical formulae for simple ionic compounds

Skills and Attitudes

- create models of atoms and ions
- draw Bohr models
- use the periodic table and common ion chart
- write chemical formulae and symbols
- name chemical compounds

KEY ELEMENTS: PHYSICAL SCIENCE

Characteristics of Electricity (22-25 hours)

Vocabulary

acetate, amperes, coulombs, current, electric force, electrons, energy, joules, kilowatt·hours, ohms, Ohm's Law, power, resistance, series and parallel circuits, static charge, Van de Graaff generator, voltage, volts

Knowledge

- static electrical charges
- relationships between charged objects
- electricity
- movement of charged particles
- electric current
- resistance and voltage
- Ohm's Law
- series and parallel circuits
- power and energy consumption

Skills and Attitudes

- measure voltage and current using appropriate equipment
- perform calculations
- draw circuit diagrams

GRADE 9 PHYSICAL SCIENCE: ATOMS, ELEMENTS, AND COMPOUNDS

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.* *Students who have fully met the prescribed learning outcome are able to*:
C1 use modern atomic theory to describe the structure and components of atoms and molecules	❑ describe the development of atomic theory, including reference to Dalton, Rutherford, and Bohr ❑ distinguish between atoms and molecules ❑ identify the three subatomic particles, their properties, and their location within the atom
C2 use the periodic table to compare the characteristics and atomic structure of elements	❑ explain the organization of the periodic table of elements (e.g., atomic number, atomic mass, properties, families) ❑ distinguish between metals, non-metals, and metalloids ❑ use the periodic table to predict the properties of a family of elements (e.g., alkali, alkaline earth, halogens, and noble gases) ❑ draw a Bohr model of each atom up to atomic number 20 (including only protons and electrons)
C3 write and interpret chemical symbols of elements and formulae of ionic compounds	❑ differentiate between elements and compounds ❑ write chemical symbols for atoms and ions of elements ❑ differentiate between atoms and ions in terms of structure, using Bohr models ❑ write chemical formulae for ionic compounds, including those involving metals with non-metals, multivalent metals, and polyatomic ions ❑ name ionic compounds, given the chemical formula
C4 describe changes in the properties of matter	❑ identify physical properties of matter, including mass, volume, density, state at room temperature, colour, melting/boiling point, and conductivity ❑ differentiate between physical and chemical changes, citing observable evidence ❑ name the changes of state of matter, and describe how the kinetic molecular theory explains those changes

GRADE 9 PHYSICAL SCIENCE: CHARACTERISTICS OF ELECTRICITY

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.* *Students who have fully met the prescribed learning outcome are able to:*
C5 explain the production, transfer, and interaction of static electrical charges in various materials	❑ explain, with illustrations, how static charges are separated because of transfer between various materials ❑ describe types of static electrical charge (positive, negative) and no charge (neutral) with reference to atomic theory ❑ describe how the electric force between two objects depends on types of charge, size of charge, and the distance between the two objects
C6 explain how electric current results from separation of charge and the movement of electrons	❑ distinguish between - potential and kinetic energy - static electricity and electric current - conventional current and electron flow ❑ relate the charge on electrons to electron flow in a circuit (i.e., from negative to positive) ❑ define *current* in terms of the amount of electric charge that passes a point in a given time interval
C7 compare series and parallel circuits involving varying resistances, voltages, and currents	❑ define resistance ❑ draw circuit diagrams using appropriate symbols that are properly placed ❑ conduct experiments to - measure voltage and current, using appropriate equipment and units (e.g., volts, amperes) - determine resistance, using current and voltage data ❑ perform calculations using Ohm's Law ❑ for a fixed supply voltage, differentiate qualitatively between series and parallel circuits in terms of - current (may change from resistor to resistor in parallel; remains the same in series) - voltage (may change from resistor to resistor in series; remains the same in parallel) - total resistance (increases with the number of resistors in series; decreases in parallel)
C8 relate electrical energy to power consumption	❑ define electrical energy and power ❑ calculate the following: - power—using voltage and current data - energy consumption—given the power rating of a device and duration of use

GRADE 9

KEY ELEMENTS: EARTH AND SPACE SCIENCE

Estimated Time: 20-25 hours

By the end of the grade, students will have examined the formation, composition, and characteristics of the solar system, stars, and universe.

Vocabulary

asteroids, axis tilt, Big Bang, colonization, comets, constellations, Copernicus, galaxies, Kepler, moons, nebulae, planets, probes, Ptolemy, revolution, rotation, satellites, solar and lunar eclipses, spectroscopes, star clusters/types, Sun, telescopes, terraforming

Knowledge

- technologies advance understanding of the solar system, stars, and universe
- components of the universe and solar system
- significance of Earth's rotation, revolution, and axis tilt
- celestial sphere in relation to constellations and their location
- motion of constellations, planets, moons, sun, asteroids, and comets
- solar and lunar eclipses
- implications of space travel

Skills and Attitudes

- illustrate astronomical phenomena
- show respect for Aboriginal perspectives
- identify ethical considerations associated with space travel

GRADE 9 EARTH AND SPACE SCIENCE: SPACE EXPLORATION

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each corresponding prescribed learning outcome.* *Students who have fully met the prescribed learning outcome are able to:*
D1 explain how a variety of technologies have advanced understanding of the universe and solar system	❑ identify and describe a range of instruments that are used in astronomy (e.g., telescopes, spectroscopes, satellites, probes, robotic devices) ❑ give examples of how astronomers use astronomical and space exploration technologies to advance understanding of the universe and solar system (e.g., using red shift to support the idea of an expanding universe, using parallax to measure distance)
D2 describe the major components and characteristics of the universe and solar system	❑ identify galaxies, star clusters/types, planets, constellations, nebulae according to their distinguishing characteristics ❑ relate mass to different stages in the life cycle of stars ❑ describe theories on the nature of the solar system (e.g., Ptolemy, Copernicus, Kepler) ❑ describe the formation of the solar system (e.g., condensing nebula) and its components (e.g., planets, moons, comets, asteroids, the Sun) and the formation of the universe (e.g., Big Bang) ❑ describe the processes that generate and events that distribute the energy of the Sun and other stars (e.g., nuclear fusion, solar flares and prominences, sun spots, solar wind)
D3 describe traditional perspectives of a range of Aboriginal peoples in BC on the relationship between the Earth and celestial bodies	❑ identify passages related to the relationship between the Earth and various celestial bodies within specific traditional stories of BC Aboriginal peoples ❑ respond to BC Aboriginal stories and presentations focusing on the nature of stars, the moon, planets, comets, or eclipses (e.g., by creating illustrations; by identifying similarities among stories or between stories and contemporary scientific understanding)
D4 explain astronomical phenomena with reference to the Earth/moon system	❑ describe the formation of the Earth's moon, with reference to supporting evidence ❑ describe the significance of Earth's rotation, revolution, and axis tilt (e.g., seasons, day/night) ❑ describe the celestial sphere in relation to constellations and their locations ❑ explain the apparent motion of constellations, planets, the Sun, the moon, asteroids, and comets ❑ explain and illustrate solar and lunar eclipses

PRESCRIBED LEARNING OUTCOMES	SUGGESTED ACHIEVEMENT INDICATORS
D5 analyse the implications of space travel	❑ identify various possibilities and limitations associated with space travel (e.g., with reference to factors such as time, essential human needs, robots, budget choices, militarization of space) ❑ debate a range of ethical issues related to space travel (e.g., appropriateness of terraforming another planet, exposing humans to risks) ❑ research current ideas or initiatives for further space exploration (e.g., space elevator, colonization of other planets, search for extraterrestrial life)