DEPARTMENT OF ACADEMIC UPGRADING

COURSE OUTLINE – Winter 2025

SC0110 (A3): Science Grade 10 Equivalent – 5 (6-0-1.5) HS

112.5 Hours for 15 Weeks

Northwestern Polytechnic acknowledges that our campuses are located on Treaty 8 territory, the ancestral and present-day home to many diverse First Nations, Metis, and Inuit people. We are grateful to work, live and learn on the traditional territory of Duncan's First Nation, Horse Lake First Nation and Sturgeon Lake Cree Nation, who are the original caretakers of this land.

We acknowledge the history of this land and we are thankful for the opportunity to walk together in friendship, where we will encourage and promote positive change for present and future generations.

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OFFICE HOURS:	TBD or by appointment		

CALENDAR DESCRIPTION:

This course provides an introduction to major concepts in biology, chemistry and physics. The four areas of study are: Energy and Matter in Chemical Change, Energy Flow in Technological Systems, Cycling of Matter in Living Systems and Energy Flow in Global Systems.

PREREQUISITE(S):

Complete All of the following:

- SC0100 or permission of the department
- EN0090 or EN0110 placement
- MA0091 or MA0093 or MA0110 placement

REQUIRED TEXT/RESOURCE MATERIALS:

Science 10 Addison Wesley

Non-graphing scientific calculator;

Internet access for MyClass and additional material.

DELIVERY MODE(S):

- On-campus (attend on-campus, in-person) – This type of course will be delivered on campus in a specific location which will be indicated on the student timetable. Students are expected to fully attend in person.
- Use of D2L is required.
- In-person classroom instruction with labs to incorporate hands-on learning experience. Materials will be delivered as lecture-style presentations supplemented with practice problems, discussion, and review questions.

LEARNING OUTCOMES:

Unit A: Energy and Matter in Chemical Change (Chemistry)

- Describe the basic particles that make up the underlying structure of matter, and investigate related technologies
- Explain, using the periodic table, how elements combine to form compounds, and follow IUPAC guidelines for naming ionic compounds and simple molecular compounds
- Identify and classify chemical changes, and write word and balanced chemical equations for significant chemical reactions, as applications of Lavoisier's law of conservation of mass

Unit B: Energy Flow in Technological Systems (Physics)

- Analyze and illustrate how technologies based on thermodynamic principles were developed before the laws of thermodynamics were formulated
- Explain and apply concepts used in theoretical and practical measures of energy in mechanical systems
- Apply the principles of energy conservation and thermodynamics to investigate, describe and predict efficiency of energy transformation in technological systems

Unit C: Cycling of Matter in Living Systems (Biology)

- Explain the relationship between developments in imaging technology and the current understanding of the cell

- Describe the function of cell organelles and structures in a cell, in terms of life processes, and use models to explain these processes and their applications
  Analyze plants as an example of a multicellular organism with specialized structures at the cellular, tissue and system levels

Unit D: Energy Flow in Global Systems (Environment)

- Describe how the relationships among input solar energy, output terrestrial energy and energy flow within the biosphere affect the lives of humans and other species
- Analyze the relationships among net solar energy, global energy transfer processes—primarily radiation, convection and hydrologic cycle—and climate.
- Relate climate to the characteristics of the world's major biomes, and compare biomes in different regions of the world
- Investigate and interpret the role of environmental factors on global energy transfer and climate change

TRANSFERABILITY:

Please consult the Alberta Transfer Guide for more information. You may check to ensure the transferability of this course at the Alberta Transfer Guide main page http://www.transferalberta.alberta.ca.

** Grade of D or D+ may not be acceptable for transfer to other post-secondary institutions. **Students are cautioned that it is their responsibility to contact the receiving institutions to ensure transferability.**

EVALUATIONS:

Labs, Quizzes, Assignments	20%
Unit Tests	40%
Final Exam (cumulative)	40%

GRADING CRITERIA:
Please note that most universities will not accept your course for transfer credit **IF** your grade is **less than C-**.

Alpha Grade	4-point Equivalent	Percentage Guidelines		Alpha Grade	4-point Equivalent	Percentage Guidelines
A+	4.0	95-100		C+	2.3	67-69
A	4.0	85-94		C	2.0	63-66
A-	3.7	80-84		C-	1.7	60-62
B+	3.3	77-79		D+	1.3	55-59
B	3.0	73-76		D	1.0	50-54
B-	2.7	70-72		F	0.0	00-49

COURSE SCHEDULE/TENTATIVE TIMELINE:
SC0110 consists of four units (approx. 3 weeks each) Exam dates to be announced in class.

Unit A Chemistry
Unit B Physics
Unit C Biology
Unit D Environment

Labs: Schedule will be announced in class, pending the availability of the lab rooms.

- Attendance is compulsory in all labs.
- Missed labs result in a score of zero. **There are NO make-up labs.**
- If you are late and have missed the lab safety discussion, you MAY be excluded from participating in the lab and will receive a mark of zero.
- Download the lab sheets and complete the Pre-lab assignment before the lab period, data tables are completed during the lab and analysis and questions after the lab.

STUDENT RESPONSIBILITIES:

In addition to the Student Rights and Responsibilities as set out in the Northwestern Polytechnic website (https://www.nwpolytech.ca/about/administration/policies/fetch.php?ID=69), the following guidelines will maintain an effective learning environment for everyone:

- Attendance: Regular attendance and class participation is expected of all students and is crucial to good performance in the course. Class interruption due to habitual late arrival or leaving early will not be permitted. You may be debarred from the final exam if your absences exceed 15% of class days (10 lecture classes).
- Check myClass as well as NWP email on a regular basis.
- Assignments and lab reports must be submitted on time.
- Exams must be written on the days announced in class.
    - If an emergency prevents attendance on an exam day, students must contact me as soon as possible via phone or email, and may be asked to provide documentation to justify their absence.
- No unspecified electronic devices will be permitted during exams.
- Complete daily homework. At least 1 hour of study per day outside of class time is required.
- Behaviors that interfere with learning are not acceptable.
- Take responsibility for your learning.

STATEMENT ON ACADEMIC MISCONDUCT:

Academic Misconduct will not be tolerated. For a more precise definition of academic misconduct and its consequences, refer to the Student Rights and Responsibilities policy available at https://www.nwpolytech.ca/about/administration/policies/index.html.

**Note: all Academic and Administrative policies are available on the same page.

Additional Information:

Unit A: Energy and Matter in Chemical Change

Key Concepts:

- how chemical substances meet human needs
- Workplace Hazardous Materials Information System (WHMIS)
- evidence of chemical change
- role and need for classification of chemical change

• writing and balancing equations
• law of conservation of mass and the mole concept
• International Union of Pure and Applied Chemistry (IUPAC) nomenclature, ionic and molecular compounds, acids and bases

Students will:

1. Describe the basic particles that make up the underlying structure of matter, and investigate related technologies
   • identify historical examples of how humans worked with chemical substances to meet their basic needs (e.g., how pre-contact First Nations communities used biotic and abiotic materials to meet their needs)
   • outline the role of evidence in the development of the atomic model consisting of protons and neutrons (nucleons) and electrons; i.e., Dalton, Thomson, Rutherford, Bohr
   • identify examples of chemistry-based careers in the community (e.g., chemical engineering, cosmetology, food processing)
2. Explain, using the periodic table, how elements combine to form compounds, and follow IUPAC guidelines for naming ionic compounds and simple molecular compounds
   • illustrate an awareness of WHMIS guidelines, and demonstrate safe practices in the handling, storage and disposal of chemicals in the laboratory and at home
   • explain the importance of and need for the IUPAC system of naming compounds, in terms of the work that scientists do and the need to communicate clearly and precisely
   • explain, using the periodic table, how and why elements combine to form compounds in specific ratios
   • predict formulas and write names for ionic and molecular compounds and common acids (e.g., sulfuric, hydrochloric, nitric, ethanoic), using a periodic table, a table of ions and IUPAC rules
   • classify ionic and molecular compounds, acids and bases on the basis of their properties; i.e., conductivity, pH, solubility, state
   • predict whether an ionic compound is relatively soluble in water, using a solubility chart
   • relate the molecular structure of simple substances to their properties (e.g., describe how the properties of water are due to the polar nature of water molecules, and relate this property to the transfer of energy in physical and living systems)
   • outline the issues related to personal and societal use of potentially toxic or hazardous compounds (e.g., health hazards due to excessive consumption of alcohol and nicotine; exposure to toxic substances; environmental concerns related to the handling, storage and disposal of heavy metals, strong acids, flammable gases, volatile liquids)
3. Identify and classify chemical changes, and write word and balanced chemical equations for significant chemical reactions, as applications of Lavoisier's law of conservation of mass
   • provide examples of household, commercial and industrial processes that use chemical reactions to produce useful substances and energy (e.g., baking powder in baking, combustion of fuels, electrolysis of water into H2(g) and O2(g))

- identify chemical reactions that are significant in societies (e.g., reactions that maintain living systems, such as photosynthesis and respiration; reactions that have an impact on the environment, such as combustion reactions and decomposition of waste materials)
- describe the evidence for chemical changes; i.e., energy change, formation of a gas or precipitate, colour or odour change, change in temperature
- differentiate between endothermic and exothermic chemical reactions (e.g., combustion of gasoline and other natural and synthetic fuels, photosynthesis)
- classify and identify categories of chemical reactions; i.e., formation (synthesis), decomposition, hydrocarbon combustion, single replacement, double replacement
- translate word equations to balanced chemical equations and vice versa for chemical reactions that occur in living and nonliving systems
- predict the products of formation (synthesis) and decomposition, single and double replacement, and hydrocarbon combustion chemical reactions, when given the reactants
- define the mole as the amount of an element containing 6.02 × 1023 atoms (Avogadro's number) and apply the concept to calculate quantities of substances made of other chemical species (e.g., determine the quantity of water that contains 6.02 × 1023 molecules of H2O)
- interpret balanced chemical equations in terms of moles of chemical species, and relate the mole concept to the law of conservation of mass

Unit B: Energy Flow in Technological Systems

Key Concepts

- forms and interconversions of energy • one-dimensional motion • mechanical energy conversions and work
- efficient use of energy, and the environmental impact of inefficient use of energy
- technological innovations of engines that led to the development of the concept of energy
- design and function of technological systems and devices involving potential and kinetic energy and thermal energy conversions

Students will:

1. Analyze and illustrate how technologies based on thermodynamic principles were developed before the laws of thermodynamics were formulated
   - illustrate, by use of examples from natural and technological systems, that energy exists in a variety of forms (e.g., mechanical, chemical, thermal, nuclear, solar)
   - describe, qualitatively, current and past technologies used to transform energy from one form to another, and that energy transfer technologies produce measurable changes in motion, shape or temperature (e.g., hydroelectric and coal-burning generators, solar heating panels, windmills, fuel cells; describe examples of Aboriginal applications of thermodynamics in tool making, design of structures and heating)
   - identify the processes of trial and error that led to the invention of the engine, and relate the principles of thermodynamics to the development of more efficient engine designs (e.g., the work of James Watt; improved valve designs in car engines)

- analyze and illustrate how the concept of energy developed from observation of heat and mechanical devices (e.g., the investigations of Rumford and Joule; the development of pre-contact First Nations and Inuit technologies based on an understanding of thermal energy and transfer)

2. Explain and apply concepts used in theoretical and practical measures of energy in mechanical systems
   - describe evidence for the presence of energy; i.e., observable physical and chemical changes, and changes in motion, shape or temperature
   - define kinetic energy as energy due to motion, and define potential energy as energy due to relative position or condition
   - describe chemical energy as a form of potential energy (e.g., energy stored in glucose, adenosine triphosphate [ATP], gasoline)
   - define, compare and contrast scalar and vector quantities
   - describe displacement and velocity quantitatively
   - define acceleration, quantitatively, as a change in velocity during a time interval: $a = \Delta v/\Delta t$
   - explain that, in the absence of resistive forces, motion at constant speed requires no energy input
   - recall, from previous studies, the operational definition for force as a push or a pull, and for work as energy expended when the speed of an object is increased, or when an object is moved against the influence of an opposing force
   - define gravitational potential energy as the work against gravity
   - relate gravitational potential energy to work done using Ep = mgh and W = Fd and show that a change in energy is equal to work done on a system: $\Delta E = W$
   - quantify kinetic energy using Ek = 1/2 mv2 and relate this concept to energy conservation in transformations (e.g., for an object falling a distance "h" from rest: mgh = Fd = 1/2 mv2)
   - derive the SI unit of energy and work, the joule, from fundamental units
   - investigate and analyze one-dimensional scalar motion and work done on an object or system, using algebraic and graphical techniques (e.g., the relationships among distance, time and velocity; determining the area under the line in a force–distance graph)

3. Apply the principles of energy conservation and thermodynamics to investigate, describe and predict efficiency of energy transformation in technological systems
   - describe, qualitatively and in terms of thermodynamic laws, the energy transformations occurring in devices and systems (e.g., automobile, bicycle coming to a stop, thermal power plant, food chain, refrigerator, heat pump, permafrost storage pits for food)
   - describe how the first and second laws of thermodynamics have changed our understanding of energy conversions (e.g., why heat engines are not 100% efficient)
   - define, operationally, "useful" energy from a technological perspective, and analyze the stages of "useful" energy transformations in technological systems (e.g., hydroelectric dam)
   - recognize that there are limits to the amount of "useful" energy that can be derived from the conversion of potential energy to other forms in a technological device (e.g., when the potential energy of gasoline is converted to kinetic energy in an automobile engine,

some is also converted to heat; when electrical energy is converted to light energy in a light bulb, some is also converted to heat)

- explain, quantitatively, efficiency as a measure of the "useful" work compared to the total energy put into an energy conversion process or device
- apply concepts related to efficiency of thermal energy conversion to analyze the design of a thermal device (e.g., heat pump, high efficiency furnace, automobile engine)
- compare the energy content of fuels used in thermal power plants in Alberta, in terms of costs, benefits, efficiency and sustainability
- explain the need for efficient energy conversions to protect our environment and to make judicious use of natural resources (e.g., advancement in energy efficiency; Aboriginal perspectives on taking care of natural resources)
- investigate and interpret how variations in thermal properties of materials can lead to uneven heating and cooling
- investigate and explain how evaporation, condensation, freezing and melting transfer thermal energy; i.e., use simple calculations of heat of fusion $H_{fus} = nQ$ and vaporization $H_{vap} = nQ$, and $Q=mc\Delta t$ to convey amounts of thermal energy involved, and link these processes to the hydrologic cycle

Unit C: Cycling of Matter in Living Systems

Key Concepts

- microscopy and the emergence of cell theory
- cellular structures and functions, and technological applications
- active and passive transport of matter
- relationship between cell size and shape, and surface area to volume ratio
- use of explanatory and visual models in science
- cell specialization in multicellular organisms; i.e., plants
- mechanisms of transport, gas exchange, and environmental response in multicellular organisms; i.e., plants

Students will:

1. Explain the relationship between developments in imaging technology and the current understanding of the cell
   - trace the development of the cell theory: all living things are made up of one or more cells and the materials produced by these, cells are functional units of life, and all cells come from pre-existing cells (e.g., from Aristotle to Hooke, Pasteur, Brown, and Schwann and Schleiden; recognize that there are sub-cellular particles, such as viruses and prions, which have some characteristics of living cells)
   - describe how advancements in knowledge of cell structure and function have been enhanced and are increasing as a direct result of developments in microscope

technology and staining techniques (e.g., electron microscope, confocal laser scanning microscope [CLSM])
- identify areas of cell research at the molecular level (e.g., DNA and gene mapping, transport across cell membranes)

2. Describe the function of cell organelles and structures in a cell, in terms of life processes, and use models to explain these processes and their applications
   - compare passive transport of matter by diffusion and osmosis with active transport in terms of the particle model of matter, concentration gradients, equilibrium and protein carrier molecules (e.g., particle model of matter and fluid-mosaic model)
   - use models to explain and visualize complex processes like diffusion and osmosis, endo- and exocytosis, and the role of cell membrane in these processes
   - describe the cell as a functioning open system that acquires nutrients, excretes waste, and exchanges matter and energy
   - identify the structure and describe, in general terms, the function of the cell membrane, nucleus, lysosome, vacuole, mitochondrion, endoplasmic reticulum, Golgi apparatus, ribosomes, chloroplast and cell wall, where present, of plant and animal cells
   - compare the structure, chemical composition and function of plant and animal cells, and describe the complementary nature of the structure and function of plant and animal cells
   - describe the role of the cell membrane in maintaining equilibrium while exchanging matter
   - describe how knowledge about semi-permeable membranes, diffusion and osmosis is applied in various contexts (e.g., attachment of HIV drugs to cells and liposomes, diffusion of protein hormones into cells, staining of cells, desalination of sea water, peritoneal or mechanical dialysis, separation of bacteria from viruses, purification of water, cheese making, use of honey as an antibacterial agent and berries as a preservative agent by traditional First Nations communities)
   - describe cell size and shape as they relate to surface area to volume ratio, and explain how that ratio limits cell size (e.g., compare nerve cells and blood cells in animals, or plant root hair cells and chloroplast-containing cells on the surface of leaves)
3. Analyze plants as an example of a multicellular organism with specialized structures at the cellular, tissue and system levels
   - explain why, when a single-celled organism or colony of single-celled organisms reaches a certain size, it requires a multicellular level of organization, and relate this to the specialization of cells, tissues and systems in plants
   - describe how the cells of the leaf system have a variety of specialized structures and functions; i.e., epidermis including guard cells, palisade tissue cells, spongy tissue cells, and phloem and xylem vascular tissue cells to support the process of photosynthesis
   - explain and investigate the transport system in plants; i.e., xylem and phloem tissues and the processes of transpiration, including the cohesion and adhesion properties of water, turgor pressure and osmosis; diffusion, active transport and root pressure in root hairs
   - explain and investigate the gas exchange system in plants; i.e., lenticels, guard cells, stomata and the process of diffusion

- explain and investigate phototropism and gravitropism as examples of control systems in plants
- trace the development of theories of phototropism and gravitropism (e.g., from Darwin and Boysen-Jensen to Went)

Unit D: Cycling of Matter in Living Systems

Key Concepts

- social and environmental contexts for investigating climate change
- solar radiation budget
- climate zones, transfer of thermal energy by the hydrosphere and the atmosphere
- hydrologic cycle and phase change
- relationship between biomes, solar energy and climate
- human activity and climate change

Students will:

1. Describe how the relationships among input solar energy, output terrestrial energy and energy flow within the biosphere affect the lives of humans and other species
   - explain how climate affects the lives of people and other species, and explain the need to investigate climate change (e.g., describe the responses of human and other species to extreme climatic conditions; describe housing designs, animal habitats, clothing and fur in conditions of extreme heat, cold, dryness or humidity, wind)
   - identify the Sun as the source of all energy on Earth
   - analyze, in general terms, the net radiation budget, using per cent; i.e., solar energy input, terrestrial energy output, net radiant energy
   - describe the major characteristics of the atmosphere, the hydrosphere and the lithosphere, and explain their relationship to Earth's biosphere
   - describe and explain the greenhouse effect, and the role of various gases—including methane, carbon dioxide and water vapour—in determining the scope of the greenhouse effect
2. Analyze the relationships among net solar energy, global energy transfer processes—primarily radiation, convection and hydrologic cycle—and climate.
   - describe, in general terms, how thermal energy is transferred through the atmosphere (i.e., global wind patterns, jet stream, Coriolis effect, weather systems) and through the hydrosphere (i.e., ocean currents, large bodies of water) from latitudes of net radiation surplus to latitudes of net radiation deficit, resulting in a variety of climatic zones (e.g., analyze static and animated satellite images)
   - investigate and describe, in general terms, the relationships among solar energy reaching Earth's surface and time of year, angle of inclination, length of daylight, cloud cover, albedo effect and aerosol or particulate distribution
   - explain how thermal energy transfer through the atmosphere and hydrosphere affects climate

3. Relate climate to the characteristics of the world's major biomes, and compare biomes in different regions of the world
   - describe a biome as an open system in terms of input and output of energy and matter and exchanges at its boundaries (e.g., compare and contrast cells and biomes as open systems)
   - relate the characteristics of two major biomes (i.e., grassland, desert, tundra, taiga, deciduous and rain forest) to net radiant energy, climatic factors (temperature, moisture, sunlight and wind) and topography (mountain ranges, large bodies of water)
   - analyze the climatographs of two major biomes (i.e., grasslands, desert, tundra, taiga, deciduous and rain forest) and explain why biomes with similar characteristics can exist in different geographical locations, latitudes and altitudes
   - identify the potential effects of climate change on environmentally sensitive biomes (e.g., impact of a reduction in the Arctic ice pack on local species and on Aboriginal societies that rely on traditional lifestyles)
4. Investigate and interpret the role of environmental factors on global energy transfer and climate change
   - investigate and identify human actions affecting biomes that have a potential to change climate (e.g., emission of greenhouse gases, draining of wetlands, forest fires, deforestation) and critically examine the evidence that these factors play a role in climate change (e.g., global warming, rising sea level(s))
   - identify evidence to investigate past changes in Earth's climate (e.g., ice core samples, tree ring analysis)
   - describe and evaluate the role of science in furthering the understanding of climate and climate change through international programs (e.g., World Meteorological Organization, World Weather Watch, Global Atmosphere Watch, Surface Heat Budget of the Arctic Ocean (SHEBA) project, The Intergovernmental Panel on Climate Change (IPCC); the study of paleoclimates and models of future climate scenarios)
   - describe the role of technology in measuring, modelling and interpreting climate and climate change (e.g., computer models, devices to take measurements of greenhouse gases, satellite imaging technology)
   - describe the limitations of scientific knowledge and technology in making predictions related to climate and weather (e.g., predicting the direct and indirect impacts on Canada's agriculture, forestry and oceans of climate change, or from changes in energy transfer systems, such as ocean currents and global wind patterns)
   - assess, from a variety of perspectives, the risks and benefits of human activity, and its impact on the biosphere and the climate (e.g., compare the Gaia hypothesis with traditional Aboriginal perspectives on the natural world; identify and analyze various perspectives on reducing the impact of human activity on the global climate)

Lab Skills and objectives are included in labs and assignments in each unit of the course.

Specific Outcomes for Skills (focus on scientific inquiry)

Northwestern Polytechnic

Initiating and Planning

Students will:

- define and delimit problems to facilitate investigation
- design an experiment, identifying and controlling major variables (e.g., design an experiment to differentiate between categories of matter, such as acids, bases and neutral solutions, and identify manipulated and responding variables)
- state a prediction and a hypothesis based on available evidence and background information (e.g., state a hypothesis about what happens to baking soda during baking)
- evaluate and select appropriate instruments for collecting evidence and appropriate processes for problem solving, inquiring and decision making (e.g., list appropriate technology for classifying compounds, such as litmus paper or conductivity tester

Performing and Recording

Students will:

- carry out procedures, controlling the major variables and adapting or extending procedures (e.g., when performing an experiment to illustrate conservation of mass, demonstrate an understanding of closed and open systems and control for loss or gain of matter during a chemical change)
- demonstrate a knowledge of WHMIS standards by selecting and applying proper techniques for the handling and disposal of laboratory materials (e.g., recognize and use Material Safety Data Sheets [MSDS] information)
- select and use apparatus, technology and materials safely (e.g., use equipment, such as Bunsen burners, electronic balances, laboratory glassware, electronic probes and calculators correctly and safely)
- compile and organize data, using appropriate formats and data treatments to facilitate interpretation of the data (e.g., use a computer-based laboratory to compile and organize data from an experiment to demonstrate the equivalency of work done on an object and the resulting kinetic energy)

Analyzing and Interpreting

Students will:

- describe and apply classification systems and nomenclature used in the sciences (e.g., investigate periodicity in the periodic table, classify matter, and name elements and compounds based on IUPAC guidelines)
- apply and assess alternative theoretical models for interpreting knowledge in a given field (e.g., compare models for the structure of the atom)
- compare theoretical and empirical values and account for discrepancies (e.g., measure the mass of a chemical reaction system before and after a change, and account for any discrepancies)
- identify and explain sources of error and uncertainty in measurement, and express results in a form that acknowledges the degree of uncertainty (e.g., measure and record the mass of a material, use significant digits appropriately)

- identify new questions or problems that arise from what was learned (e.g., how did ancient peoples discover how to separate metals from their ores? evaluate the traditional Aboriginal method for determining alkaline properties of substances)
- compile and display evidence and information, by hand or using technology, in a variety of formats, including diagrams, flow charts, tables, graphs and scatterplots (e.g., plot distance–time, velocity–time and force–distance graphs; manipulate and present data through the selection of appropriate tools, such as scientific instrumentation, calculators, databases or spreadsheets)
- identify limitations of data or measurement (e.g., recognize that the measure of the local value of gravity varies globally; use significant digits appropriately)
- interpret patterns and trends in data, and infer or calculate linear and nonlinear relationships among variables (e.g., interpret a graph of changing kinetic and potential energy from a pendulum during one-half of a period of oscillation; calculate the slope of the line in a distance–time graph; analyze a simple velocity–time graph to describe acceleration; calculate the area under the line in a force–distance graph)
- compare theoretical and empirical values and account for discrepancies (e.g., determine the efficiency of thermal energy conversion systems)
- state a conclusion based on experimental data, and explain how evidence gathered supports or refutes the initial hypothesis (e.g., explain the discrepancy between the theoretical and actual efficiency of a thermal energy conversion system)
- construct and test a prototype of a device or system, and troubleshoot problems as they arise (e.g., design and build an energy conversion device)
- propose alternative solutions to a given practical problem, identify the potential strengths and weaknesses of each and select one as the basis for a plan (e.g., assess whether coal or natural gas should be used to fuel thermal power plants in Alberta)
- evaluate a personally designed and constructed device on the basis of self-developed criteria (e.g., evaluate an energy conversion device based on a modern or traditional design)

Communication and Teamwork

Students will:

- communicate questions, ideas and intentions; and receive, interpret, understand, support and respond to the ideas of others (e.g., use appropriate communication technology to elicit feedback from others)
- represent large and small numbers using appropriate scientific notation
- select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results (e.g., use appropriate Système international (SI) units, and IUPAC nomenclature)

