DEPARTMENT OF ACADEMIC UPGRADING
COURSE OUTLINE Fall 2019
SC0100 5(5 – 0 – 0) 5.0 hr for 15 weeks (75 hr total)

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OFFICE HOURS:	by appointment		

CALENDAR DESCRIPTION: This course is meant to increase the pre-high school student's understanding of connections between science, technology and society. You will be introduced to basic ideas about science, technology, biology, chemistry, physics, ecology, scientific method, along with related social issues.

Required Text/Resource Materials:
Science in Action 9 Addison Wesley
Lab manual (Can be printed from Moodle)
10 quad to 1 cm graph paper (can be printed from Moodle)
Nonprogrammable calculator
Lab notebook

PREREQUISITES: EN 0080 and MA 0081 or MA 0091 placement.

DELIVERY MODE(S): Classroom instruction and lab. Moodle will be used extensively.

COURSE OBJECTIVES: ***Students will:***

Unit A: Biological Diversity
- investigate and interpret diversity among species and within species, and describe how diversity contributes to species survival
- investigate the nature of reproductive processes and their role in transmitting species characteristics
- describe, in general terms, the role of genetic materials in the continuity and variation of species characteristics; and investigate and interpret related technologies
- identify impacts of human action on species survival and variation within species, and analyze related issues for personal and public decision making

Unit B: Environmental Chemistry
- investigate and describe, in general terms, the role of different substances in the environment in supporting or harming humans and other living things
- identify processes for measuring the quantity of different substances in the environment and for monitoring air and water quality
- analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment

Unit C: Electrical Principles and Technologies
- investigate and interpret the use of devices to convert various forms of energy to electrical energy, and electrical energy to other forms of energy
- describe technologies for transfer and control of electrical energy
- identify and estimate energy inputs and outputs for example devices and systems, and evaluate the efficiency of energy conversions
- describe and discuss the societal and environmental implications of the use of electrical energy

Unit D: Space Exploration

- investigate and describe ways that human understanding of Earth and space has depended on technological development
- identify problems in developing technologies for space exploration, describe technologies developed for life in space, and explain the scientific principles involved
- describe and interpret the science of optical and radio telescopes, space probes and remote sensing technologies
- identify issues and opportunities arising from the application of space technology, identify alternatives involved, and analyze implications

Note: We will NOT be covering Unit B Matter and Chemical Change because those topics are covered again and in much greater detail in SC0110.

LEARNING OUTCOMES: Please see the detailed Course Outline, which follows (pages 3-9).

TRANSFERABILITY:
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.
**Although 50% (D) is considered a pass for this course, it is strongly recommend that you achieve a mark of 65% (C) to be successful at the next level.

EVALUATIONS: Course final grade will be based on the following components.

Unit Tests (equal weighting)	45%	
Labs	10%	**Late penalty 20% per day for 2 days.**
Assignments, Quizzes	15%	**Late penalty 20% per day for 2 days.**
Final Exam (Cumulative)	30%	

Penalties for late **lab reports/assignments** are as follows:
24 hours - 20%
48 hours – 40 %, anything after that is a zero.
A LATE ASSIGNMENT OR LAB WILL NOT BE ACCEPTED ONCE THE ASSIGNMENT OR LAB HAS BEEN RETURNED TO THE OTHER STUDENTS. You may still submit it and I will mark it (so that you have feedback on how well you understood the concepts) but the mark WILL NOT count towards your grade.

All tests and exams MUST be written at the scheduled times unless **PRIOR** arrangements have been made with the instructor. A missed test (exam) will result in a score of ZERO on that test (exam). Only in very specific cases may student be given an opportunity to make up a missed exam (student will be presented with a different version of the exam). Doctor, lawyer or police documentation may be required. The final exam is 3 hours long and is scheduled by the registrars' office during GPRC Exam weeks. Do not book vacation in this time period.

GRADING CRITERIA: Final Grades will be assigned on the Letter Grading System.

Alpha Grade	4-point Equivalen	Percentage Guideline		Alpha Grade	4-point Equivalen	Percentage Guideline
A+	4.0	90-100		C+	2.3	67-69
A	4.0	85-89		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

STUDENT RESPONSIBILITIES:
Refer to the College Policy on Student Rights and Responsibilities at
https://www.gprc.ab.ca/files/forms_documents/StudentRightsandResponsibilities.pdf

The Academic Upgrading Department is an adult education environment. Students are expected to show respect for each other as well as faculty and staff. Students are expected to participate fully in achieving their educational goals.

Certain activities are disruptive and not conducive to an atmosphere of learning. In addition to the *Student Rights and Responsibilities* as set out in the College calendar, the following guidelines will maintain an effective learning environment for everyone. We ask the cooperation of all students in the following areas of classroom deportment.

1. Regular attendance is expected of all students, and is crucial to passing this course. Students who miss classes will soon find themselves falling behind and failing. Lateness will **not** be tolerated as it interrupts the instructor and fellow classmates.
2. Check **Moodle** as well as **GPRC email** on a regular basis. Any changes to the Course Timeline or Exam Dates will be communicated on Moodle. Students will be held to the deadlines listed on the Course Timeline whether or not those deadlines are spoken about in class.
3. As per Department Policy, if you miss more than 10 per semester of classes in any course, you may be debarred from the final exam for that course.
4. A certificate (a doctor's or a note from the funeral home) will be required to make up the midterm or final exam. **You will receive a grade of F if you miss the final.** Call if you are going to miss a test. There may be a deduction of 10% for test rewrites.

***Very important:**

Laboratory attendance to each specific experiment is compulsory; a passing grade in the laboratory component is required to pass the course. There are **NO** 'make up' labs in this course. Being absent from an experiment will result in a grade of **ZERO** for that experiment.

Lab reports must be submitted on the required date and at the **required time**.

Assignments will not be accepted after the assignment has been returned to the class.

Recommendations for success:

- Review material that is prerequisite to this course quickly so it does not slow you down.
- Complete all pre class and pre-lab assignments before arriving in class.
- Keep up with course material.
- Put away your phone!!! The average mark of people more interested in their phone than the class was 35%.
- If you are experiencing difficulties with course material, get help immediately.
- Catch up on missed material before the next class.
- Provide documentation for missed midterms or finals.
- Be aware of penalty for failing the lab component and not writing the final.

STATEMENT ON PLAGIARISM AND CHEATING:

Cheating and plagiarism will not be tolerated and there will be penalties. For a more precise definition of plagiarism and its consequences, refer to the Student conduct section of the College Calendar at:

https://www.gprc.ab.ca/files/forms_documents/Student_Misconduct.pdf

Instructors reserve the right to use electronic plagiarism detection services on written assignments. **Instructors also reserve the right to ban the use of any form of electronics (cell phones, Blackberries, iPods, tablets, scanning pens, electronic dictionaries, etc.) during class and during exams.**

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

Additional Information (Optional):

**Note: all Academic and Administrative policies are available https://www.gprc.ab.ca/about/administration/policies

Detailed Course Outline and Learning Objectives

Unit A: Biological Diversity (25%)

Key Concepts

- biological diversity
- habitat diversity
- asexual and sexual reproduction
- cell division—includes binary fission and formation of sex cells
- species
- niches
- inheritance
- diversity within species
- populations
- chromosomes, genes and DNA (introductory treatment)
- natural and artificial selection of genetic characteristics

Students will:

1. Investigate and interpret diversity among species and within species, and describe how diversity contributes to species survival
   - observe variation in living things, and describe examples of variation among species and within species *(e.g., observe and describe characteristics that distinguish two closely related species)*
   - identify examples of niches, and describe the role of variation in enabling closely related living things to survive in the same ecosystem *(e.g., investigate different bird species found in a local park ecosystem, and infer how each is adapted to life within that ecosystem)*
   - investigate and interpret dependencies among species that link the survival of one species to the survival of others
     - identify examples of symbiotic relationships *(e.g., organisms that benefit other organisms by providing habitat, food, means of fertilization, or a source of oxygen)*
     - classify symbiotic relationships as mutualism, commensalism, parasitism
   - identify the role of variation in species survival under changing environmental conditions *(e.g., resistance to disease, ability to survive in severe environments)*
2. Investigate the nature of reproductive processes and their role in transmitting species characteristics
   - distinguish between sexual and asexual reproduction, and identify and interpret examples of asexual and sexual reproduction in different species, by:
     - describing mechanisms of asexual reproduction including binary fission, budding and the production of spores
     - describing mechanisms of sexual reproduction *(e.g., cross-fertilization in seed plants, sexual reproduction in mammals)*
     - describing examples of organisms that show both sexual and asexual reproduction *(e.g., yeasts that reproduce both by budding and sexual reproduction; plants that reproduce through suckering, runners or bulbs, as well as by seed production)*
     - describing the formation of zygote and embryo in plant and animal reproduction
   - describe examples of variation of characteristics within a species, and identify examples of both discrete and continuous variation *(e.g., hand clasping preference is an example of a discrete variation, the length of human hands varies on a continuum)*
   - investigate the transmission of characteristics from parents to offspring, and identify examples of characteristics in offspring that are:
     - the same as the characteristics of both parents
     - the same as the characteristics of one parent
     - intermediate between parent characteristics
     - different from both parents
   - distinguish those characteristics that are heritable from those that are not heritable, and identify characteristics for which heredity and environment may both play a role *(e.g., recognize that eye colour is heritable but that scars are not; recognize that a person's height and weight may be largely determined by heredity but that diet may also play a role)*
   - identify examples of dominant and recessive characteristics and recognize that dominance and recessiveness provide only a partial explanation for the variation of characteristics in offspring
3. Describe, in general terms, the role of genetic materials in the continuity and variation of species characteristics; and investigate and interpret related technologies
   - describe, in general terms, the role and relationship of chromosomes, genes and DNA
   - distinguish between cell division that leads to identical daughter cells, as in binary fission and mitosis, and cell division that leads to formation of sex cells, as in meiosis; and describe, in general terms, the synthesis of genetic materials that takes place during fertilization *[Note: At this level, students should understand that the formation of sex cells involves the halving of the parent cell's genetic materials and that this process leads to zygote formation. Opportunity for further study of the specific stages of cell division will be provided in senior high school courses (e.g., prophase, metaphase, anaphase, telophase).]*
   - compare sexual and asexual reproduction, in terms of the advantages and disadvantages *(e.g., recognize that asexual reproduction provides an efficient means of transmitting characteristics and that sexual reproduction provides an opportunity for recombination of characteristics)*
   - distinguish between, and identify examples of, natural and artificial selection *(e.g., evolution of beak shapes in birds, development of high milk production in dairy cows)*
   - describe, in simple terms, some genetic technologies *(e.g., cloning and genetic engineering)*; and identify questions and issues related to their application
4. Identify impacts of human action on species survival and variation within species, and analyze related issues for personal and

public decision making

- describe the relative abundance of species on Earth and in different environments *(e.g., note the overall abundance of insect species; note that in harsh environments there are relatively fewer species found than in temperate and tropical environments)*
- describe ongoing changes in biological diversity through extinction and extirpation of native species, and investigate the role of environmental factors in causing these changes *(e.g., investigate the effect of changing river characteristics on the variety of species living in the river; investigate the effect of changing land use on the survival of wolf or grizzly bear populations)*
- evaluate the success and limitations of various local and global strategies for minimizing loss of species diversity *(e.g., breeding of endangered populations in zoos, development of seed banks, designating protected areas, development of international treaties regulating trade of protected species and animal parts)*
- investigate and describe the use of biotechnology in environmental, agricultural or forest management; and identify potential impacts and issues *(e.g., investigate issues related to the development of patented crop varieties and varieties that require extensive chemical treatments; identify issues related to selective breeding in game farming and in the rearing of fish stocks*

Unit B: Environmental Chemistry (25%)

Key Concepts

- Workplace Hazardous Materials Information System (WHMIS) and safety
- substrates and nutrients
- organic and inorganic material
- ingestion and absorption of materials
- evidence of toxicity
- uncertainties in environmental monitoring and in assessing toxicity and risk
- chemicals essential to life
- air and water quality
- acids and bases
- concentration and dispersal
- stability and biodegradability
- hazards, probabilities and risk assessment

Students will:

1. Investigate and describe, in general terms, the role of different substances in the environment in supporting or harming humans and other living things
   - identify common organic and inorganic substances that are essential to the health and growth of humans and other living things, and illustrate the roles served by these substances *(e.g., identify calcium as an essential material for bones; identify minerals that are known to enhance plant growth but that limit growth if too little or too much is available)*
   - describe, in general terms, the forms of organic matter synthesized by plants and animals, including carbohydrates, proteins and lipids
   - describe and illustrate processes by which chemicals are introduced to the environment or their concentrations are changed *(e.g., dilution in streams, biomagnification through food chains)*
   - describe the uptake of materials by living things through ingestion or absorption, and investigate and describe evidence that some materials are difficult for organisms to break down or eliminate *(e.g., DDT, mercury)*
   - identify questions that may need to be addressed in deciding what substances—in what amounts—can be safely released into the environment *(e.g., identify questions and considerations that may be important in determining how much phosphate can be released into river water without significant harm to living things)*
2. Identify processes for measuring the quantity of different substances in the environment and for monitoring air and water quality
   - identify substrates and nutrient sources for living things within a variety of environments
   - describe and illustrate the use of biological monitoring as one method for determining environmental quality *(e.g., assess water quality, by observing the relative abundance of various vertebrate and invertebrate species)*
   - identify chemical factors in an environment that might affect the health and distribution of living things in that environment *(e.g., available oxygen, pH, dissolved nutrients in soil)*
   - apply and interpret measures of chemical concentration in parts per million, billion or trillion
   - identify acids, bases and neutral substances, based on measures of their pH *(e.g., use indicator solutions or pH meters to measure the pH of water samples)*
   - investigate, safely, and describe the effects of acids and bases on each other and on other substances *(e.g., investigate and describe the reaction that results when baking powder is dissolved; describe the role of acids and bases in neutralizing each other)*
   - describe effects of acids and bases on living things *(e.g., acid rain in lakes, antacids for upset stomachs, pH in shampoos and conditioners)*
3. Analyze and evaluate mechanisms affecting the distribution of potentially harmful substances within an environment
   - describe mechanisms for the transfer of materials through air, water and soil; and identify factors that may accelerate or retard distribution *(e.g., wind speed, soil porosity)*
   - describe mechanisms for biodegradation, and interpret information on the biodegradability of different materials
   - comprehend information on the biological impacts of hazardous chemicals on local and global environments, by:
     - interpreting evidence for environmental changes in the vicinity of a substance release
     - interpreting LD50 data and other information on toxicity *[Note: LD50 refers to the amount of a substance found to be lethal to 50% of a population, if ingested.]*
     - identifying concerns with the disposal of domestic wastes, such as paints and oils, and industrial wastes

- describe and evaluate methods used to transport, store and dispose of hazardous household chemicals
- investigate and evaluate potential risks resulting from consumer practices and industrial processes, and identify processes used in providing information and setting standards to manage these risks *(e.g., interpret and explain the significance of manufacturer's information on how wood preservatives can be safely applied; recognize that some individuals may have greater sensitivity to particular chemical substances than do others in the general population)*
- identify and evaluate information and evidence related to an issue in which environmental chemistry plays a major role *(e.g., evaluate evidence that the use of insecticides to control mosquitoes has an effect/has no effect on bird populations)*

Unit C: Electrical Principles and Technologies (25%)

Key Concepts

- forms of energy
- electric charge and current
- energy transmission
- renewable and nonrenewable energy
- energy transformation
- circuits
- measures and units of electrical energy
- generation of electrical energy
- electrical energy storage
- electrical resistance and Ohm's law

Students will:

1. Investigate and interpret the use of devices to convert various forms of energy to electrical energy, and electrical energy to other forms of energy
   - identify, describe and interpret examples of mechanical, chemical, thermal, electrical and light energy
   - investigate and describe evidence of energy transfer and transformation *(e.g., mechanical energy transformed into electrical energy, electrical energy transferred through power grids, chemical energy converted to electrical energy and then to light energy in a flashlight, thermal energy converted to electrical energy in a thermocouple)*
   - investigate and evaluate the use of different electrodes, electrolytes and electrolytic concentrations in designing electrical storage cells
   - construct, use and evaluate devices for transforming mechanical energy into electrical energy and for transforming electrical energy into mechanical energy
   - modify the design of an electrical device, and observe and evaluate resulting changes *(e.g., investigate the effect of changes in the orientation and placement of magnets, commutator and armature in a St. Louis motor or in a personally-built model of a motor)*
2. Describe technologies for transfer and control of electrical energy
   - assess the potential danger of electrical devices, by referring to the voltage and current rating (amperage) of the devices; and distinguish between safe and unsafe activities
   - distinguish between static and current electricity, and identify example evidence of each
   - identify electrical conductors and insulators, and compare the resistance of different materials to electric flow *(e.g., compare the resistance of copper wire and nickel-chromium/Nichrome wire; investigate the conduction of electricity through different solutions; investigate applications of electrical resistance in polygraph or lie detector tests)*
   - use switches and resistors to control electrical flow, and predict the effects of these and other devices in given applications *(e.g., investigate and describe the operation of a rheostat)*
   - describe, using models, the nature of electrical current; and explain the relationship among current, resistance and voltage *(e.g., use a hydro-flow model to explain current, resistance and voltage)*
   - measure voltages and amperages in circuits *(e.g., determine the resistance in a circuit with a dry cell and miniature light; determine the resistances of copper, nickel-chromium/ Nichrome wire, pencil graphite and salt solution)*
     - apply Ohm's law to calculate resistance, voltage and current in simple circuits
   - develop, test and troubleshoot circuit designs for a variety of specific purposes, based on low voltage circuits *(e.g., develop and test a device that is activated by a photoelectric cell; develop a model hoist that will lift a load to a given level, then stop and release its load; test and evaluate the use of series and parallel circuits for wiring a set of lights)*
   - investigate toys, models and household appliances; and draw circuit diagrams to show the flow of electricity through them *(e.g., safely dismantle discarded devices, such as heating devices or motorized toys, and draw diagrams to show the loads, conductors and switching mechanisms)*
   - identify similarities and differences between microelectronic circuits and circuits in a house *(e.g., compare switches in a house with transistors in a microcircuit)*
3. Identify and estimate energy inputs and outputs for example devices and systems, and evaluate the efficiency of energy conversions
   - identify the forms of energy inputs and outputs in a device or system
   - apply appropriate units, measures and devices in determining and describing quantities of energy transformed by an electrical device, by:
     - measuring amperage and voltage, and calculating the number of watts consumed by an electrical device, using the formula P = IV [power (in watts) = current (in amps) × voltage (in volts)]
     - calculating the quantity of electric energy, in joules, transformed by an electrical device, using the formula E = P × t *[energy (in joules) = power (in watts) × time (in seconds)]*

- the concepts of conservation of energy and efficiency to the analysis of energy devices *(e.g., identify examples of energy dissipation in the form of heat, and describe the effect of these losses on useful energy output)*
- compare energy inputs and outputs of a device, and calculate its efficiency, using the formula, percent efficiency = energy output/energy input × 100 *(e.g., compare the number of joules of energy used with the number of joules of work produced, given information on electrical consumption and work output of a motor-driven device)*
- investigate and describe techniques for reducing waste of energy in common household devices *(e.g., by eliminating sources of friction in mechanical components, using more efficient forms of lighting, reducing overuse of appliances as in "overdrying" of clothes)*

4. Describe and discuss the societal and environmental implications of the use of electrical energy
   - identify and evaluate sources of electrical energy, including oil, gas, coal, biomass, wind and *solar (e.g., identify and evaluate renewable and nonrenewable sources for generating electricity; evaluate the use of batteries as an alternative to internal combustion engines)*
   - describe the by-products of electrical generation and their impacts on the environment *(e.g., identify by-products and potential impacts of coal-fired electricity generation)*
   - identify example uses of electrical technologies, and evaluate technologies in terms of benefits and impacts *(e.g., identify benefits and issues related to the use of electrical technologies for storing and transmitting personal information)*
   - identify concerns regarding conservation of energy resources, and evaluate means for improving the sustainability of energy use

Unit D: Space Exploration (25%)

Key Concepts

- technologies for space exploration and observation
- satellites and orbits
- composition and characteristics of bodies in space
- communication technologies
- reference frames for describing position and motion in space
- distribution of matter through space
- life-support technologies

Students will:

1. Investigate and describe ways that human understanding of Earth and space has depended on technological development
   - identify different ideas about the nature of Earth and space, based on culture and science *(e.g., compare geocentric and heliocentric models [Note: knowledge of epicycles is not required]; describe Aboriginal views of space and those of other cultures; describe the role of observation in guiding scientific understanding of space)*
   - investigate and illustrate the contributions of technological advances—including optical telescopes, spectral analysis and space travel—to a scientific understanding of space
   - describe, in general terms, the distribution of matter in star systems, galaxies, nebulae and the universe as a whole
   - identify evidence for, and describe characteristics of, bodies that make up the solar system; and compare their composition and characteristics with those of Earth
   - describe and apply techniques for determining the position and motion of objects in space, including:
     - constructing and interpreting drawings and physical models that illustrate the motion of objects in space *(e.g., represent the orbit of comets around the Sun, using a looped-string model)*
     - describing in general terms how parallax and the Doppler effect are used to estimate distances of objects in space and to determine their motion
     - describing the position of objects in space, using angular coordinates *(e.g., describe the location of a spot on a wall, by identifying its angle of elevation and its bearing or azimuth; describe the location of the Sun and other stars using altitude-azimuth coordinates, also referred to as horizon coordinates or local coordinates) [Note: A description of star positions based on right ascension and declination is not required.]*
   - investigate predictions about the motion, alignment and collision of bodies in space *(e.g., investigate predictions about eclipses; identify uncertainties in predicting and tracking meteor showers)*
2. Identify problems in developing technologies for space exploration, describe technologies developed for life in space, and explain the scientific principles involved
   - analyze space environments, and identify challenges that must be met in developing life-supporting systems *(e.g., analyze implications of variations in gravity, temperature, availability of water, atmospheric pressure and atmospheric composition)*
   - describe technologies for life-support systems, and interpret the scientific principles on which they are based *(e.g., investigate systems that involve the recycling of water and air)*
   - describe technologies for space transport, and interpret the scientific principles involved *(e.g., describe the development of multistage rockets, shuttles and space stations; build a model vehicle to explore a planet or moon)*
   - identify materials and processes developed to meet needs in space, and identify related applications *(e.g., medicines, remote sensing, microelectronics, polymers, medical imaging, wireless communication technologies, synthesis of fuels)*
   - describe the development of artificial satellites, and explain the major purposes for which they are used *(e.g., communication, GPS—global positioning system, weather observation)*
3. Describe and interpret the science of optical and radio telescopes, space probes and remote sensing technologies
   - explain, in general terms, the operation of optical telescopes, including telescopes that are positioned in space environments
   - explain the role of radio and optical telescopes in determining characteristics of stars and star systems

- describe and interpret, in general terms, the technologies used in global positioning systems and in remote sensing *(e.g., use triangulation to determine the position of an object, given information on the distance from three different points) [Note: This example involves the use of geometric approaches rather than mathematical calculations.]*

4. Identify issues and opportunities arising from the application of space technology, identify alternatives involved, and analyze implications
   - recognize risks and dangers associated with space exploration *(e.g., space junk, fuel expenditure, satellites burning up in the atmosphere, solar radiation)*
   - describe Canadian contributions to space research and development and to the astronaut program *(e.g., Canadarm)*
   - identify and analyze factors that are important to decisions regarding space exploration and development *(e.g., identify examples of costs and potential benefits that may be considered; investigate and describe political, environmental and ethical issues related to the ownership and use of resources in space)*

Lab skills and objectives are included in labs and assignments in each unit of the course.
Specific Outcomes for Skills (focus on scientific inquiry)

Initiating and Planning
Students will:
Ask questions about the relationships between and among observable variables, and plan investigations to address those questions
identify science-related issues *(e.g., identify issues related to loss of species diversity)*

- identify questions to investigate arising from science-related issues *(e.g., "What factors affect the ability of organisms to survive and reproduce in this ecosystem?" Identify issues regarding the use of soil fertilizers)*
- state a prediction and a hypothesis based on background information or an observed pattern of events *(e.g., predict changes to an area of local parkland that is subject to intense use; hypothesize means of impact, such as soil compaction and disturbance of nest sites. Predict the amount of current in a circuit of known resistance and applied voltage. Formulate operational definitions of major variables in the study of electrical circuits (e.g., provide operational definitions for current, resistance, voltage, polarity). Identify practical problems (e.g., identify problems that must be addressed in developing a lifesupporting space environment). Predict the next appearance of a comet, based on past observations; develop a hypothesis about the geologic history of a planet or its moon, based on recent data)*
- define and delimit questions and problems to facilitate investigation *(e.g., delimit an electronic search for information on species survival by framing a question about a specific group of organisms or a specific ecosystem)*
- identify questions arising from practical problems and issues *(e.g., ask questions about the needs of different living things for nutrients and about the mechanisms by which these nutrients are obtained. Identify questions, such as: "How can the amount of electric current in a circuit be controlled?" Rephrase questions in a testable form, and clearly define practical problems (e.g., rephrase questions, such as: "Why do we use parallel circuits rather than series circuits in household wiring?" to become "How do series circuits and parallel circuits respond differently under load?")*
- state a prediction and a hypothesis about the concentration or dispersal of a chemical substance within an environment *(e.g., state a hypothesis that relates the amount of oxygen in a local water sample to the presence or absence of dissolved nutrients)*
- select appropriate methods and tools for collecting data and information and for solving problems *(e.g., design an investigation to compare the chemical characteristics of two soils)*
- propose alternative solutions to a given practical problem, select one, and develop a plan *(e.g., design and describe a model of a technology to be used in a space station)*

Performing and Recording
Students will:
Conduct investigations into the relationships between and among observations, and gather and record qualitative and quantitative data

- observe and record data, and prepare simple line drawings *(e.g., compare two related plants by measuring, describing and drawing them)*
- estimate measurements (*e.g., estimate the population of a given plant species within a study plot*; *estimate the efficiency of a mechanical device)*
- research information related to a given issue *(e.g., conduct an electronic search for information on factors that affect the reproduction and survival of wood frogs)*
- demonstrate knowledge of WHMIS standards, by using proper techniques for handling and disposing of laboratory materials
- identify data and information that are relevant to the issue
- select and integrate information that is relevant to the issue *(e.g., demonstrate proficiency in uploading and downloading text, image, audio and video files)*
- use instruments and materials effectively and accurately for collecting data *(e.g., measure and compare the pH in household products, foods and environments; use appropriate sources of electrical energy, and follow procedures to ensure personal and group safety; use ammeters and voltmeters)*
- organize data, using a format that is appropriate to the task or experiment *(e.g., maintain a log of observed changes in the night sky; prepare a data table to compare various planets)*

- select and integrate information from various print and electronic sources or from several parts of the same source *(e.g., compile and compare information about two exploratory missions)*

Analyzing and Interpreting

Students will:

Analyze qualitative and quantitative data, and develop and assess possible explanations

- identify strengths and weaknesses of different ways of displaying data *(e.g., compare different ways of recording and displaying data on plant variation in a study plot; compare Earth-based observations with those made from spacecraft)*
- interpret patterns and trends in data, and infer and explain relationships among the variables *(e.g., interpret data on changing animal populations, and infer possible causes)*
- apply given criteria for evaluating evidence and sources of information *(e.g., evaluate sources based on their currency, credibility and the extent to which claims are supported by data; use scatterplot data in evaluating how strong a relationship exists between two variables; evaluate claims of environmental impacts, based on the scope and relevance of supporting evidence)*
- state a conclusion, based on experimental data, and explain how evidence gathered supports or refutes an initial idea
- identify new questions and problems that arise from what was learned *(e.g. identify questions to guide further investigation, such as: "What limits the travelling distance and duration of space exploration?", "How old are the planets, and how did they form?")*
- identify strengths and weaknesses of different ways of displaying data
- identify and suggest explanations for discrepancies in data *(e.g., identify possible reasons for variation in the measured concentration of a chemical, where one sample is very different from others or where one group has a very different result from others)*
- identify the line of best fit on a scatterplot, and interpolate or extrapolate based on the line of best fit *(e.g., interpret class data on the effects of acidity on mould growth, graph the data, prepare a line of best fit, and predict the amount of growth that might be expected at different acidity values)*
- evaluate designs and prototypes in terms of function, reliability, safety, efficiency, use of materials and impact on the environment *(e.g., evaluate the safety, durability, efficiency and environmental impact of a personally-constructed wet cell design)*
- identify and suggest explanations for discrepancies in data *(e.g., measure the current in similar circuits, and provide possible explanations for differences in current flow)*
- identify potential sources of error, and determine the amount of error in a given measurement *(e.g., identify the precision of voltmeters and ammeters used to measure current flow)*
- test the design of a constructed device or system *(e.g., create and test a model device for remote manipulation of materials)*
- identify and correct practical problems in the way a prototype or constructed device functions *(e.g., identify and correct problems in the functioning of a model "remote transportation device" that they have designed and built)*

Communication and Teamwork

Students will:

Work collaboratively on problems; and use appropriate language and formats to communicate ideas, procedures and results

- communicate questions, ideas, intentions, plans and results, using lists, notes in point form, sentences, data tables, graphs, drawings, oral language and other means *(e.g., illustrate and compare methods of reproduction in sample organisms studied; use charts to present data on the voltage, current (amperage) and resistance found in series and parallel circuits)*
- evaluate individual and group processes used in investigating an issue and evaluating alternative decisions *(e.g., evaluate strategies for locating information, such as the use of particular key words or search tools; evaluate approaches for sharing work on a given research task and for synthesizing the information found)*
- defend a given position on an issue, based on their findings *(e.g., defend a position on a proposed measure to protect a particular plant or animal population; provide a clear rationale for a choice between alternative chemical products in a consumer application; develop and defend a proposal on the appropriateness of an alternative energy source in a given application; conduct appropriate research to justify their position on the economic costs or benefits of space exploration)*
- receive, understand and act on the ideas of others *(e.g., follow given safety procedures; take into account advice provided by other students or individuals in designing a model space suit or space vehicle; seek and achieve group consensus on procedures to be used in an investigative activity, and act on that consensus)*
- work cooperatively with team members to develop and carry out a plan, and troubleshoot problems as they arise *(e.g., write and act out a skit to demonstrate tasks carried out by astronauts on a mission)*