Catholic District School Board Writing Partnership

Science

Course Profile

Science

Grade 12
Workplace Preparation
SNC4E

• *for teachers by teachers*

This sample course of study was prepared for teachers to use in meeting local classroom needs, as appropriate. This is not a mandated approach to the teaching of the course. It may be used in its entirety, in part, or adapted.

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Course Overview
Science, SNC4E, Grade 12, Workplace Preparation

Policy Document: *The Ontario Curriculum, Grades 11 and 12, Science, 2000.*
Prerequisite: Science, Grade 11, Workplace Preparation

Course Description
This course provides students with the science-related knowledge and skills they need to help them make informed decisions in the workplace and in their personal lives. Students will explore a range of topics, including chemistry at home and at work; communications technology; medical technology; gardening, horticulture, landscaping, and forestry; and alternative life-sustaining environments. Emphasis is placed on relating these topics directly to students' experiences both in the world of work and in daily life.

How This Course Supports the Ontario Catholic School Graduate Expectations
The study of science helps students to learn to be reflective, critical, and creative thinkers, as well as discerning believers, who can apply their knowledge to the world around them. They can make appropriate decisions in light of Gospel values and Church teachings. Through the study of the techniques of science, particularly experimentation, students learn to be collaborative contributors to an interdependent team, respecting the rights, responsibilities, and contributions of others. Studying the applications of science to work leads students to find meaning, dignity, fulfillment, and vocation in the work they do that contributes to the common good. Overall, students become aware of the spiritual, as well as the physical dimension of the world and of the need to respect the environment and to use resources wisely in order to fulfill their roles as stewards of God's creation. It is the Christian perspective on life and its meaning as revealed in Jesus Christ which underlies our education approach and which is reflected throughout the curriculum.

Course Notes
The overall intent of the Science curriculum is that all graduates of Ontario secondary schools will strive for excellence and a high degree of scientific literacy while maintaining a sense of wonder about the world around them. Accordingly, the Science curriculum for the workplace is activity-based as much as it is an organized body of knowledge. Science cannot be learned in any meaningful way by reading and discussion alone. The experimental nature of Science is to be emphasized. The teacher will provide ample opportunity for students to engage in safe, effective laboratory activities in all units of the course. The health and safety of teachers and students must be of paramount importance when conducting laboratory activities. All must comply with the provisions of Workplace Hazardous Materials Information Systems (WHMIS) legislation and must practise established safe laboratory procedures. Students should recognize the importance of this legislation.

Workplace Preparation courses are designed to equip students with the knowledge and skills they need for direct entry into the workplace or for admission to apprenticeship programs and other training programs offered in the community. Teaching and learning will emphasize the workplace applications of the course content, but will also explore the theoretical material that underlies these practical applications. Cooperative education and work experience placements within the community are important components of workplace preparation courses. Where possible, schools should involve employers and site supervisors to support the intent of the course. This Science course designed for workplace preparation will emphasize the development of generic employment skills, as well as independent research and learning skills.

In the science policy document list of expectations, Scientific Investigative Skills (SIS) are given that precedes the strands for each course. These expectations describe skills that are considered to be essential for scientific investigation, and skills required for investigating possible careers in the subject area. Since some students will not have studied Science since Grade 10, diagnostic assessment in these skills may be required before proceeding with certain activities.

Teachers should ensure that students develop these skills in appropriate ways while achieving the curriculum expectations outlined in the strands. Throughout this Course Profile these expectations have been broken down into manageable chunks so that the teacher can assess them well and that the student can comprehend the meaning and nature of the skill.

The clusters of expectations in each unit are based on the main themes that run throughout the unit. Each cluster is a combination of expectations that should be assessed using all four areas of the Achievement Chart. The teacher should use a variety of assessment tools. Within each cluster some areas of achievement tend to have a greater focus. These areas have been **bolded** so that it is clear to the teacher what category for that cluster should be weighted more heavily.

The organization of the course is based on five units that follow the logical development of knowledge, theories, and skills. The units are: Chemistry at Home and Work; Communications: Sounds and Pictures; Medical Technologies; Gardening, Horticulture, Landscaping, and Forestry; and Alternative Environments. Each unit has been divided into clusters. The order of the units could change to allow for the Horticulture unit to be offered during a time of good weather so that a field trip could be planned allowing students to explore one of the venues in horticulture. Pre-planning is needed for most units and equipment such as plants and electrical devices are needed to start the first activity. **Note:** the content and context of each unit is outlined in detail within the unit description.

In writing journal reflections, students consider a Learning/Valuing/Acting Model. The Learning/ Valuing/Acting model promotes the importance of the need to act appropriately in light of what we know and what we value. In this way students are constantly challenging themselves about the social teachings of the Church and the importance of every individual's actions in working towards the common good and creating a just society. This model may not be applicable for all student reflections in this course. However, it should be considered when dealing with issues of environmental stewardship, community, social justice, dignity of the human person, and the wise use of resources. "Learning" involves the students reflecting on what they have learned from any unit of the course, from reading the newspapers, from watching television news shows or from their own experience about an issue. "Valuing" requires students to reflect on which Catholic values are important in dealing with the issue. "Acting" requires students to decide on a course of action that they could take to either further the positive works that they learned about or help right the social injustice that was present in what they learned about the issue. The Learning/Valuing/Acting Journal embraces the CGE 2b: reads, understands and uses written materials effectively, as well as CGE 2d: writes and speaks fluently one or both of Canada's official languages. These two CGEs are interwoven throughout all of the units and activities. Journal activities should not be limited to written submissions. Alternate activities such as, collages, drawings, graphic organizers and cartoons could be used as journal activities.

Students are expected to use computer technology that has been developed for use in Science. Computer-based simulations, multi-media applications, databases, computer-assisted laboratory apparatus, and learning modules should be used, wherever appropriate. Care must be taken, however, to ensure that computer-assisted laboratory programs are not used in situations where students' own technical skills should be developed. Wherever possible, the teacher should provide opportunities for students to experience the world of Science first-hand by participating in field trips and excursions. Students should be provided with opportunities to recognise and participate in applications of Science in the world around them through fieldtrips and excursions such as work locations, College faculties, guest presentations, and

destination explorations. Misconceptions in the science curriculum usually arise during brainstorming activities. It is important to lead these discussions and to hear all information from students. These are good opportunities to clarify information with students.

Units: Titles and Time

Unit 1	Chemistry at Home and Work	25 hours
Unit 2	Communications: Sounds and Pictures	25 hours
Unit 3	Medical Technologies	15 hours
Unit 4	Gardening, Horticulture, Landscaping, and Forestry	25 hours
* Unit 5	Alternative Environments	20 hours

* This unit is fully developed in this Course Profile.

Unit Overviews

Unit 1: Chemistry at Home and Work

Time: 25 hours

Unit Description

Students demonstrate an understanding of the basic concepts of common organic materials encountered in the home and workplace. Students investigate, using safe laboratory techniques, the properties of some organic substances as well as prepare common organic products and emulsions. Students conclude this unit by demonstrating an awareness of some health, safety, economic, and environmental issues related to the use of organic substances. In light of Catholic faith tradition and social teaching, students demonstrate an understanding of the importance of the environment and the impact we as humans have on it.

This unit is organized into four clusters. Cluster 1 leads students through the structure and properties of organic compounds. In Cluster 2 students explore the concept of emulsifiers in theory and practice. Cluster 3 focuses on polymers and on safe practices during investigations. In Cluster 4 students prepare and present a report on the social, environmental, and economic consequences of the use and disposal of organic products. Students are encouraged to present their information in many different forms.

Unit Overview Chart

Cluster	Learning Expectations	Assessment Categories	Focus
1	HWV.01, HWV.02, HW1.01, HW1.02, HW1.03, HW2.01, HW2.02 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08 CGE4b	**Knowledge/Understanding** **Inquiry**	Structure and Properties of Organic Compounds
2	HWV.02, HWV.03, HW1.02, HW1.04, HW2.01, HW2.02, HW2.03, HW2.04, HW2.05, HW3.01 SIS.01, SIS.03, SIS.04, SIS.06, SIS.07 CGE3c, CGE4b	Knowledge/Understanding **Inquiry** **Making Connections**	Emulsifiers
3	HWV.02, HWV.03, HW1.05, HW1.06, HW2.01, HW2.05, HW2.06, HW2.07, HW3.01 SIS.01, SIS.03, SIS.04, SIS.06, SIS.07 CGE3c, CGE4b	Knowledge/Understanding **Inquiry** **Making Connections**	Polymers

Cluster	Learning Expectations	Assessment Categories	Focus
4	HWV.03, HW2.01, HW3.02 SIS.01, SIS.04, SIS.05, SIS.06, SIS.08 CGE1d, CGE3b	Making Connections **Communication**	Health and Safety and Environmental Economics

Unit 2: Communications: Sounds and Pictures

Time: 25 hours

Unit Description

Students demonstrate an understanding of the basic operating principles of entertainment and communication devices that are commonly found in the home and the workplace. Students carry out investigations concerning the scientific concepts involved in communications technology, and examine and operate some common communication devices. Students conclude this unit through research and evaluation of the role played by many different kinds of technological devices used for communication, as well as their impact on the way we conduct our lives at home and at work.

This unit is organized into four clusters. Cluster 1 focuses on properties of waves. Investigations on wave-related quantities and their relationship to common domestic and industrial communication technologies should be carried out to reinforce the theory of waves. Cluster 2 focuses on vibrating objects and how they produce waves. Investigations in this cluster expand on common domestic and industrial communication technologies as they influence the lives of the students. A model must be built to be able to carry out the investigation. Cluster 3 deals with energy transformations in relation to waves and common communication equipment. Cluster 4 focuses on the history and development of communication technology. The specific focus of this cluster is the contribution of Canadians to the field of communication technology.

Unit Overview Chart

Cluster	Learning Expectations	Assessment Categories	Focus
1	SPV.01, SPV.02, SP1.02, SP1.03, SP1.05, SP1.06, SP1.07, SP2.01, SP2.03, SP2.04 SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08	**Knowledge/Understanding** **Inquiry** Communication Making Connections	Properties of Waves
2	SPV.01, SPV.02, SP1.01, SP1.02, SP2.02, SP2.04, SP2.05, SP2.06, SP3.02 SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08 CGE4f, CGE5a, CGE5g	**Knowledge/Understanding** Communication **Inquiry** Making Connections	Properties of Vibrating Objects
3	SPV.01, SPV.02, SP1.04, SP1.08, SP3.02 SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08	Knowledge/Understanding **Making Connections**	Energy Transformations
4	SPV.03, SP2.06, SP3.01, SP3.03, SP3.04 SIS.03, SIS.05, SIS.06, SIS.07, SIS.08 CGE1d, CGE5a, CGE5e	**Communication** Thinking/Inquiry **Making Connections**	History and Development of Communications Technology

Unit 3: Medical Technologies

Time: 15 hours

Unit Description

In light of Catholic faith tradition and social teachings dealing with the dignity of the human person, students demonstrate an understanding of the role of genetics and of the various technologies, including biotechnology, in the diagnosis and treatment of human illness. The sanctity of life and the value of the human person will be the underlying premise of this unit.

Students gather and analyse scientific data using techniques similar to those employed in medical testing and diagnosis. Students evaluate, based on representative examples, ways in which science and technology have influenced the diagnosis and treatment of human illness. Students are encouraged to work collaboratively to analyse an issue related to biotechnology in light of Catholic faith tradition and social teachings.

This unit is organized into three clusters. Cluster 1 focuses on basic genetic principles. Investigations on karotypes and pedigrees are suggested to give students practical applications. Appropriate sensitivity might be needed when dealing with genetic disorders in the case where a student or a family member might have a genetic disorder. Cluster 2 focuses on technology for biomedical repair. Investigations should simulate processes occurring in a medical apparatus. It is recommended that when students are discussing modern genetic technology the Catholic perspective of the sanctity of life should be the main focus. Cluster 3 focuses on the diagnosis and treatment of human illness. Investigations dealing with how medical technologies have become part of our daily lives conclude this unit.

Note: The time allotted for this unit could be expanded if a variety of equipment is available in the school or if a series of field trips to medical facilities are planned. It is suggested that a hands-on focus be used in this unit where available.

Unit Overview Chart

Cluster	Learning Expectations	Assessment Categories	Focus
1	MTV.01, MT1.01, MT1.04, MT1.05 CGE1d, CGE2c, CGE3b, CGE3f	**Knowledge/Understanding** Making Connections Communication	Basic Genetic Principles
2	MTV.01, MTV.02, MT1.01, MT1.02, MT1.03, MT1.06, MT2.01, MT3.01, MT3.02 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08, SIS.09 CGE1d, CGE1e, CGE2e, CGE3b, CGE3d, CGE5a	Knowledge/Understanding **Inquiry** **Making Connections** Communication	Technology
3	MTV.01, MTV.03, MT1.01, MT1.02, MT1.03, MT2.02, MT3.01 SIS.05 CGE1d, CGE1e, CGE2e, CGE3b, CGE3d, CGE4f	Knowledge/Understanding **Communication** **Making Connections** Inquiry	Diagnosis and Treatment

Unit 4: Gardening, Horticulture, Landscaping, and Forestry

Time: 25 hours

Unit Description

Students build on their knowledge and skill from Grade 9 to demonstrate a further understanding of the conditions required for plant growth. Students demonstrate an understanding of how God created living things to interact interdependently. Students demonstrate an understanding of the conditions required for plant growth, and of the techniques used in gardening, horticulture, landscaping, and forestry. Students investigate the effect of various conditions on the growth of plants, and demonstrate skills in the use of tools and techniques associated with either gardening, horticulture, or landscaping. Students conclude this unit by demonstrating an understanding of the importance of cultivated and wild plants to society, the economy, and the environment. Growing plants takes time that is not built into the unit. It is suggested that the planting take place prior to the start of the unit.

This unit is organized into five clusters. Cluster 1 focuses on the general conditions required for plant growth. Investigation in this cluster should focus on the effect of various environmental conditions on plant growth. Cluster 2 expands on the knowledge from Cluster 1 and focuses on the experimental nature of gardening and the conditions necessary for good plant growth. Cluster 3 uses the general conditions for plant growth and focuses specifically on landscaping. Investigations dealing with landscape design and architecture are highly recommended. A field trip in this unit would be very beneficial to explain the elements of design. Cluster 4 shifts the focus from gardening and landscaping to forestry. It is recommended that a focus on Canadian forest management be used in this cluster. Cluster 5 allows the students to focus on one of the areas studied so far in the unit and focus on how the plants in that area are influenced by society as well as how the plants influence the area they are in.

Unit Overview Chart

Cluster	Learning Expectations	Assessment Categories	Focus
1	GHV.01, GHV.02, GH1.01, GH1.02, GH1.03, GH2.01, GH3.01 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08	**Knowledge/ Understanding** **Inquiry** Making Connections Communication	Gardening
2	GHV.02, GH1.03, GH1.05, GH2.01, GH2.02 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08 CGE5a	Knowledge/ Understanding **Inquiry**	Growing Plants: Experimental Processes
3	GHV.01, GHV.02, GHV.03, GH1.04, GH1.07, GH2.03, GH2.05, GH3.04 SIS.03, SIS.04, SIS.05, SIS.06, SIS.07 CGE1d, CGE3b, CGE5a	Knowledge/ Understanding Inquiry Making Connections **Communication**	Landscaping
4	GHV.01, GHV.03, GH1.06, GH3.03, GH3.04 SIS.09 CGE1d, CGE3b	Knowledge/ Understanding Making Connections	Forestry
5	GHV.03, GH1.05, GH1.07, GH2.04, GH3.01, GH3.02, GH3.04 SIS.01, SIS.02, SIS.03, SIS.04, SIS.05, SIS.06, SIS.07, SIS.08 CGE1d, CGE3b	Knowledge/ Understanding **Inquiry** Making Connections	Plants and Society

Unit 5: Alternative Environments

Time: 20 hours

Unit Description

Students demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment. Through the lens of stewardship and Catholic social teaching students analyse major variables that affect the various inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment. Students demonstrate an understanding of what would be required to equip and operate an alternative environment capable of supporting human life, and compare its sustainability to that of our normal planetary environment.

Unit Overview Chart

Cluster	Learning Expectations	Assessment Categories	Focus
1	AEV.01, AE1.01, AE1.02, AE2.01, AE2.02, AE3.03 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08 CEG1d, CGE2c, CGE3d, CGE3f, CGE4g, CGE7e	**Knowledge/ Understanding** **Inquiry** Communication	Factors for Human Life
2	AEV.01, AEV.02, AE1.01, AE1.02, AE1.03, AE1.04, AE1.05, AE2.02, AE2.03, AE3.01, AE3.02, AE3.03, AE3.04 SIS.05, SIS.07, SIS.09 CEG1d, CGE2c, CGE3d, CGE3f, CGE4g, CGE7e	**Knowledge/ Understanding** Making Connections **Communication**	Factors in an alternate environment (input/output)
3	AEV.01, AEV.02, AEV.03, AE1.02, AE1.03, AE1.04, AE1.05, AE2.03, AE3.01, AE3.04 SIS.05, SIS.06, SIS.07 CEG1d, CGE2c, CGE3d, CGE3f, CGE4g, CGE7e	Knowledge/ Understanding **Making Connections**	Analysing alternate environments

Teaching/Learning Strategies

Students should be familiar with many of the following strategies, as they have been consistently used in the Grade 9, 10 and 11 Science Course Profiles. It is recommended that teachers review these strategies and then monitor the use of the strategy as well as provide encouragement for its effective use. It is also recommended that teachers use a variety of the teaching strategies throughout the course.

Expectations that require Knowledge/Understanding can be developed through:

- brainstorming;
- teacher-directed lessons and demonstrations;
- small group instruction;
- independent study;
- self-directed learning, etc.

Expectations that involve Inquiry can be met by:

- conducting and analysing experiments;
- designing lab investigations;
- formulating questions;
- solving problems;
- field study;
- research activities.

Expectations that encourage Communication can be demonstrated by:

- written reports;
- group discussion;
- debates;
- seminars;
- student presentations, e.g., oral presentations, skits, photo essays etc.;
- interview;
- science log - a record of research, contacts, and jot notes that a student has complied;
- flow charts;
- graphic organizers;
- models, blueprints, etc.

Expectations where students expand their knowledge to Make Connections can be developed through:

- independent research;
- exposure to experts in their field, for example guest speakers, or by attending community activities;
- reflective papers;
- portfolios;
- reflective journals;
- case study;
- collaborative/cooperative learning;
- computer-based learning;
- conferencing – teacher to student discussion.

Assessment & Evaluation of Student Achievement

This Workplace Preparation course is based on the rationale that teaching and learning will emphasize concrete applications of the theoretical material covered in the course, and will also emphasize the development of critical thinking and problem-solving skills.

Assessment is the process of gathering information from a variety of sources that accurately reflects how well a student is meeting the curriculum expectations. In Science, these expectations include the Understanding of Basic Concepts, which may be assessed for Knowledge and Understanding, the Developing Skills of Inquiry and Communication, which may be assessed for Inquiry and Communication, and Relating Science to Technology, Society, and the Environment, which may be assessed for Making Connections. Inquiry, in a narrow sense, is based on the Scientific Model. In a broader sense, inquiry in science should also include the gathering of information from many sources. The gathering of information should be done through investigations, research of print and electronic sources, interviews, and informal conversations. Evaluation refers to the process of determining the quality of student work on the basis of established criteria, and then assigning a value to represent that quality. The value assigned will be in the form of a percentage grade. According to the *Program Planning and Assessment, 2000* policy:

Seventy per cent of the grade will be based on assessments and evaluations conducted throughout the course. Thirty per cent of the grade will be based on a final evaluation in the form of an examination, performance, essay, and/or other methods of evaluation.

In all of their courses students must be provided with numerous and varied opportunities to demonstrate the full extent of their achievement of the curriculum expectations which encompasses all four categories of knowledge and skills.

Accommodations

Teachers must consider the needs of exceptional students in planning the delivery of the science curriculum. Accommodations to the program activities and/or to the environment may be necessary. Where the student has an Individual Education Plan (IEP), the course may be modified to meet the student's needs as outlined in the plan, taking care to ensure that such modification does not place the credit at risk. Teachers should consult individual student IEPs for specific direction on accommodation for individuals.

For English as a Second Language (ESL) students or English Literacy Development (ELD) students, teachers should provide opportunities for the students to demonstrate their learning by alternative means (such as spoken English, direct demonstration and pictorial representation) while written English is developing.

For students with physical or learning impairments, classroom and laboratory activities should be altered to permit as much participation as possible. Laboratory safety must also be considered for students with physical or learning impairments.

Where possible, peers should be encouraged to assist students in order to permit participation in some group or individual activities. For assessment of certain students, it may be necessary to use oral testing, a scribe to record answers given orally, or other demonstrations of learning in order to determine the level of achievement.

Resources

Units in this course profile make reference to the use of specific texts, magazines, films, videos, and websites. Teachers need to consult their board policies regarding use of any copyrighted materials. Before reproducing materials for student use from printed publications, teachers need to ensure that their board has a Cancopy licence and that this licence covers the resources they wish to use. Before screening videos/films with their students, teachers need to ensure that their board/school has obtained the appropriate public performance videocassette licence from an authorized distributor, e.g., Audio Cine Films Inc. Teachers are reminded that much of the material on the Internet is protected by copyright. The copyright is usually owned by the person or organization that created the work. Reproduction of any work or substantial part of any work on the Internet is not allowed without the permission of the owner.

Print

Catechism of the Catholic Church. Ottawa: Publication Service, Canadian Conference of Catholic Bishops, 1994. ISBN 0-88997-281-8

Challenge and A Responsibility, AIDS A Catholic Educational Approach to HIV. Toronto: OCCB, 1999.

Caulderwood, C. and N. Campbell. *Understanding Biology: Laboratory Manual.* Toronto: J. Wiley & Sons, 1989. ISBN 0-471-79635-2

Celebrating an Education for Justice and Peace, The Catholic Bishops of Ontario. Toronto: OCCB, 1996.

Clancy, Christina, et al. *SciencePower 9*. Toronto: McGraw-Hill Ryerson Limited, 1999. ISBN 0-07-560361-6

Drew, A.M., J. Laney, E. Parkison, and A. Wilcox. 365 *Meditations for Teachers*. Dimensions for Living, 1996. ISBN 0-687-01025-X

Galbraith, Don, et al. *Biology 11*. Toronto: McGraw-Hill Ryerson, 2001. ISBN 0-07-088708-X

Galbraith, D., et al. *Understanding Biology*. Toronto: J. Wiley & Sons, 1989. ISBN 0-471-79654-9

Grace, Eric, et al. *SciencePower 10.* Toronto: McGraw-Hill Ryerson. 2000. ISBN 0-07-560364-0

Instruction on Respect for Human Life in Its Origin and the Dignity of Procreation. Vatican City: Vatican Press, 1987.

Plumb, Donald, et al. *Science 9*. Scarborough: Nelson Thomson Learning, 1999

Poole, M., G. Pilkey, and E. Johnson. *Biology in Action.* Toronto: Harcourt Brace Jovanovich, 1992. ISBN 0-7747-1348-8

Ritter, Bob, et al. *Science 10.* Scarborough: Nelson Thomson Learning, 2000. ISBN 0-17-607501-1

Scarrow, H. *Biology: Your Bodyworks.* Toronto: Globe/Modern Curriculum Press, 1990. ISBN 0-88996-214-6

Suzuki, David. *Earth Times.* Toronto: Stoddart Publishing Co., 1998.

Suzuki, David. *The Sacred Balance.* Toronto: Greystone Books, 1997.

The New American Catholic Bible. Wichita, Kansas: Catholic Bible Publications, 1992.

Websites

The URLs for the websites were verified by the writers prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Biosphere 2 Center – www.bio2.edu

Canada's SchoolNet and the Canadian Space Agency's SPACE – http://www.schoolnet.ca/space/main_E.htm

The Canadian Space Agency – http://www.space.gc.ca

Challenger Center Online – http://www.challenger.org

Discovery Channel Canada – http://www.exn.ca

Montreal Biodome – http://www.ville.montreal.qc.ca/biodome/e1–intro/ef1_cam.htm#camera

NASA Human SpaceFlight – http://spaceflight.nasa.gov/index.html

Spacelink – http://spacelink.nasa.gov/index.html
– http://www.accessexcellence.com/AE/AEC/AEF/1996/doerder_micro.html

CD-ROMs

A.D.A.M. Fort Erie: Films for the Humanities and Sciences, 2000.

Life Processes and Green Plants. Fort Erie: Films for the Humanities and Sciences, 2000.

Genetics. Fort Erie: Films for the Humanities and Sciences, 2000.

Human Health. Fort Erie: Films for the Humanities and Sciences, 2000.

Humans as Organisms. Fort Erie: Films for the Humanities and Sciences, 2000.

Masterman, Dan. *Biology with Computers Using Logger Pro.* Portland: Vernier Software.

Plant Biology Tutor. Fort Erie: Films for the Humanities and Sciences, 2000.

Inspiration®6 ©1988-1999 Inspiration® Software Inc.

Journals

Crucible – published by the Science Teachers' Association of Ontario – www.stao.org

The American Biology Teacher – published by the National Association of Biology Teachers – www.nabt.org

The Science Teacher – published by the National Science Teachers' Association - www.nsta.org

Cattiaux, P. "Astronaut Julie Payette is Out of This World." *REALM.* (Winter 2001/2002): 26-29 [also available at http://realm.net]

OSS Considerations

Students can benefit from experience in science related activities through Cooperative Education. Students may consider a Cooperative Education placement related to this science course. Students should explore various science-related careers throughout the course and consider them when they are developing their Annual Education Plan (AEP). Various environmental groups frequently look for volunteer support to aid their cause and provide opportunities for students to complete this requirement. This may also provide students with an opportunity to become aware of various career opportunities. Students graduating from Ontario schools are expected to be technologically literate. Through the study of this science course, students should be able to understand and apply technological concepts, to use computers in various applications, and to analyse the implications of technology on the individual and society.

It is also suggested that students explore the school to work opportunities available in their school to further their science skills acquired in this course.

Coded Expectations, Science, Grade 12, Workplace Preparation, SNC4E

Scientific Investigation Skills

SIS.01 - demonstrate an understanding of safety practices consistent with Workplace Hazardous Materials Information System (WHMIS) legislation by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials (e.g., identify the appropriate procedures for storing and disposing of flammable solvents, and for handling acids, bases, and non-aqueous solutions of toxic substances);

SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data (e.g., frequency meter, oscilloscope, dialysis tubing, data loggers);

SIS.03 - demonstrate the skills required to plan and carry out investigations, using laboratory equipment safely, effectively, and accurately (e.g., conduct an experiment to investigate the physical and chemical properties of common synthetic polymers);

SIS.04 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results (e.g., express as an equation the relationship among variables for a vibrating string pendulum);

SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet sites (e.g., compile a table of energy sources and their uses; prepare a report on waste disposal in alternative life-sustaining environments);

SIS.06 - compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams;

SIS.07 - communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports (e.g., prepare a laboratory report on the dialysis of nutrients);

SIS.08 - select and use appropriate SI units;

SIS.09 - identify and collect information on science- and technology-based careers related to the subject area under study (e.g., horticulturalist, medical technician, forester).

Chemistry at Home and Work

Overall Expectations

HWV.01 · demonstrate an understanding of the structure, properties, and reactions of common organic materials encountered in the home and workplace;

HWV.02 · investigate the properties of some organic substances, and safely prepare a number of common organic products and emulsions;

HWV.03 · describe the importance of common organic substances used in the home and workplace, and demonstrate an awareness of some of the health, safety, economic, and environmental issues related to the use of these substances.

Specific Expectations

Understanding Basic Concepts

HW1.01 – illustrate and explain the formation of covalent bonds, especially those involving H, C, N, O;

HW1.02 – explain how the hydrophobic, hydrophilic, or amphiphilic character of organic molecules is related to the presence of O, N, or ions in the molecule;

HW1.03 – predict, on the basis of the affinity of substances with similar chemical properties, the solubility of common organic substances in aqueous and non-aqueous solvents (e.g., polar and ionic substances are generally soluble in polar solvents; non-polar substances are generally soluble in non-polar solvents);

HW1.04 – explain the behaviour of emulsifying agents (e.g., soap, eggs);

HW1.05 – write word equations for simple condensation and hydrolysis reactions;

HW1.06 – describe the process of polymerization in terms of one or two simple molecules that are repetitively connected into a very large structure (e.g., ethene to polyethylene; glucose to starch; adipic acid and diaminohexane to nylon).

Developing Skills of Inquiry and Communication

HW2.01 – select and use appropriate vocabulary, including correct chemical terminology (e.g., *condensation, hydrolysis, miscible, emulsion, hydrophilic, hydrophobic, amphiphilic*), to communicate scientific ideas, procedures, and results;

HW2.02 – determine, through their own observations, the miscibility of a variety of organic liquids with each other and with water;

HW2.03 – plan and carry out safely laboratory investigations of emulsions (e.g., determine the effects on the stability of emulsions of emulsion-forming and emulsion-breaking agents such as soap, salt, and eggs);

HW2.04 – carry out experiments to compare the relative quantities of soap and detergent required to form emulsions in hard and soft water;

HW2.05 – safely prepare some common organic products by the processes of emulsion, condensation, hydrolysis, and polymerization (e.g., cold cream, mayonnaise, aspirin/ASA, or soap);

HW2.06 – carry out experiments safely to identify some of the physical and chemical properties of common synthetic polymers (e.g., determine the fusibility and aqueous and non-aqueous solubility of polyethylene, styrofoam, nylon, polyester, or melamine);

HW2.07 – test and compare the properties of naturally occurring polymers, such as cotton and silk, with their synthetic counterparts, rayon and nylon.

Relating Science to Technology, Society, and the Environment

HW3.01 – research an important application of condensation, hydrolysis, or emulsification processes, and report on their findings using an appropriate format (e.g., the industrial or home preparation of an emulsified food or cosmetic product, such as salad dressing, skin cream, or lipstick; the important role of condensation and hydrolysis reactions in the synthesis and digestion of major molecules in living organisms);

HW3.02 – prepare, and present to classmates, a report on the social, environmental, and economic consequences of the use and discarding of organic products (e.g., common addition plastic, copolymer, thermosetting plastic, or vulcanized products; natural and synthetic fabrics).

Communications: Sounds and Pictures

Overall Expectations

SPV.01 · demonstrate an understanding of the basic operating principles of entertainment and communications devices that are commonly found in the home and the workplace;

SPV.02 · carry out investigations concerning the scientific concepts involved in communications technology, and examine and operate some common communications devices;

SPV.03 · research and evaluate the role played by the many different kinds of technological devices used for communication, and their impact on the way we conduct our lives at home and at work.

Specific Expectations

Understanding Basic Concepts

SP1.01 – describe and illustrate the properties of a vibrating object, and explain how vibrating objects (e.g., drums, guitar strings, wave-making machines in theme parks) produce waves;

SP1.02 – explain in qualitative terms how frequency, amplitude, and wave shape affect the pitch, intensity, and quality of notes produced by musical instruments;

SP1.03 – describe and compare the properties of transverse and longitudinal waves;

SP1.04 – explain how different forms of energy can be transformed into, and transmitted as, waves (e.g., mechanical energy to sound energy; electrical energy to electromagnetic energy);

SP1.05 – describe and explain in qualitative terms what happens when waves interact (interfere) with one another (e.g., production of beats, or of voice patterns on an oscilloscope);

SP1.06 – explain, in terms of the properties of waves, how energy from communications devices is transmitted, reflected, and absorbed by different kinds of matter (e.g., how devices such as motion detectors, cordless telephones, and television remote controls work);

SP1.07 – describe in qualitative terms, with examples, the effects produced by the refraction and total internal reflection of visible light waves as they pass through different transparent media, and explain how these effects are applied in various entertainment and communications devices (e.g., the function of lenses and prisms in a television camera);

SP1.08 – examine and describe the operation of transducers that carry out the energy transformations in common communications equipment (e.g., explain how transducers work in microphones, photocells, aerials and antennas, earphones, loudspeakers, product code readers, or television screens).

Developing Skills of Inquiry and Communication

SP2.01 – formulate scientific questions about waves (e.g., What are the properties of longitudinal and transverse waves? What happens when two identical periodic waves travelling in opposite directions interact?);

SP2.02 – determine experimentally the relationships among the major variables for a vibrating object (e.g., carry out an investigation to determine the relationships among the length of a string pendulum and the frequency and period of its vibration);

SP2.03 – estimate the value of some wave-related quantities (e.g., the period and frequency of a string pendulum; the note produced by a musical instrument; the intensity of a sound in decibels; the distance from an observer to the location of a bolt of lightning);

SP2.04 – use instruments and communications equipment safely, effectively, and accurately to collect and present data (e.g., instruments/equipment such as a stopwatch, frequency meter, oscilloscope, tape recorder, VCR, or sound data logger);

SP2.05 – conduct investigations to analyse and explain the production of sound by a vibrating object (e.g., how different string or wind instruments produce notes);

SP2.06 – construct and test a prototype of a communications device, and resolve problems as they arise (e.g., work cooperatively with team members to construct and test a simple loudspeaker; construct, test, and demonstrate a simple audio amplifier).

Relating Science to Technology, Society, and the Environment

SP3.01 – describe the historical development of a significant product of communications technology (e.g., telephone, radio, television, cell phone, communications satellite);

SP3.02 – describe, using scientific principles, the functioning of common domestic and industrial communications technologies (e.g., cell phone, satellite system, ATM, store check-out system);

SP3.03 – describe some Canadian contributions to the field of communications technology (e.g., the work of Alexander Graham Bell or Reginald A. Fessenden);

SP3.04 – describe the impact of developments in communications technology on the way we work and on our social environment (e.g., telecommuting, flexible workplace, global communications).

Medical Technology

Overall Expectations

MTV.01 · demonstrate an understanding of the role of genetics and of various technologies, including biotechnology, in the diagnosis and treatment of human illness;

MTV.02 · gather and analyse scientific data using techniques similar to those employed in medical testing and diagnosis;

MTV.03 · evaluate, based on representative examples, ways in which science and technology have influenced the diagnosis and treatment of human illness, and work collaboratively to analyse an issue related to biotechnology.

Specific Expectations

Understanding Basic Concepts

MT1.01 – demonstrate an understanding of terms related to medical and reproductive technology (e.g., *cloning, genetic engineering, heredity, karyotype, pedigree*);

MT1.02 – explain the use of technology for diagnostic medical applications (e.g., the use of lasers, ultrasound, computer axial tomography [CAT] scans, doppler scans, X-rays, magnetic resonance imaging [MRI], fibre optics);

MT1.03 – describe the use of technology for biomedical repair (e.g., prosthetics, artificial organs, plastic surgery);

MT1.04 – describe and illustrate the role of chromosomes in the transmission of hereditary information from one cell to another, and explain how genetic disorders may occur;

MT1.05 – describe the use of karyotypes and pedigrees as diagnostic tools for determining genetic diseases (e.g., analyse the karyotypes or pedigree from the case study of a person having Down syndrome);

MT1.06 – describe the basic scientific and technological principles involved in genetic engineering (e.g., compile and display information on bacterial production of human insulin, or DNA fingerprinting).

Developing Skills of Inquiry and Communication

MT2.01 – conduct a laboratory experiment that simulates a process occurring in a medical apparatus (e.g., simulate the dialysis of nutrients by collecting and accurately recording data in an experiment on the diffusion of glucose through an artificial membrane);

MT2.02 – state a hypothesis and make predictions, based on available evidence and background information, concerning a particular medical problem (e.g., analyse a pedigree or karyotype for a genetic disorder).

Relating Science to Technology, Society, and the Environment

MT3.01 – provide examples of how science and technology have influenced the diagnosis and treatment of human illness, and have made medical technology an integral part of our lives (e.g., the role of X-rays, ultrasound, wheelchairs, artificial organs, prosthetics, reproductive technologies, laser surgery, computer axial tomography [CAT] scans);

MT3.02 – work as a member of a team to research, develop, and present material on an issue related to modern genetic technology (e.g., the ethical issues involved in the cloning of animals or humans, the use of genetic evidence in court, the insertion of animal genes in plants, the question of who owns genetic information).

Gardening, Horticulture, Landscaping, and Forestry

Overall Expectations

GHV.01 · demonstrate an understanding of the conditions required for plant growth, and of the techniques used in gardening, horticulture, landscaping, and forestry;

GHV.02 · investigate experimentally the effect of various conditions on the growth of plants, and demonstrate skills in the use of tools and techniques associated with either gardening, horticulture, or landscaping;

GHV.03 · demonstrate an understanding of the importance of cultivated and wild plants to society, the economy, and the environment.

Specific Expectations

Understanding Basic Concepts

GH1.01 – identify the general conditions necessary for healthy plant growth (e.g., describe optimal growth conditions for a specific type of plant);

GH1.02 – describe the basic steps in growing plants from seed (e.g., collecting seeds, sowing, providing conditions favourable to germination, and thinning);

GH1.03 – identify evidence of plant problems (e.g., wilting, off-colour leaves, leaf and bud drop, root and stem rot, and the visible presence of pests);

GH1.04 – describe, with examples, the differences among common house and garden plants and native trees that have been classified according to normal life cycles (e.g., annuals, biennials, and perennials) or method of culture (e.g., potting, seeding, making cuttings, transplanting);

GH1.05 – describe different methods of gardening and how each controls conditions of growth (e.g., organic gardening, greenhouse gardening, and hydroponics);

GH1.06 – describe some common forest-management practices (e.g., clear-cutting, sustainable forestry based on selective cutting, pruning);

GH1.07 – describe the design elements (e.g., colour, texture, balance, contrast, harmony, repetition) and the materials (e.g., plant materials, construction materials, soil, water) used in landscaping.

Developing Skills of Inquiry and Communication

GH2.01 – design and conduct an experiment to determine the effect of various environmental conditions (e.g., temperature, light, fertilizers, plant hormones) on plant growth;

GH2.02 – carry out soil tests to determine optimum conditions for the growth of plants (e.g., determine experimentally the correct pH value of the soil, or the optimum percentages of nitrogen, phosphorus, and potassium for particular plants);

GH2.03 – investigate the various methods used to control the conditions of growth for plants (e.g., describe how conditions are controlled in a greenhouse, tree nursery, or hydroponic installation);

GH2.04 – propagate and grow plant crops for use or sale, and keep records of their growth (e.g., grow vegetables or bedding plants from seed and transplant them to the home garden; grow trees from seeds, or plant seedlings on the school grounds);

GH2.05 – identify the features of a good landscape architecture site, and prepare a plan to scale for an outdoor garden (e.g., in the school grounds, or a public park).

Relating Science to Technology, Society, and the Environment

GH3.01 – describe the diversity of environments that must be maintained in order to provide habitats for a wide variety of plants (e.g., make a list of the environmental conditions – soil composition, light conditions, landscaping – required for particular types of plants);

GH3.02 – demonstrate an understanding of the variety of ways in which human populations depend on healthy plant populations (e.g., for food, clothing fibres, fuel, structural materials);

GH3.03 – demonstrate an understanding of the role of forests as essential habitats for other plants and animals, including threatened and endangered species (e.g., describe the environmental, economic, and social effects of various types of forestry practice, such as clear-cut forestry or sustainable forestry using selective cutting);

GH3.04 – analyse the social, economic, and environmental factors that determine the different approaches and methods required in gardening, horticulture, landscaping, and forestry (e.g., explain and evaluate the problems of monoculture and the environmental need for biodiversity in horticulture; or participate in a group debate concerning the economic benefits and costs of sustainable forestry).

Alternative Environments

Overall Expectations

AEV.01 · demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment;

AEV.02 · analyse major variables that affect the various inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment;

AEV.03 · demonstrate an understanding of what would be required to equip and operate an alternative environment capable of supporting human life, and compare its sustainability to that of our normal planetary environment.

Specific Expectations

Understanding Basic Concepts

AE1.01 – identify the systems required to sustain human life in an environment (e.g., biotic and abiotic factors in our ecosystem);

AE1.02 – describe the inputs of food, energy, air, and water needed to maintain an alternative life-sustaining environment;

AE1.03 – identify the components of an alternative life-sustaining environment (e.g., source[s] of energy, atmosphere, means for recycling or disposing of waste), and describe how they must interact to be successful;

AE1.04 – describe the outputs of an alternative life-sustaining environment, and the systems required to handle them (e.g., air filtration systems);

AE1.05 – describe the difficulties facing humans living in a weightless self-supporting environment (e.g., the difficulties of reducing human waste).

Developing Skills of Inquiry and Communication

AE2.01 – determine, through experimentation, the different factors affecting a controlled micro-environment (e.g., the factors affecting a yeast suspension, a fruit-fly culture, an aquarium, or a terrarium);

AE2.02 – formulate scientific questions about the nature of alternative life-sustaining environments (e.g., What becomes of the waste produced in an alternative environment?);

AE2.03 – use flow charts to diagram the inputs, outputs, and interactions of the various life-sustaining components of an alternative environment (e.g., energy flow, waste disposal, atmosphere).

Relating Science to Technology, Society, and the Environment

AE3.01 – analyse, using knowledge of the requirements for sustainability, existing alternative life-sustaining environments (e.g., International Space Station, Earth-based self-sustaining biodome experiments, nuclear submarines, off-shore oil rigs), and make suggestions for their improvement or development;

AE3.02 – assess a Canadian contribution to the development of alternative life-sustaining environments (e.g., gather, integrate, and analyse information about the Montreal Biodome);

AE3.03 – relate what they have learned about sustaining life in alternative environments to the processes through which our own natural environment sustains life (e.g., relate the mechanical processes of an air purification system to the natural process of air purification by trees);

AE3.04 – analyse the costs and benefits to society, the economy, and the environment of constructing and operating an alternative environment capable of supporting human life (e.g., write a brief essay on the potential economic benefits of maintaining an alternative life-sustaining environment such as the International Space Station).

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

CGE1a -illustrates a basic understanding of the **saving story** of our Christian faith;
CGE1b -participates in the **sacramental life** of the church and demonstrates an understanding of the centrality of the Eucharist to our Catholic story;
CGE1c -actively reflects on **God's Word** as communicated through the Hebrew and Christian scriptures;
CGE1d -develops attitudes and values founded on Catholic **social teaching** and acts to promote social responsibility, human solidarity and the common good;
CGE1e -speaks the **language of life**... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith)
CGE1f -seeks intimacy with God and celebrates **communion** with God, others and creation through prayer and worship;
CGE1g -understands that one's purpose or **call in life** comes from God and strives to discern and live out this call throughout life's journey;
CGE1h -respects the **faith traditions**, world religions and the life-journeys **of all people of good will**;
CGE1i -integrates faith with life;
CGE1j -recognizes that "sin, human weakness, conflict and forgiveness are part of the human journey" and that the cross, the ultimate sign of forgiveness is at the heart of **redemption**. (Witnesses to Faith)

An Effective Communicator who
CGE2a -listens actively and critically to understand and learn in light of gospel values;
CGE2b -reads, understands and uses written materials effectively;
CGE2c -presents information and ideas clearly and honestly and with sensitivity to others;
CGE2d -writes and speaks fluently one or both of Canada's official languages;
CGE2e -uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life.

A Reflective and Creative Thinker who
CGE3a -recognizes there is more grace in our world than sin and that hope is essential in facing all challenges;
CGE3b -creates, adapts, evaluates new ideas in light of the common good;
CGE3c -thinks reflectively and creatively to evaluate situations and solve problems;
CGE3d -makes decisions in light of gospel values with an informed moral conscience;
CGE3e -adopts a holistic approach to life by integrating learning from various subject areas and experience;
CGE3f -examines, evaluates and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society.

A Self-Directed, Responsible, Life Long Learner who

CGE4a -demonstrates a confident and positive sense of self and respect for the dignity and welfare of others;
CGE4b -demonstrates flexibility and adaptability;
CGE4c -takes initiative and demonstrates Christian leadership;
CGE4d -responds to, manages and constructively influences change in a discerning manner;
CGE4e -sets appropriate goals and priorities in school, work and personal life;
CGE4f -applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE4g -examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE4h -participates in leisure and fitness activities for a balanced and healthy lifestyle.

A Collaborative Contributor who

CGE5a -works effectively as an interdependent team member;
CGE5b -thinks critically about the meaning and purpose of work;
CGE5c -develops one's God-given potential and makes a meaningful contribution to society;
CGE5d -finds meaning, dignity, fulfillment and vocation in work which contributes to the common good;
CGE5e -respects the rights, responsibilities and contributions of self and others;
CGE5f -exercises Christian leadership in the achievement of individual and group goals;
CGE5g -achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others;
CGE5h -applies skills for employability, self-employment and entrepreneurship relative to Christian vocation.

A Caring Family Member who

CGE6a -relates to family members in a loving, compassionate and respectful manner;
CGE6b -recognizes human intimacy and sexuality as God given gifts, to be used as the creator intended;
CGE6c -values and honours the important role of the family in society;
CGE6d -values and nurtures opportunities for family prayer;
CGE6e -ministers to the family, school, parish, and wider community through service.

A Responsible Citizen who

CGE7a -acts morally and legally as a person formed in Catholic traditions;
CGE7b -accepts accountability for one's own actions;
CGE7c -seeks and grants forgiveness;
CGE7d -promotes the sacredness of life;
CGE7e -witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society;
CGE7f -respects and affirms the diversity and interdependence of the world's peoples and cultures;
CGE7g -respects and understands the history, cultural heritage and pluralism of today's contemporary society;
CGE7h -exercises the rights and responsibilities of Canadian citizenship;
CGE7i -respects the environment and uses resources wisely;
CGE7j -contributes to the common good.

Unit 5: Alternative Environments

Time: 20 hours

Unit Description

Students demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment. Through the lens of stewardship and Catholic social teaching students analyse major variables that affect the various inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment. Students demonstrate an understanding of what would be required to equip and operate an alternative environment capable of supporting human life, and compare its sustainability to that of our normal planetary environment.

Unit Synopsis Chart

Activity	Learning Expectations	Assessment Categories	Task
1.1 Getting Ready 1.5 hours	AE1.01, AE1.02, AE2.01, AE2.02, AE3.03 SIS.03 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding	Brainstorming Activity
1.2 Factors Affecting a Controlled Micro-environment 3.5 hours	AEV.01, AE2.02 SIS.01, SIS.02, SIS.03, SIS.04, SIS.06, SIS.07, SIS.08 CGE 1d, 2c, 3d, 3f, 4g, 7e	Communication Inquiry	Laboratory Activity
2.1 Alternative Environment Analysis 2.0 hours	AEV.01, AEV.02, AE1.02, AE1.03, AE1.04, AE2.02, AE2.03, AE3.01 SIS.05, SIS.07 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding Making Connections	Flow chart, Quiz
2.2 Canada's Contribution to the International Space Station 3.0 hours	AEV.01, AEV.02, AE1.01, AE1.03, AE1.04, AE2.02, AE3.02, AE3.04 SIS.05, SIS.07 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding Making Connections Communication	Poster
2.3 Cost/Benefit Analysis of an Alternative Environment 1.0 hours	AE3.04 SIS.05, SIS.07 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding Communication	Report
2.4 Press Conference 2.0 hours	AE1.05, AE3.02 SIS.05, SIS.07, SIS.09 CGE 1d, 2c, 3d, 3f, 4g, 7e	Communication	Presentation
2.5 Spaceship Earth 2.0 hours	AE3.03 SIS.05, SIS.07 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding	Formal Report, Quiz
3.1 Create a lunar/martian ecosystem 5.0 hours	AEV.01, AEV.02, AEV.03, AE1.02, AE1.03, AE1.04, AE1.05, AE2.03, AE3.01, AE3.04 SIS.05, SIS.07 CGE 1d, 2c, 3d, 3f, 4g, 7e	Knowledge/ Understanding	Flow chart, Display

Activity 1: Getting Ready

Time: 5 hours (1-2 weeks for micro-ecosystem)

Description

Students determine factors that are essential for human life on Earth. Students reflect on Catholic values and determine what is truly important for a life-sustaining environment. Students construct a functional micro-environment that models a naturally occurring ecosystem and determine the effects of altering abiotic factors on the controlled environment.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE 1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;
CGE 2c - presents information and ideas clearly and honestly and with sensitivity to others;
CGE 3d - makes decisions in light of gospel values with an informed moral conscience;
CGE 3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society;
CGE 4g - examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE 7e - witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society.

Strand(s): Alternative Environments

Overall Expectations

AEV.01 - demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment.

Specific Expectations

AE1.01 - identify the systems required to sustain human life in an environment (e.g., biotic and abiotic factors in our ecosystem);
AE1.02 - describe the inputs of food, energy, air, and water needed to maintain an alternative life-sustaining environment;
AE2.01 - determine, through experimentation, the different factors affecting a controlled microenvironment (e.g., the factors affecting a yeast suspension, a fruit-fly culture, an aquarium, or a terrarium);
AE2.02 - formulate scientific questions about the nature of alternative life-sustaining environments (e.g., What becomes of the waste produced in an alternative environment?);
AE3.03 - relate what they have learned about sustaining life in alternative environments to the processes through which our own natural environment sustains life (e.g., relate the mechanical processes of an air purification system to the natural process of air purification by trees).

Scientific Investigation Skills

SIS.01 - demonstrate an understanding of the safety practices consistent with Workplace Hazardous Materials Information System (WHMIS) legislation by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials;
SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data;
SIS.03 - demonstrate the skills required to plan and carry out investigations, using laboratory equipment safely, effectively, and accurately;
SIS.04 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results;

SIS.06 - compile, organize, and interpret data, using appropriate formats and treatments, including tables, flow charts, graphs, and diagrams;
SIS.07 - communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports;
SIS.08 - select and use appropriate SI units.

Prior Knowledge & Skills

- Grade 10 Science (Applied or Academic) – Biology strand
- Grade 9 Science (Applied or Academic) – Earth and Space Science strand

Planning Notes

- Chart paper and markers should be made available to allow students to brainstorm in small groups for Activity 1.1.
- The teacher prepares the materials needed to create a controlled micro-environment (Activity 1.2). Materials may include:
  - 10-gallon aquarium (1 per 4-5 students)
  - Glass piece cut to fit the top of the tank
  - Duct tape for sealing the lids on the tanks
  - Gravel, sand, and rocks
  - Soil
  - Seeds - collect local or purchase seeds (seeds of small plants work best.)
  - Other organisms required, (in terms of matter and energy requirements, trophic levels and population interactions) to sustain each micro-ecosystem. The teacher can choose to develop any type of ecosystem within the limitations of a 10-gallon tank.
- **Note:** the laboratory activity takes 1-2 weeks to achieve good results
- Safety consideration: Some seeds might contain fungicides. Be aware of this during the experiment

Teaching/Learning Strategies

Activity 1.1: Getting Ready
Students brainstorm materials required for survival on Earth. Students reflect on Catholic values, and consider what factors are truly important for sustaining human life. (Reflection: Luke 6:27-36 or Luke 12:34)

The teacher:

- leads the class in a discussion to determine what types of materials and criteria (biotic and abiotic factors) are essential for human life on Earth;
- asks questions that will guide the students in determining life's necessities. Such questions may include:
  - What are some factors that we could not possibly live without, i.e., oxygen supply, food supply, water supply, climate control, medical aid, waste disposal, etc.?;
  - What are some of the manufactured things that we have now, that our ancestors never had? Are they essential for life?
  - What are the minimum requirements to sustain life on Earth?
  - If you had to choose only four things you could own/buy…what would they be?
  - Our society has become more dependent on technology. Name some advancements in technology that have made our lives much easier. Are these inventions crucial for life on Earth (e.g., transportation)?

- divides students into small groups and provides the groups with the chart paper required to brainstorm criteria;
- monitors group discussions, and ensures that groups are remaining on task;
- identifies and corrects misconceptions that the students may have.

Students:

- participate in a class discussion based on materials required to sustain human life on Earth.
- working in small groups, participate in the brainstorming activity.
- present ideas to other groups and discuss opinions.
- write a reflective journal focusing on what is truly important in life. Students should recognize how insignificant many things are (e.g., fancy cars, large houses, etc.)

Activity 1.2: Experiment: Micro-ecosystems, i.e., Yeast Growth

Students construct a functional micro-ecosystem that will model a naturally occurring ecosystem and witness the interaction between the biotic and abotic factors within it. Students alter abiotic factors to determine the effects these factors have on the controlled environment.

The teacher:

- recaps briefly, through question and answer period, the factors required for sustaining life on Earth.
- brainstorms factors that may affect life in a closed environment, e.g., temperature, available water, oxygen levels, energy source, etc.
- constructs a closed ecosystem that may be used as a control.
- divides the class into groups of four or five students, with each group assigned to test one of the variables being examined.

Students:

- brainstorm factors required for sustaining life in a closed environment;
- carefully plan, as a class, the ecosystem with regards to: matter and energy requirements, trophic levels and size of populations;
- identify variables that may affect a closed micro-environment;
- carefully construct closed environments that are as similar to each of the other groups as possible (limiting experimental error);
- test the variable they are assigned, and examine the affects that the variable has on the closed system;
- record observations they witness in the ecosystems and try to explain most of the changes that they observe;
- share findings and pool data with other students;
- draw tentative conclusions concerning factors that affect a controlled micro-environment;
- create a formal lab write up determining the factors that affect a controlled micro-environment.

Assessment & Evaluation of Student Achievement

- Discussion/brainstorming activity can be assessed for Communication using a rubric.
- A diagnostic assessment of student's Knowledge/Understanding during discussion activity can be done informally through a class discussion.
- Communication can be assessed using a science log – a record of research that the student has compiled (AE2.01).
- The lab can be assessed for Knowledge/Understanding, Inquiry, Communication, and Making Connections using a rubric (AE2.01).

Accommodations

- Reflection journals can be produced using a computer or a tape recorder.
- Alternate assessment methods could be used.

Resources

Print

Grace, Eric, et al. *SciencePower 10*. Toronto: McGraw-Hill Ryerson. 2000. ISBN 0-07-560364-0

Plumb, Donald, et al. *Science 9*. Scarborough: Nelson Thomson Learning, 1999.

Clancy, Christina, et al. *SciencePower 9.* Toronto: McGraw-Hill Ryerson Limited, 1999. ISBN 0-07-560361-6

Ritter, Bob, et al. *Science 10.* Scarborough: Nelson Thomson Learning, 2000. ISBN 0-17-607501-1

Websites

– http://www.accessexcellence.com/AE/AEC/AEF/1996/doerder_micro.html

Activity 2: Analysing Alternative Environments

Time: 10 hours

Description

Students analyse various existing alternative life-sustaining environments in terms of the factors required for sustainability studied in Activity 1. Students research and assess Canada's contribution to the International Space Station, then perform a cost/benefit analysis of constructing and maintaining the International Space Station. Students investigate careers in Earth and space science by researching a Canadian astronaut.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations

CGE 1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;
CGE 2c - presents information and ideas clearly and honestly and with sensitivity to others;
CGE 3d - makes decisions in light of gospel values with an informed moral conscience;
CGE 3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society;
CGE 4g - examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE 7e - witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society.

Strand(s): Alternative Environments

Overall Expectations

AEV.01 - demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment;
AEV.02 - analyse major variables that affect the various inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment.

Specific Expectations

AE1.01 - identify the systems required to sustain human life in an environment (e.g., biotic and abiotic factors in our ecosystem);
AE1.02 - describe the inputs of food, energy, air, and water needed to maintain an alternative life-sustaining environment;
AE1.03 - identify the components of an alternative life-sustaining environment (e.g., source[s] of energy, atmosphere, means for recycling or disposing of waste), and describe how they must interact to be successful;

AE1.04 - describe the outputs of an alternative life-sustaining environment, and the systems required to handle them (e.g., air filtration systems);
AE1.05 - describe the difficulties facing humans living in a weightless self-supporting environment (e.g., the difficulties of reducing human waste);
AE2.02 - formulate scientific questions about the nature of alternative life-sustaining environments (e.g., What becomes of the waste produced in an alternative environment?);
AE2.03 - use flow charts to diagram the inputs, outputs, and interactions of the various life-sustaining components of an alternative environment (e.g., energy flow, waste disposal, atmosphere);
AE3.01 - analyse, using knowledge of the requirements for sustainability, existing alternative life-sustaining environments (e.g., International Space Station, Earth-based self-sustaining biodome experiments, nuclear submarines, off-shore oil rigs), and make suggestions for their improvement or development;
AE3.02 - assess a Canadian contribution to the development of alternative life-sustaining environments (e.g., gather, integrate, and analyse information about the Montreal Biodome);
AE3.03 - relate what they have learned about sustaining life in alternative environments to the processes through which our own natural environment sustains life (e.g., relate the mechanical processes of an air purification system to the natural process of air purification by trees);
AE3.04 - analyse the costs and benefits to society, the economy, and the environment of constructing and operating an alternative environment capable of supporting human life (e.g., write a brief essay on the potential economic benefits of maintaining an alternative life-sustaining environment such as the International Space Station).

Scientific Investigation Skills
SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet websites;
SIS.07 - communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports;
SIS.09 - identify and collect information on science- and technology-based careers related to the subject area under study.

Prior Knowledge & Skills

- Grade 9 Science (Academic or Applied) - Earth and Space Science strand
- Grade 10 Science (Academic or Applied) - Biology strand

Planning Notes

- Reserve library/resource centre/computer lab time for the class.
- Gather various multi-media resources on the International Space Station and other alternative environments (Montreal Biodome, Biosphere 2, etc.).
- Prepare to discuss recent movies that deal with space travel and alternate environments to generate interest and introduce the topics.
- Visit the NASA SpaceFlight website to determine when the International Space Station can be seen from your city.
- The topics in this activity are very timely. There may be missions into space planned which relate to the topics being studied. Begin saving articles and other information related to the topics studied.
- Prepare templates for students to use when analysing alternative environments and writing research papers.

Teaching/Learning Strategies

Activity 2.1: Alternative Environment Analysis

Students use the concept of sustainability to analyse existing life-sustaining alternative environments. Students study inputs, outputs, and interactions between components and summarize their information in a flow chart.

The teacher:

- reviews factors required for life on Earth studied in Activity 1.1;
- leads a class discussion on the factors that must be considered when designing an alternative environment, e.g., inputs, outputs, protection from the environment, etc., using a space suit as an example;
- discusses and lists the students' responses on the board;
- introduces existing alternative environments. If possible, show photographs, websites, newspaper/magazine articles, etc.;
- briefly reviews formation of scientific questions and assists students in generating suitable scientific questions for study. Since the students will be participating in a jigsaw activity, they should all have the same questions to research. The four factors for sustainability should be considered, i.e., air, water, energy and food. Research questions should include (but not be limited to):
  - How is oxygen supplied to the environment?
  - How is carbon dioxide removed from the environment?
  - How is water (hot and cold) produced?
  - What energy source powers the environment?
  - What is the food source?
  - How are wastes disposed of?
- assigns each student to an "expert group" and a "home group". Assign each expert group one alternative life-sustaining environment (International Space Station, Biosphere, Montreal Biodome). Students could also take part in virtual tours of the alternative environments listed, if Internet access is available. The home groups each have at least one representative from each expert group. The expert groups compile information to answer the scientific questions raised. The information is then presented in flow chart form on chart paper showing inputs, outputs and interactions between the components. If computer access is available, students could use a software program to generate flow charts. Each student creates their own summary sheet and present this information to their home group. Students in each home group then assess each alternative environment, list suggestions for their improvement and present their suggestions to the class;
- monitors group discussions.

Students:

- participate in a class discussion on factors required for life on Earth;
- discuss how an alternative environment such as a space suit sustains life;
- formulate scientific questions about the nature of alternative environments;
- in their expert groups, analyse existing alternative environments and present findings in a flow chart;
- present this information to their home groups;
- in their home groups, make suggestions for improving existing alternative environments and present information.

Activity 2.2: Canada's Contribution to the International Space Station
Students research Canada's contribution to the International Space Station. Students create a timeline of the development of the International Space Station and a poster to display their research.

The teacher:

- introduces the International Space Station in a class discussion. Shows video of a recent mission, if possible (see Planning Notes);
- provides students with background information from the Internet, newspaper/magazine articles, media broadcasts, or videos;
- assigns students to groups of four to research Canada's contributions to the International Space Station. If Internet access is available, students can take a virtual tour of the International Space Station. Each student creates a summary sheet of the research. When the students have completed their research they present their findings in a poster to be displayed in the classroom. Research should include (but not be limited to):
  - a diagram showing the components;
  - a description of its function/purpose;
  - a timeline of its development (including projected future developments);
  - a description of research carried out;
  - the relevance of the research to life on Earth.
- monitors group work and discussions;
- guides students in a Gallery Walk to peer assess other posters;
- leads students in a discussion on research conducted in space and how it can be used to improve life on Earth. Specifically, discuss research that deals with human growth and life keeping in mind Gospel teaching. Provide students with time to write a reflection in their Science Journals. (Reflection Mark 9:33-37).

Students:

- participate in a class discussion on the International Space Station;
- analyse information from various media to assess Canada's contribution to the International Space Station;
- in groups of four, research Canada's contribution to the International Space Station;
- each create a one-page summary sheet of their research;
- in groups of four, present their research in a poster;
- participate in a Gallery Walk to observe and peer assess other posters;
- write a reflection in their Science Journals on how research conducted in space can be used to improve life on Earth, keeping in mind Gospel teaching.

Activity 2.3: Cost/Benefit Analysis
Students analyse the costs and benefits to society, economy and the environment of constructing and operating a life-sustaining alternative environment, then write a report.

The teacher:

- reviews the alternative environments studied in Activity 2.1;
- leads a class discussion on alternative environments, specifically how the technologies and research can be used to improve the lives of people on Earth;
- assigns students, in groups of two, to review the information and create a qualitative summary chart of costs and benefits of an alternative environment, e.g., International Space Station, Biosphere, Montreal Biodome. The teacher outlines a template which the students use when gathering information (Appendix 2.3A – Template for Cost/Benefit Analysis);

- reviews report writing and paragraph structure with the students. Each student uses their summary chart to write a three-paragraph report, with an introduction and conclusion. Each student is provided with a template for writing paragraphs and allowed time to prepare a rough draft (Appendix 2.3B – Template for Report Outline). The students are then paired to peer assess their work, using a teacher designed checklist. The students then edit their work and submit a final report to the teacher (Appendix 2.3C – Peer Assessment Checklist);
- leads the class in discussing whether money should be spent on research in space, or be used to directly improve the lives of people on Earth, referring to Gospel teaching. The teacher then provides an opportunity for students to write a refection in their Science Journals. (Reflection John 13:1-13).

Students:

- participate in a class discussion of alternative environments and their impact on people on Earth;
- participate in a class discussion of the International Space Station;
- use reference material to create a qualitative summary sheet of costs and benefits of the International Space Station then write a three-paragraph report, with an introduction and conclusion, summarizing their research;
- participate in a class discussion on Gospel teaching and research conducted in space
- write in their Science Journal, reflecting on whether money should be spent on research in space, or be used to directly improve lives of people suffering on Earth.

Activity 2.4: Press Conference

Students collect and analyse information on careers in Earth and Space Science by preparing an information package to be used at a press conference for an astronaut and crew returning from a mission.

The teacher:

- leads a class discussion on recent space missions involving Canadian astronauts;
- leads students in a think/pair/share activity to determine characteristics of an astronaut;
- provides students with resources or library/resource centre/computer time to research a recent Canadian mission. The teacher arranges students in groups of three or four students. Each student in a group plays the role of a different member of the crew. Students can play the role of a Canadian astronaut (Chris Hadfield, Julie Payette, Robert Thirsk, Dave Williams, Bjarni Tryggvason, Roberta Bondar, or Marc Garneau), technician, or trades person. The students research their character's contribution to the success of the mission. Students use their research to prepare a script for a press conference that will be presented to the class. When students are not presenting, they play the role of reporters for various media and ask questions of the presenters. If equipment is available, students can videotape the press conference. The students' research should include (but not be limited to):
    - personal data, e.g., date of birth, place of residence, family, hobbies/interests;
    - education and training;
    - description of most recent mission, e.g. research carried out, length of mission;
    - their role in this mission;
    - the mission patch.
    - provides time for preparing the script and rehearsing the press conference.

Students:

- participate in a class discussion on recent missions to space and brainstorm characteristics of an astronaut;
- research a Canadian astronaut, technician or trades person, then prepare an informational package to be used at a press conference describing a recent mission;
- will present their information to the class in the style of a press conference and answer questions;
- participate in other groups' press conferences by asking questions. (Appendix 2.4 – Presentation Assessment Rubric)

Activity 2.5: Spaceship Earth

Students relate components of a closed system to our environment. Students will view the Earth as a closed system where supplies are limited. Students may use this exercise to bring forth Catholic values and reflect on how their values and aspirations can affect other members of their community. Students reflect on the way many people currently take the Earth's resources for granted and how important it is to treat the Earth with respect.

The teacher:

- distributes role-playing journal reflective cards to the small groups. Each card has a different scenario written on it, e.g., (1) The father has to leave. How will this affect the community? What role does the father play in this community? (2) Someone in the community is continually dumping their garbage in a nearby park. How does this affect the community?)
- assigns student's the task of creating a short skit to act out their scenario;
- leads a discussion regarding ways one's roles and values affect the communities they are a part of;
- engages the class in a discussion relating what has been learned about sustaining life in alternative environments to Earth, i.e., relating the mechanical processes of an air purification system to the natural process of air purification by trees;
- introduces the concept of Earth as a closed system known as "Spaceship Earth." Earth is more closed than even a spaceship because there is no "refuelling station" to take on supplies. The teacher encourages the students to think about the following facts about our planet:
  - There is no outside source for life-sustaining raw materials.
  - There is no interplanetary garbage dump.
- leads a discussion about rules that may be followed on spaceships to avoid fouling the air and overusing vital water and food supplies;
- leads the class in a reflective discussion about how the Earth should be respected and viewed of as a gift from God;
- stimulates discussion regarding the way human civilization has taken the Earth for granted, and what we, as Catholics, can do to prevent its deterioration.

Students:

- are assigned to groups of three or four students and are given group role-playing journal reflection cards;
- act out scenario given to them on their journal reflection card;
- participate in a discussion on how their roles and values affect the rest of their community;
- participate in the discussion on "spaceship Earth";
- write a rules manual that should include (but is not limited to):
  - A set of rules for human passengers on spaceship Earth;
  - An evaluation of how closely these rules are presently being followed;
  - Suggestions about how some human behaviours should be altered;
  - A prediction about how these human practices and behaviours may affect the diversity of living things.
- take part in a reflective discussion regarding ways humans take Earth's resources for granted;
- discuss ways they can help prevent the Earth's deterioration.

Assessment & Evaluation of Student Achievement

- Flow chart can be assessed for Knowledge/Understanding and Communication using a checklist (AE1.02, AE1.03, AE1.04, AE2.03, AE3.01).
- Analysis of alternative environments can be assessed for Knowledge/Understanding using a quiz (AE1.02, AE1.03, AE1.04, AE3.01).
- Students' scientific questions can be assessed for Inquiry using a suitable rubric or rating scale (AE2.02).
- Poster can be assessed for Making Connections and Communication using a suitable rubric or rating scale by both the teacher and peers (AE1.01, AE1.03, AE1.04, AE3.02).
- Report can be assessed for Knowledge/Understanding and Communication using a suitable rubric or rating scale (AE3.04).
- Press conference can be peer assessed for Communication using a suitable rating scale (AE1.05, AE3.02).
- Spaceship Earth is assessed for Knowledge/Understanding, Communication, and Making Connections based on the criteria given by the teacher with regards to the formal paper (AE3.03).
- A quiz may also be given to assess for Knowledge/Understanding relating sustaining life on a closed alternative environment to the process through which our own natural environment sustains life (AE3.03).

Accommodations

- For students with physical or learning impairments, classroom activities can be adapted, where possible, to permit participation in activities. Peer assistance should be encouraged. Access to a computer or tape recorder should be provided, where possible.
- If a student has an individual education plan (IEP), this activity must be adapted to meet the needs as outlined in the IEP.
- For enrichment activities:
  - Choose one of the ways that our natural environment sustains life, e.g., air purification by trees. Research this process in detail and present findings to the class in a formal presentation.
  - Research rules that are followed by Canadian astronauts on spaceships to avoid fouling air and overusing vital water and food supplies. Present research to the class.
- ESL/ESD students should have opportunities to demonstrate their learning by alternate means, e.g., spoken English, direct demonstration, and/or pictorial representation.

Resources

Print

Grace, Eric, et al. *SciencePower 10*. Toronto: McGraw-Hill Ryerson. 2000. ISBN 0-07-560364-0

Plumb, Donald, et al. *Science 9.* Scarborough: Nelson Thomson Learning, 1999.

Cattiaux, P. "Astronaut Julie Payette is Out of This World." REALM. (Winter 2001/2002): 26-29 [also available at http://realm.net]

Clancy, Christina, et al. *SciencePower 9.* Toronto: McGraw-Hill Ryerson Limited, 1999. ISBN 0-07-560361-6

Ritter, Bob, et al. *Science 10.* Scarborough: Nelson Thomson Learning, 2000. ISBN 0-17-607501-1

Websites

Biosphere 2 Center – www.bio2.edu

Canada's SchoolNet and the Canadian Space Agency's SPACE – http://www.schoolnet.ca/space/main_E.htm

The Canadian Space Agency – http://www.space.gc.ca

Challenger Center Online – http://www.challenger.org
Discovery Channel Canada – http://www.exn.ca
Montreal Biodome – http://www.ville.montreal.qc.ca/biodome/e1–intro/ef1_cam.htm#camera
NASA Human SpaceFlight – http://spaceflight.nasa.gov/index.html
Spacelink – http://spacelink.nasa.gov/index.html

Software
Inspiration®6 ©1988-1999 Inspiration® Software Inc.

Activity 3.1: Create a Lunar/Martian Ecosystem

Time: 5 hours

Description

Students design a closed ecosystem capable of supporting human life. Students write a reflective journal emphasizing what is truly important in life.

Strand(s) & Learning Expectations

Ontario Catholic School Graduate Expectations
CGE 1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;
CGE 2c - presents information and ideas clearly and honestly and with sensitivity to others;
CGE 3d - makes decisions in light of gospel values with an informed moral conscience;
CGE 3f - examines, evaluates, and applies knowledge of interdependent systems (physical, political, ethical, socio-economic and ecological) for the development of a just and compassionate society;
CGE 4g - examines and reflects on one's personal values, abilities and aspirations influencing life's choices and opportunities;
CGE 7e - witnesses Catholic social teaching by promoting equality, democracy, and solidarity for a just, peaceful and compassionate society.

Strand(s): Alternative Environments

Overall Expectations
AEV.01 - demonstrate a knowledge of the inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment;
AEV.02 - analyse major variables that affect the various inputs, outputs, and interactions involved in maintaining an alternative life-sustaining environment;
AEV.03 - demonstrate an understanding of what would be required to equip and operate an alternative environment capable of supporting human life, and compare its sustainability to that of our normal planetary environment.

Specific Expectations
AE1.02 - describe the inputs of food, energy, air, and water needed to maintain an alternative life-sustaining environment;
AE1.03 - identify the components of an alternative life-sustaining environment (e.g., source[s] of energy, atmosphere, means for recycling or disposing of waste), and describe how they must interact to be successful;
AE1.04 - describe the outputs of an alternative life-sustaining environment, and the systems required to handle them (e.g., air filtration systems);
AE1.05 - describe the difficulties facing humans living in a weightless self-supporting environment (e.g., the difficulties of reducing human waste);

AE2.03 - use flow charts to diagram the inputs, outputs, and interactions of the various life-sustaining components of an alternative environment (e.g., energy flow, waste disposal, atmosphere);
AE3.01 - analyse, using knowledge of the requirements for sustainability, existing alternative life-sustaining environments (e.g., International Space Station, Earth-based self-sustaining biodome experiments, nuclear submarines, off-shore oil rigs), and make suggestions for their improvement or development;
AE3.04 - analyse the costs and benefits to society, the economy, and the environment of constructing and operating an alternative environment capable of supporting human life (e.g., write a brief essay on the potential economic benefits of maintaining an alternative life-sustaining environment such as the International Space Station).

Scientific Investigation Skills
SIS.05 - locate, select, analyse, and integrate information on topics under study, working independently and as part of a team, and using appropriate library and electronic research tools, including Internet websites;
SIS.07 - communicate the procedures and results of laboratory investigations and research for specific purposes using data tables and laboratory reports.

Prior Knowledge & Skills

- Grade 10 Science - Biology strand
- Grade 9 Science - Earth and Space Science strand

Planning Notes

- Reserve the library/resource centre/computer lab time for the class.
- Collect materials that are available in the school for building a display.

Teaching/Learning Strategies

The teacher:

- briefly reviews factors required to sustain life in an alternative life-sustaining environment;
- records all major factors on board. Such factors should include air, water, food, energy, waste disposal, etc.;
- assigns students with the responsibility of designing and creating a display (drawing or three-dimensional model) depicting a sustainable space research colony suitable for permanent human habituation.

Students:

- design and create a display depicting a sustainable space research colony suitable for permanent human habituation;
- hand in a completed display that includes:
  - a demonstration of how the colony will be adapted to the environment (keeping in mind problems that the colony will face in a weightless self-supporting environment, e.g., waste disposal;
  - a plan that will outline how colonists will achieve self-sufficiency in both short and long terms;
  - evidence of how knowledge gained from existing space explorations and space technology will be used;
  - a flow chart to diagram the inputs, outputs, and interactions of the various life-sustaining components of the student's space colony.

- present completed displays to the class and justify their designs. Students must defend the criteria they have chosen to include in their space colony;
- write a reflective journal entitled How can I take all that I have learned to the future? Students reflect on Catholic values, and reflect on factors that are truly important in their lives.

Assessment & Evaluation of Student Achievement

- Space colony activity can be assessed for Knowledge/Understanding, Communication, Inquiry, and Application using a task specific rubric (AEV.01, AEV.02, AEV.03, AE1.02, AE1.03, AE1.04, AE1.05).
- The flow chart can be assessed for Communication and Making Connections (AE2.03)

Accommodations

- Reflective journals can be produced using a computer or a tape recorder.
- Graphic organizers and diagrams could be used as alternate journal activities.

Resources

Print

Grace, Eric, et al. *SciencePower 10.* Toronto: McGraw-Hill Ryerson. 2000. ISBN 0-07-560364-0

Plumb, Donald, et al. *Science 9.* Scarborough: Nelson Thomson Learning, 1999.

Clancy, Christina, et al. *SciencePower 9.* Toronto: McGraw-Hill Ryerson Limited, 1999. ISBN 0-07-560361-6

Ritter, Bob, et al. *Science 10.* Scarborough: Nelson Thomson Learning, 2000. ISBN 0-17-607501-1

Appendix 2.3 A

Template for Cost/Benefit Analysis

Costs and Benefits to Society

Costs	Benefits

Costs and Benefits to The Economy

Costs	Benefits

Costs and Benefits to The Environment

Costs	Benefits

Appendix 2.3 B

Template for Report Outline

Introduction: _____

Paragraph 1: Effects on Society
Topic Sentence 1: _____
Support:
1. _____
2. _____
3. _____
4. _____
Linking sentence: _____

Paragraph 2: Effects on the Economy
Topic Sentence 2: _____
Support:
1. _____
2. _____
3. _____
4. _____
Linking sentence: _____

Paragraph 3: Effects on the Environment
Topic Sentence 3: _____
Support:
1. _____
2. _____
3. _____
4. _____
Concluding Sentence: _____

Conclusion: _____

Notes:
- Topic Sentence: point being developed
- Linking Sentence: takes the reader to the next point

Appendix 2.3 C

Peer Assessment Checklist

Cost/Benefit Analysis Peer Checklist

Name: _____ Evaluator: _____

Criteria	Yes	No
Topic sentence is clear and easily understood.		
Evidence is relevant and supports the topic sentence.		
Evidence is in the student's own words.		
Linking sentences introduce the following paragraph.		
Spelling errors have been fixed.		
Grammar and punctuation errors have been fixed.		
Report follows a logical order.		
Reference material is properly referenced.		

Appendix 2.4

Presentation Assessment Rubric

(Generic model – modify to meet local criteria)

Category/ Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge/ Understanding				
- understanding of concepts, principles, laws, and theories	- demonstrates limited understanding of concepts, principles, laws, and theories	- demonstrates some understanding of concepts, principles, laws, and theories	- demonstrates considerable understanding of concepts, principles, laws, and theories	- demonstrates thorough understanding of concepts, principles, laws, and theories
- knowledge of facts and terms	- demonstrates limited knowledge of facts and terms	- demonstrates some knowledge of facts and terms	- demonstrates considerable knowledge of facts and terms	- demonstrates thorough knowledge of facts and terms
- transfer of concepts to new contexts	- transfers simple concepts to new contexts infrequently	- transfers simple concepts to new contexts sometimes	- transfers simple and some complex concepts to new contexts usually	- transfers complex concepts to new contexts routinely
Inquiry				
- application of the skills and strategies of scientific inquiry	- applies few of the skills and strategies of scientific inquiry	- applies some of the skills and strategies of scientific inquiry	- applies most of the skills and strategies of scientific inquiry	- applies all or almost all of the skills and strategies of scientific inquiry
Communication				
- communication of information and ideas	- communicates information and ideas with limited clarity and precision	- communicates information and ideas with moderate clarity and precision	- communicates information and ideas with considerable clarity and precision	- communicates information and ideas with a high degree of clarity and precision

Appendix 2.4 (Continued)

Category/ Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Communication - use of scientific terminology, symbols, conventions, and standard (SI) units	- uses scientific terminology, symbols, conventions, and SI units with limited accuracy and effectiveness	- uses scientific terminology, symbols, conventions, and SI units with some accuracy and effectiveness	- uses scientific terminology, symbols, conventions, and SI units with considerable accuracy and effectiveness	- uses scientific terminology, symbols, conventions, and SI units with a high degree of accuracy and effectiveness
- communication for different audiences and purposes	- communicates with a limited sense of audience and purpose	- communicates with some sense of audience and purpose	- communicates with a clear sense of audience and purpose	- communicates with a strong sense of audience and purpose
- use of various forms of communication (e.g., reports, essays)	- demonstrates limited command of the various forms	- demonstrates moderate command of the various forms	- demonstrates considerable command of the various forms	- demonstrates extensive command of the various forms
Making Connections - understanding of connections among science, technology, society, and the environment	- shows limited understanding of connections in familiar contexts	- shows some understanding of connections in familiar contexts	- shows considerable understanding of connections in familiar and some unfamiliar contexts	- shows thorough understanding of connections in familiar and unfamiliar contexts

Note: A student whose achievement is below Level 1 (50%) has not met the expectations for this assignment or activity.