Course Profile

Science

Grade 9
Academic

• *for teachers by teachers*

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Acknowledgments

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Unit #1: Chemistry: Atoms and Elements

Time: 27.5 hours (*22 periods of 75 minutes each*)

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Development Date: April 1, 1999.

Unit Description

This unit focuses on the physical and chemical properties and changes of matter, the history and structure of the atom, and the arrangement of elements in the periodic table. Through the study of the technologies associated with the refining and recycling of elements and compounds, the students will obtain the scientific and technological knowledge within a context enriched by their Catholic Faith culture. This will enable the students to make informed decisions and to consider their responsibilities as informed Catholic citizens in a rapidly changing society. This unit provides the background information for the Physics, Biology and Earth and Space units.

Strand & Expectations

Ontario Catholic School Graduate Expectations:
CGE 1d, i; 2a, b, c, d, e; 3b, c, d, e, f; 4a, b, c, d, e, f, g; 5a, b, c, d, e, f, g, h; 7a, b, d, e, f, h, i.

Strand: Chemistry

Overall Expectations: CHV.01, CHV.02, CHV.03

Specific Expectations: CH1.01 to CH1.15, CH2.01 to CH2.10, CH3.01 to CH3.04

Activity Titles (Time and Sequence)

Activity 1	Matter and its Properties	300 min
Activity 2	Physical and Chemical Change	225 min
Activity 3	All that Glitters is not Gold	225 min
Activity 4	Atomic Theory	450 min
Activity 5	Periodicity and the Periodic Table	300 min
Activity 6	Applications of Matter	75 min

Unit Planning Notes

The unit is laid out to accommodate the students' different learning styles, interests, and abilities. In order to assess and evaluate the students' knowledge/understanding, inquiry, communication and making connections (as laid out in the achievement chart - Grades 9-10), it is essential that all activities are completed. The timing of the activities is suggested; however, it may change based on student and teacher needs. Teachers should identify instances where students may engage in scientific inquiry that students could include in their Science World portfolio. (Appendix B)

Prior Knowledge Required

In this unit, students will apply their previous knowledge of matter. They have learned about the properties (*strength, flexibility, density*) of matter and the changes of matter (*both physical and chemical*) in previous grades. They have used the Particle Theory to describe the relationship between mass, volume and density.

Teaching/Learning Strategies

This unit has been designed to accommodate the students' different learning styles, interests, and abilities, through a variety of teaching and learning strategies (*teacher-directed lesson, teacher demonstration, student lab based inquiry, model building, research activity, independent study, collaborative learning, and group presentations*).

Assessment/Evaluation

In this unit, student achievement of the expectations is evaluated based on a variety of assessments, tools and strategies. Assessment strategies used include: teacher-student conferences, formal teacher observations, roving conferences, peer conferences, self and peer assessment, pen and paper assessment, student logs, teacher logs and wrap-up activities. Sample rubrics and a collaborative group skills rating scale have been included for the science process, lab product, and generic product which may be adapted by teachers to assess and evaluate students. Rubric A3 was intended to be a framework from which teachers could develop specific rubrics to assess research projects and not to be used "as is". In addition, up to one period has been allotted for summative evaluation. The teacher, using her/his professional judgement, may wish to evaluate students through the use of pencil and paper test, a culminating project, a laboratory activity design/practicum and/or extension essay.

Resources

Print

Alyea, H.N. and Dutton, F.B.Tested "Demonstrations in Chemistry". Journal of Chemical Education Circulation Services (1965).

Candido et al. Heath Science Connections 9. Toronto: D.C. Heath, 1987.

Donovan et al. Chemicals in Action. 2nd ed. Toronto: Holt, Rinehart and Winston, 1995.

Humphreys, David A. Demonstrating Chemistry. Hamilton: McMaster University Chemistry Department, 1983.

Maton et al. Matter: Building Blocks of the Universe. New Jersey: Prentice Hall, 1994.

Ritter et al. Nelson 9. Toronto: ITP, 1995.

Summerlin, Lee R. and Ealy, James L. Jr.Chemical Demonstrations: A Source Book for teachers 1 and 2. Washington: American Chemical Society.

Crucible,Volume 30.3, January 1999

Scripture:
Psalms: 19: 2 - 7
29: 3 - 9
104: 1 - 35
148: 1 - 10

Romans: 1: 20
Col: 1: 15 - 17

Catechism of the Catholic Church
Section 337
339
340
341
344

Berry, Thomas. Befriending the Earth: A Theology of Reconciliation Between Humans and the Earth.. Mystic, Conn.: Twenty Third Publishing, 1991.

Videotapes

World of Chemistry Series, Magic Lantern (10 Meteor Drive, Toronto, M9W 1A4) 800-263-1717

Structure of the Atom, TVO Series

Befriending the Earth: Dream of Earth Sciences Series. Thomas Berry in dialogue with Thomas Clarke. Twenty Third Publications. 1990; 13 part series of videos. Mystic Conn.

Environmental Ethics: Ideas for Classrooms Discussion. Durango Col. Group for Telly Productions, 194.

CBC. News for Review: 1996 - 1998.

Internet

Minerals and Metals Sector Main Page, http://NRCan.gc.ca/mms/

Web Elements, http://www.webelements.com/

Periodic Table of the Elements, http://www.dayah.com/periodic/

Periodic Table of the Elements at Los Alamos National Laboratory, http://pearl1.lanl.gov/periodic/

Activity #1: Matter and its Properties

Time: 225 minutes

Description

Students will learn about physical and chemical properties through observation, experimentation, and the gathering of data. These properties will be used to describe and identify everyday examples of matter. Students will recognize that through grouping and classifying, matter becomes much easier to study and to understand.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2b,c,d,e; 3b,c,f; 4f; 5a; 7b,i,j.

Strand: Chemistry

Overall Expectations: At the end of Grade 9, students will: CHV.02

Specific Expectations: Students will: CH1.03⌘, CH1.04⌘, CH1.05⌘, CH1.13⌘, CH1.15⌘, CH2.01⌘, CH2.04⌘, CH2.06⌘, CH2.08⌘,CH2.09⌘

Planning Notes

- Review lab safety, consistent with your school board policy.
- Test demos ahead of time.
- Book computer lab for element assignment. Review the ethical use of the internet with your students.
- Students have experimentally explored density in Grade 8 but have not manipulated formulas. A worksheet that explains calculating density should be prepared.
- Prepare 18 vials each containing different samples of matter eg. salt, bluestone, alcohol, water etc.
- Prepare cards with the detailed qualitative description of each sample.

Prior Knowledge Required

- Matter is classified as homogenous or heterogeneous. (Grade 5 and 7).
- Matter exists in three physical states.
- Matter is described using qualitative and quantitative physical and chemical properties. (Grade 7)
- Density, the relationship between mass and volume is a quantitative physical property. (Grade 8).

Teaching/Learning Strategies

1. **Teacher facilitator will:**
   - introduce the terminology used to describe the physical properties of matter (physical state, colour, odour, taste, clarity, luster, form, texture, hardness, brittleness, malleability, ductility, viscosity)
   - review density and introduce formula for density calculation.

Student Activity

In pairs, students will participate in a scavenger hunt. The students will be provided with 18 different descriptions of matter, each one will correspond to the contents of one vial. Students will be given time to match the descriptions with the samples in the vials. The students will:

- examine the samples of matter (vials containing: salt, bluestone, alcohol, water etc.)
- match each vial with the correct description. Identify each sample.
- design a lab which will enable the identification of similar samples of matter.
- complete a worksheet on density problems.

2. **Teacher facilitator will:**
   - present a discrepant event: For example, take a cup of hot tea and stir it with a regular spoon and then with one molded from woods metal (a low melting alloy which can be obtained through a Chemical Supply Company). Have the students explain the different outcomes they observed. Discuss the desirable properties of utensils and what they are made of. A discussion of alloys would be appropriate at this point. It is the physical and chemical properties of a substance which are of interest.

   Student Activity:

   Students will design an experiment to test a variety of substances (wax, copper nitrate, carbon, salt, baking soda, and starch) for different physical and chemical properties.
   - relative melting point - heating a sample on a watch glass and assigning the value high (doesn't melt after 30 seconds) or low (melts before 30 seconds)
   - solubility - does a sample the size of a thumbnail dissolve in 50 mL of water.
   - reaction with water - a sample in water will sometimes change the appearance of the original sample.
   - combustibility - a sample in a deflagrating spoon will burn and produce a new substance.

   Students will complete their data tables and complete a written summary of the physical and chemical properties of each of the substances examined. From their observations they will be asked to explain the properties that make it desirable for its different uses. (i.e., carbon is used for charcoal)

3. **Teacher facilitator will:**
   - review the flowchart for classification.
   - review the use of a dichotomous key.

   Student Activity:
   - students complete an exercise on classifying substances based on composition.

4. **Teacher facilitator will:**
   - demonstrate the difference between elements and compounds using styrofoam models.
   - use a Venn diagram to illustrate the terms atom, element, compound, pure substance.
   - as a class, brainstorm definitions and examples of each.
   - have students prepare a table in their books using the headings element, compound. Give the students a list of substances with formulas to classify. (Nail, water, alcohol, etc)
   - examine the formula of compounds and determine atomic composition using the list of substances (vinegar, aspirin, etc.)

   Student Activity:
   - students will examine labels of common household products for chemical compounds.
   - using a chemical dictionary they can find the atomic composition and build 3-D models of some household products, using molecular model kits.

5. **Student Activity:**
   - students will compile data for the first twenty elements and other common elements, such as, iron , copper, etc., using the internet and print materials.

- students will assimilate all the information obtained for the elements on a fact sheet.(Element, Discovery or isolation: Chemist and year, Sources: World and Canada, Alloys, Uses, and Comments).
- each student will choose one element and prepare an element poster which can be used to construct a class periodic table.

Assessment/Evaluation

- The student's ability to design an experiment, carry it out using proper lab technique and safety considerations will be assessed for inquiry, through roving conference (informal student teacher interaction) using process rubric (Appendix A1). Note: The teacher may adapt process rubric A1and/or prepare appropriate checklists or rating scales in advance to meet the specific lab requirements. (CH1.03, CH1,15, CH2.01, CH2.02, CH2.08)
- The student's ability to record observations and explain results may be assessed for knowledge, understanding, inquiry, and communication. The teacher can assess observation charts and /or lab reports by adapting the lab product rubric (Appendix A2)(CH1.03, CH1.15. CH2.02, CH2.06, CH2.08).
- In the construction of a molecular model, the student will be assessed for knowledge, understanding, inquiry, and communication. The teacher will construct a specific product rubric using Appendix A3 as a guideline.(CH1.12, CH2.09)
- Individually the student will demonstrate independent learning through their research of an element, this can be assessed through a teacher log. They collaborate with the class to produce a final periodic table which will be assessed using a process and product rubric as outlined in Appendix A1 and A2. (CH1.03)
- Students' knowledge, understanding, and communication may be assessed using summative evaluation, paper/pencil test. (CH1.04, CH1.05, CH1.13)

Resources

1. Heath Science Connections 9
2. Internet
3. Prentice Hall, Matter

Accommodations

1. Where the student has an individual educational plan, IEP, this activity will be modified to meet the student's needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities. In this activity the students may carry out the following :
   - Your school is running a Science Olympics. This contest asks you to build and race a concrete boat. How would you be able to accomplish this feat? (**Possible Science World Idea**)
   - Alloys have characteristics different from the metals of which they are composed. These new substances are vital to many technologies. The search for suitable materials in the dental field is ongoing. The standard dental amalgam was made of silver, tin, copper, and zinc which

was then mixed with mercury. One of the side effects was mercury poisoning. Research the development of amalgams in the dental industry. (**Possible Science World Idea**)

Activity #2: Physical and Chemical Changes

Time: 300 minutes

Description

Through lab inquiry the student will be able to distinguish between physical and chemical change and describe the evidence for chemical changes. Also, the students will gain the background knowledge and skills necessary to formulate hypotheses, to design a lab activity, and to conduct the lab based inquiry using the electrolysis apparatus effectively, safely, and accurately.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2b,c,d,e; 3c; 4f; 5a; 7b.

Strand: Chemistry

Overall Expectations: At the end of Grade 9, students will: CHV.02

Specific Expectations:
Students will: CH1.04⌘, CH1.14⌘, CH2.01⌘, CH2.03⌘, CH2.05⌘, CH2.06⌘

Planning Notes

- Make sure all materials and solutions for the physical and chemical change lab are prepared in advance.
- Make sure all equipment necessary for the electrolysis apparatus, including a power source for each group is available.
- Thoroughly check each group's lab preparation for completeness and safety considerations before they are allowed to proceed with their lab inquiry.
- In order to have less reliance on formal lab reports, it is suggested that students maintain a student data book in which data can be kept, and that the teacher can assign lab reports on an "as need" basis from time to time. The data book would have to be collected periodically to check for completeness.

Prior Knowledge Required

The student should have an understanding of matter, states of matter, changes of state, and properties of mixtures, and solutions.(Grade 7)

Teaching/Learning Strategies

1. **Teacher facilitator will:**
   - review and discuss formal lab write up procedures.
   - review lab procedures and make students aware of proper safety and disposal procedures.

Student activity:

- Students will conduct a lab investigation where they perform a variety of experiments to illustrate physical and chemical changes. Through their observations, they will describe the evidence for chemical change (*e.g. changes in colour, production of a gas, formation of a precipitate, production or absorption of heat, production of light)*. They should demonstrate knowledge of laboratory safety, disposal procedures, and be aware of WHMIS guidelines, emergency procedures, and proper handling. A suggested activity is *Observing Physical and Chemical Changes* (Nelson 9, pg. 156-157),

2. **Teacher facilitator will:**
   - use specific examples from previous lab activities to review the terms: physical and chemical properties.
   - given gas bottles containing hydrogen, oxygen, and carbon dioxide, have students describe the physical properties of these gases. Based on knowledge of the chemical properties of these three gases, have students suggest chemical tests for the teacher to demonstrate.
   - demonstrate the set up and use the Hoffman apparatus or a simple electrolysis apparatus.
   - have students, plan an experiment to:
     (a) gather and record qualitative and quantitative data to investigate the ratio of the gases produced by the electrolysis of water
     (b) identify the gases produced by the electrolysis of water.
   - check each group's lab preparation for completeness and safety considerations and allow students to begin conducting their investigation.
   - monitor students' progress and adherence to procedures and safety.

   Student Activity:

   In pairs, the students will:
   - make predictions about the type of gases produced, and the ratio of the gases produced by the electrolysis of water.
   - write a complete, concise, and logical procedure to test their hypothesis. Include a complete list of materials, any safety considerations, and a labeled drawing of the apparatus. Have teacher facilitator approve their procedures.
   - perform the experiment by: following the experimental procedures, properly using the electrolysis apparatus, showing an awareness for safety and WHMIS guidelines, completing the procedures within the time, and allowing time for proper clean up and return of all materials and equipment.
   - discuss their experimental results in the lab write-up to explain how their data supports or refutes their initial hypothesis. Suggest ways for improvement.
   - submit a complete lab report, including tables of qualitative and quantitative data using appropriate format, discussion and conclusion.

Assessment/Evaluation

- The student's ability to plan an experiment, carry it out using proper lab technique and safety considerations will be assessed for inquiry, through roving conference (informal student teacher interaction) using process rubric (Appendix A1). Note: The teacher may adapt process rubric A1and/or prepare appropriate checklists or rating scales in advance to meet the specific lab requirements. (CH2.01)
- The students' ability to describe evidence of a chemical change will be assessed for inquiry and knowledge/understanding using both the process rubric (Appendix A1) and product rubric (Appendix A2)
- In the electrolysis of water investigation, the student's ability to make predictions, record observations and explain result may be assessed for knowledge, understanding, inquiry, and communication. The teacher can assess observation charts and /or lab reports by adapting the lab product rubric (Appendix A2) (CH1.04, CH1.14, CH2.01, CH2.03, CH2.05, CH2.06)

Resources

1. Alyea, H.N. and Dutton, F.B. Tested Demonstrations in Chemistry
   Summerlin, Lee R. and Ealy, James L. Jr. Chemical Demonstrations: A Sourcebook for teachers
2. Humphreys, David A. Demonstrating Chemistry
3. Nelson Science 9, pp 156-157
4. Nelson Science 9, pp 158-159
   Heath Science Connections 9, pp141-143

Accommodations

1. Where the student has an individual educational plan, IEP, this activity will be modified to meet the students needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.

Activity #3: All that Glitters is not Gold

Time: 225 minutes

Description

In this activity the students will research and describe methods used to extract elements in Canada and outline the associated religious, economic, and environmental considerations. The purpose of this research is to provide the students with the opportunity to acquire some of the scientific and technological knowledge required to make informed and ethically sound decisions and to consider their responsibilities as informed Catholic citizens.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2b,c,d; 3b,c,f

Strand: Chemistry

Overall Expectations:
At the end of Grade 9, students will: CHV.03

Specific Expectations: Students will: CH3.O1⌘, CH2.04⌘

Planning Notes

- Discuss the assignment with the teacher librarian or library technician at least two weeks before presenting the assignment to the class. Book the resource center for two days. Note: If the library in the school is not available, the teacher should pre-assemble the required resources (vertical files, journals, magazines, videos, etc.) in the room before the activity starts.
- Ensure that plenty of resources are available.
- Ensure that Internet access is available and that students are reminded of the ethical use of the Internet and other information technology resources. Note: Limited access to the Internet can be overcome by the use of a "webwhacker" program.
- If your geographic community relies on mining and refining processes ensure that community links are made.(i.e., tours, phone interviews, presentations, guest speakers,surveys)
- Present the research topic to the class, discussing the refining process, possible environmental, ethical, and economic problems and their responsibility as Catholic citizens.(Appendix C1,C2,D1)
- It is suggested that two consecutive periods be used for research and that the presentation be done at a later date giving students time to complete their research and assignment.
- Teacher may adapt Appendix D1 to suit students' needs, and to ensure a variety of presentation vehicles, the student research may be presented as a research paper, poster, or video presentation.

Prior Knowledge Required

- Library research skills. (Grade 7 and 8)

Teaching/Learning Strategies

1. **Teacher facilitator will:**
   - review inquiry and research skills.
   - introduce the research assignment on metallurgy: All that Glitters is not Gold (Appendix D1).
   - review and discuss what is meant to be a steward and that to be stewards one must act in a way that ensures the survival of life on the planet. (Appendix C1 and C2).
   - in service students on the use of the resource center, including Internet.

   Student Activity:
   In groups of four, students will work collaboratively to brainstorm their chosen topic for the assignment on metallurgy: All that Glitters is not Gold (Appendix D1). Once complete, the students should have the research outline approved by the teacher facilitator, and may begin research.

2. **Teacher facilitator will:**
   - answer any questions that may have resulted from the previous day's work, and have students continue to research their chosen topic.

3. **Teacher facilitator will:**
   - on the assigned due date, direct groups of students to present completed assignment to the class. Collect completed assignment.

Assessment/Evaluation

- Students' ability to research, work collaboratively with peers and teacher, focus and solve problems and recognize relevant information, can be assessed for knowledge/understanding,

inquiry, communication and making connections using a process rubric (Appendix A1) and rating scale (Appendix A4) (CH2.04, CH3.01)

- Students will collaborate to produce a pamphlet. The teacher will assess these for inquiry, knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3) making sure to incorporate creativity, originality, Catholic teaching and scientific information. (CH2.04, CH3.01)
- Through the presentation the student integrates knowledge, skills, values and attitudes. The teacher will assess this for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3), making provisions for creativity and originality. (CH2.04, CH3.01)

Resources

1. Minerals and Metals Sector Home Page, http://NRCan.gc.ca/mms/

Accommodations

1. Where the student has an individual educational plan (IEP), this activity will be modified to meet the students needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities. In this activity the students may carry out the following::
   - Air contains sulfur compounds as a result of natural and human activities. These compounds react with silver to form black silver sulfide which adheres to the silver surface. Investigate different methods for removing tarnish. (cyanides, polishes and oxidation-reduction reactions)(**Possible Science World Idea**)
   - Aluminum is refined by electrolysis of aluminum oxide using the Hall process. Canada is a major producer of aluminum despite the fact aluminum oxide is not found anywhere is this country. Explain. (Hint: Where are the three main aluminum smelters located in Canada?) **(Possible Science World Idea)**
   - Research and define the term “quality of life” and identify/enumerate values that enhance the human life and the environment.(**Possible Science World Idea**)

Activity #4: Atomic Theory

Time: 450 minutes

Description

The purpose of this activity is to introduce students to Scientific Theories and Models, and through a black box experiment show the importance of indirect observation and the usefulness of models. Students will review the postulates of the Particle Theory and use the Particle Theory of Matter to explain observations and make predictions. The students will work collaboratively in groups of four

to research and present the development of the Atomic Theory. Lastly, students will draw the Bohr diagrams of the first 20 elements and their corresponding ions.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2b,d; 3b,c

Strand: Chemistry

Overall Expectations: At the end of Grade 9, students will: CHV.01

Specific Expectations: Students will: CH1.01⌘, CH1.02⌘, CH1.06⌘, CH1.07⌘, CH2.04⌘, CH2.07⌘,CH2.10⌘, CH3.03⌘

Planning Notes

- Prepare plasticine black boxes in advance for *Building a Model for a Black Box*.
- The research activity can be done either in the resource center or in the classroom. The teacher should collect as many resources (i.e. texts, videos) as possible and have them available for student research. The activity should be presented as an upcoming Science Conference where each scientist's research team will present its latest findings. During the first period the groups should brainstorm, divide their tasks, and begin their research. The second period should be used for finalizing written work, organizing their presentations and constructing models. In period three, the day of the conference, the research teams will make their presentations and submit final products.

Prior Knowledge Required

- Definition of matter, states of matter, changes of state, energy involved in changes of state, diffusion. (Grade 5)
- An understanding of the Particle Theory of Matter. (Grade 7)
- Research skills (Grades 7, 8)

Teaching/Learning Strategies

1. **Teacher facilitator will:**
   discuss the need for scientific models.
   Student Activity:
   Students will carry out *Building a Model for a Black Box* (Heath Science Connections 9, pp 74-75) in order to state the characteristics and usefulness of scientific models.

2. **Teacher facilitator will:**
   review and summarize the statements of the Particle Theory of Matter.
   Student Activity:
   Students will carry out the think/pair/share activity on the Particle Theory of Matter. (Appendix D2)

3. **Teacher facilitator will:**
   introduce the research assignment on The Development of the Atomic Theory. (Appendix D3)

Student Activity:
Each research team (groups of four students) will work collaboratively to brainstorm their chosen topic on The Development of the Atomic Theory (Appendix D3), and complete a research outline. Once complete, have the research outline approved by the teacher, and begin research.

4. **Teacher facilitator will:**
answer any questions that may have resulted from the previous day's work, and have students continue working on their assignment.

5. **Teacher facilitator will:**
   - direct research teams to present completed assignment to the class. (Appendix A3)
   - collect completed assignment.
   - give a quiz to assess the students' knowledge gained from the research and presentations.

   Student Activity:
   Write up News Story as take home wrap-up activity (Appendix D4)

6. **Teacher facilitator will:**
   - present a summary of the nuclear atom containing protons, electrons, and neutrons.
   - define and give examples of isotopes, ions, mass number, atomic number.
   - explain and demonstrate how to draw the Bohr diagrams for first twenty elements, and their corresponding ions.

   Student Activity:
   - In chart form, summarize the three major particles in the atom, their locations within the atom, their charges, and their relative masses.
   - Describe and draw the Bohr diagrams of the atom for the first twenty elements, and their corresponding ions.
   - Prepare element cards for the first twenty elements. (Chemicals in Action, Activity 6.6, pp 106- 107)

7. **Teacher Facilitator will:**
provide students with fact sheets on each of the technologies with which students can gather their information.
Student Activity:
Students will cooperatively review technologies (television, x-rays, nuclear medicine, nuclear power, electron microscopy), analyze, and prioritize their importance in everyday life. After the process, they will be asked to focus on one technology and write an essay on how the technology has changed the quality of life in Canada.

Assessment/Evaluation

- Students' ability to research, work collaboratively with peers and teacher, focus and solve problems, and recognize relevant information can be assessed for knowledge/understanding, inquiry, and communication, using a process rubric (Appendix A1) and rating scale (Appendix A4) (CH1.06, CH2.04,)
- Students will collaborate to produce a lab report based on their scientist's research. The teacher will assess this for inquiry, knowledge/understanding, communication, and making connections by adapting the lab product rubric (Appendix A2) making sure to incorporate accurate scientific information. (CH1.06, CH2.04)
- Students will collaborate to produce a fact sheet. The teacher will assess this for inquiry, knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3) making sure to incorporate creativity, originality, and accurate scientific information. (CH1.06, CH2.04)

- The teacher will assess student presentations for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3), making provisions for creativity and originality. (CH1.06, CH2.04)
- Students will collaborate to produce a News Story. The teacher will assess this for knowledge/understanding, communication, and making connections by using the evaluation in appendix D4 or adapting the product rubric (Appendix A3) (CH1.06, CH2.04)
- A quiz will assess the students knowledge gained from the research and presentations. (CH1.03, CH2.04)
- Students will produce an essay on a chosen technology. The teacher will assess this for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3), making provisions for creativity and originality. (CH3.03)
- Students' knowledge, understanding, and communication may be assessed using summative evaluation, paper/pencil test. (CH1.01, CH1.02, CH1.07, CH2.07, CH2.10)

Resources

1. • Heath Science Connection 9, pp 74-75; pp81-82
   • Nelson Science 9, pp 96-99

2. • Heath Science Connections 9
   • Chemicals in Action
   • World of Chemistry: The Atom, Magic Lantern Communications
   • TVO Series: The Structure of the Atom
   • Environmental Ethics : Ideas for Class-room Discussion; Durango Col. Group for Telly Prod. 1994.

3. See Resources 2

4. Chemicals in Action, Activity 6.6, pp 106-107

5. • Energy matters
   • The Extraordinary Chemistry of Ordinary Skills, Snyder

Accommodations

1. Where the student has an individual educational plan, IEP, this activity will be modified to meet the students needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities.

Activity #5: Periodicity and the Periodic Table

Time: 300 minutes

Description

Students will perform experiments using representative elements to classify elements as non-metals and metals and to exhibit trends. The development of the students personal periodic table will be accomplished by the classification of elements according to similarities in physical and chemical properties.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 1d; 2b,d,e; 4f; 5a,h; 7d

Strand: Chemistry

Overall Expectations: At the end of Grade 9, students will: CHV.02

Specific Expectations:
Students will: CH1.07⌘, CH1.08⌘, CH1.09⌘, CH1.10⌘, CH1.11⌘, CH1.12⌘, CH2.01⌘, CH2.02⌘, CH2.03⌘, CH2.04⌘, CH3.02⌘

Planning Notes

- Students need their Bohr cards from Activity 4
- Have blank and commercial periodic tables available
- Have chart paper and markers for graphing trends

Prior Knowledge Required

- lab safety skills
- graphing skills
- interpretation of graphs

Teaching/Learning Strategies

1. **Student Activity**
   Use atomic cards from Activity 4
   - State the relationship between the group number and the number of valence electrons.
   - State the relationship between the number of energy levels needed to place all the electrons and the row location.
   - Use Bohr models of the atom to explain some of the recurring or periodic properties of the elements.
   - Use a graph to illustrate trends within a family and across rows.
   - Observe the properties of various elements.
   - Examine the relationship between the elements' properties and their position on the periodic table.

2. **Teacher facilitator will:**
   - use a blank periodic table on an overhead to locate, name and number the groups and the rows in the periodic table.
   - using the periodic table, locate the atomic number and the atomic radius

   Student Activity
   Students will prepare a graph of data (atomic radius, reactivity, melting points, etc.) from the periodic table of elements within a family or period. Patterns illustrating periodicity will be found. Each pair of students will plot graphs for different variables for different periods and families. They can then analyze their graphs and compare their graphs with their peers.

3. **Student Activity**
   Students classify a variety of elements as metallic or nonmetallic based on qualitative tests. The properties that are to be examined are appearance, electrical conductivity, heat conductivity, melting point, lustre and hardness. Students will record their observations in their data book. The students will then input the observed properties onto their blank periodic table. They will find the uses of the elements based on their properties.

4. **Teacher facilitator will:**
   - demonstrate hardness and reactivity using Lithium and Sodium. Do not let students use these metals.
   - Show the video Chemical Families.

   Student Activity: "Family Ties"
   - Students will perform an activity which will compare the physical properties (hardness, malleability, lustre, state, density, melting point, boiling point) and the chemical properties of some representative elements. Suggested experiments are: reaction with water, reaction with acid, reaction with air.
   - Students will record observations in their data book.
   - Students will transfer information obtained to a blank periodic table.
   - Students will note trends.

Assessment/Evaluation

- Through graphing trends in the periodic table, the student makes connections between prior knowledge and new information and illustrates the ability to organize and interpret information. Teacher will assess inquiry, knowledge/understanding and communication by adapting a product rubric from Appendix A3. (CH1.09, CH1.10, CH2.04)
- The student will produce a completed periodic table which can be assessed for knowledge/understanding and inquiry using a product rubric (Appendix A3). (CH1.08, CH1.10, CH1.12)
- The student integrates knowledge, skills, and a cooperative attitude through the preparation, performance and reporting of lab inquiries. The teacher can adapt the process rubric (Appendix A1) and lab product rubric (Appendix A2) to assess and evaluate process and product. (CH2.01, CH2.02, CH3.02, CH3.03)
- The students' knowledge/understanding and ability to make connections about the periodic table may be assessed by a dry lab evaluation developed by the teacher where some properties of 12 unnamed elements are listed in a table. The actual elements are identified only by letters of the alphabet that do not refer to actual elements. The students can arrange the elements into the three families and answer questions. (CH1.10, CH1.11)

Resources

1. Chemicals in Action 2e, Activity 6.6

2. • Lincoln County Applied Chemistry Document
   • World of Chemistry The Periodic Table
   • Chemistry Series: Periodic Table and Periodicity
   • Chemical Families: Chem Study series

3. Samples of the first 20 elements (Boreal)

Accommodations

1. Where the student has an individual educational plan, IEP, this activity will be modified to meet the students needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities. In this activity the students may:
   • Examine the behaviour of different metals and their metal salts in order to develop the activity series. (**Possible Science World Idea**)
   • Acid rain has become a major concern today because it reacts with magnesium and calcium carbonates in the soil to form soluble magnesium and calcium salts. These salts cause the water to become hard. Test the water in your area for hardness. Investigate different methods used to remove hardness from water. (**Possible Science World Idea**)

Activity #6: Applications of Matter "Elements in Space"

Time: 75 minutes

Description

Students will compare the physical and chemical properties of elements and assess their potential uses in the international space station.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 4g; 5b,d,e,g,h

Strand: Chemistry

Overall Expectations: At the end of Grade 9, students will: CHV.02, CHV.03

Specific Expectations:
Students will: CH1.10⌘ CH1.15⌘ CH2.02⌘ CH2.04⌘ CH3.02⌘ CH3.04⌘

Planning Notes

- Book the resource centre for research
- Ensure the Internet is available.
- This activity can be planned as a link between the Chemistry and the Earth and Space units.

Prior Knowledge Required

- Properties and changes of matter in grade 5
- Mechanisms in grade 7

Teaching/Learning Strategies

Canada has played a significant role in the development of the international space station. The knowledge gained about matter and its properties can be applied to their uses in the construction of the international space station.

Student Activity:

- Students will work collaboratively in groups to study the physical and chemical properties of elements, alloys, and compounds used on a space station.
- In groups of four, students will choose a topic. Suggested topics are: development of material used for structures in space, development of material used for clothing in space, materials used for fuels
- The students will research the use of elements, alloys, compounds in their selected topic.
- The students will present their topic in the form of a bulletin board.
- Research a career that one could pursue in space technology. Prepare a list of questions to be used in an interview with an astronaut or space engineer.
- Identify contributions that Canada has made to space research.

Assessment/Evaluation

- Students' ability to research, work collaboratively with peers and teacher, focus and solve problems, recognize relevant information, can be assessed for knowledge/understanding, inquiry, communication and making connections, using a process rubric (Appendix A1) and rating scale (Appendix A4) (CH1.10, CH1.15, CH2.02, CH2.04, CH3.03, CH3.04)
- Students will collaborate to produce a bulletin board. The teacher will assess this for inquiry, knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3) making sure to incorporate creativity, originality and accurate scientific information. (CH1.10, CH1.15, CH2.02, CH2.04, CH3.03, CH3.04)
- The teacher will assess student presentations for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3), making provisions for creativity and originality.(CH1.10, CH1.15, CH2.02, CH2.04, CH3.03, CH3.04)
- The student will produce career related questions. The teacher will assess these for knowledge/understanding, communication, and making connections by adapting the product rubric (Appendix A3). (CH3.04)

Resources

Websites:

- Canadian Space Resource Centre: www.spacenet@eybe.edu.on.can
- NASA website: www.nasa.gov/(links to educational resources and to information on space missions, shuttle flights, launch information)

Accommodations

1. Where the student has an individual educational plan, IEP, this activity will be modified to meet the students needs as outlined in the plan.
2. For ESL/D, students will have opportunities to demonstrate their learning by alternative means while written English is developing (spoken English, direct demonstration and pictorial representation). At the same time, instruction in written, science-specific language will continue.
3. For students with physical or learning impairments, classroom and laboratory activities will be modified to permit participation regardless of the impairment. Where possible, peers will be encouraged to assist the student to permit participation in all group and individual activities.
4. For the purpose of providing extensions and enrichment, students will have opportunities to investigate the topics presented here in greater detail. Close collaboration between teacher and student is required to ensure appropriate enrichment opportunities.

Unit # 2: Physics: The Characteristics of Electricity

Time: 27.5 hours *(22 periods of 75 minutes each)*

Unit Developers

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Development Date: April 1, 1999.

Unit Description

In this unit students will describe and apply models of static and current electricity, design and conduct investigations into electrical circuits found in everyday life and into the quantitative relationships among current, potential difference and resistance. Students will also evaluate the social, economic, ethical and environmental costs and benefits arising from the methods of electrical energy production used in Canada. This unit should follow the Chemistry Unit which develops models of the atom to aid in understanding the electrical nature of matter. It should be followed by the Earth and Space Sciences Unit, since much of the understanding of the universe has come from the application of the knowledge of electricity.

Strand & Expectations

Ontario Catholic School Graduate Expectations:
CGE1d; 2a, b, c, d, e; 3b, c, f; 4a, b, e, f; 5a, e, f, g; 7a, b, i.

Strand: Physics

Overall Expectations: PHV.01, PHV.02, PHV.03

Specific Expectations: PH1.01 to PH1.13, PH2.01 to PH2.11, PH3.01 to PH3.03

Activity Titles (Time + Sequence)

Activity 1	Introduction to Properties of Static Electricity	75 min
Activity 2	Charging by Friction, Contact and Induction	150 min
Activity 3	Voltaic Cells and other sources of Current Electricity	225 min
Activity 4	Properties of Circuits 1: Loads in Series and Parallel	150 min
Activity 5	Properties of Circuits 2: Cells in Series and Parallel	150 min
Activity 6	Properties of Circuits 3: Resistance in series and parallel	300 min
Activity 7	Energy and Efficiency of Conversion	225 min
Activity 8	Alternative Energy Sources	300 min

Unit Planning Notes

This unit emphasizes the flow of concepts from the particle theory as the basis for electrical phenomena to applications of electricity as well as the implications for society of the excessive use of electricity. Teachers are required to teach the proper use of electrical meters. It is advisable that overhead demonstration meters are available to show students how to read meters correctly. Alternately, digital multimeters are very easy to read but require increased caution in use since they must be adjusted depending upon their intended use. In order to efficiently plan for Activity 8, the research project, teachers must introduce the parameters of the project early in the unit, particularly if a student presentation will be required. Teachers should collect Energuide information in order to have available information about the efficiency of appliances. Teachers should help students become aware of Church documents and the Catholic perspective on the role of humans in the environment as stewards of the world's resources. Catholic teaching on this issue could be reviewed with the assistance of the school's Religious Education department. (Refer to Appendix C: A Catholic Perspective on the Applications of Science: Guiding Principles) In addition, for summative evaluation, up to one period may be allotted. The teacher may wish to evaluate students through the use of pencil/paper test, culminating project, a laboratory activity design/practicum and/or extension essay.

Prior Knowledge Required

In grade 6 students have studied the basic concepts of electricity, including the sources of static electricity and the difference between static and current electricity. Students have also designed and constructed simple electrical circuits that transform electricity into other forms of energy. The students should also have the knowledge of the atomic structure of matter from the unit on Chemistry: Atoms and Elements. Knowledge about the correct procedure for identifying and controlling variables is assumed from previous science courses. Students should also have knowledge of the proper use of the library and the ethical use of the Internet for research work. Teachers should spend time reviewing the previous expectations and provide opportunities for extra help as needed.

Teaching/Learning Strategies

The teaching and learning strategies suggested for use in delivery of this unit include teacher demonstration, student experimentation, library research and a field trip to a generating station or a local Public Utility site. A neighbourhood walkabout to view electrical connections and services to homes or businesses from local electrical lines is recommended as an introduction to the unit. Teachers should identify instances where students may engage in scientific inquiry/experience that students could include in there Science World portfolio (see Appendix B).

Assessment/Evaluation

In this unit, student achievement of the expectations is evaluated based on a variety of assessments, tools and strategies. Assessment strategies used include: teacher-student conferences, formal teacher observations, roving conferences, peer conferences, self and peer assessment, pen and paper assessment, student logs, and wrap-up activities. Sample rubrics and a collaborative group skills rating scale have been included for the science process, lab product, and generic product which may be adapted by teachers to assess and evaluate students. Rubric A3 was intended to be a framework from which teachers could develop specific rubrics to assess research projects and not to be used "as is". In addition, for summative evaluation, up to one period may been allotted. The teacher may wish to evaluate students through the use of pencil/paper test, a culminating project, a laboratory activity design/practicum and/or extension essay.

Resources

Print

Andrews et al. Science 10 An Introductory Study. Canada: Prentice Hall, 1987.

Candido et. al. Heath Science Connections 10. Canada: D.C. Heath, 1988.

Rosen, S, Science Workshop Series: Physical Science: Volume: Electricity & Magnetism. Cambridge, Canada.

Hirsch et al. Science Explorations 10. Toronto: John Wiley & Son, 1987.

Martindale et al. Fundamentals of Physics: An Introductory Course. Toronto: D.C. Heath, 1987.

Liem, T.L. Invitations to Science Inquiry. 2nd ed.

Videotapes

Bill Nye The Science Guy Series "Static Electricity" and "Electrical Current"

Physical Science Series "Electric Current and Circuits" and "Electricity and Magnetism"

Physical Science II Series "Static and Current Electricity"

These videotapes are available from Magic Lantern Communications Ltd

Computer Software

Word Processing Programs such as MS Word or Word Perfect
Multimedia presentation tools such as Microsoft PowerPoint or Lotus Freelance Graphics
Spreadsheet Programs such as QuattroPro or Excel
Various Internet sites

Activity # 1: Introduction to Static Electricity

Time: 75 minutes

Description

Through the use of a variety of demonstrations, students will be introduced to static electricity as a natural phenomenon. By observing static discharge (e.g. from a Van de Graaff machine or Wimshurst machine), students will recognize lightning as a natural occurrence of static electricity. Discussion of common uses of static electricity such as in a photocopier, anti-static sprays, plastic wraps that cling to bowls, static strap for cars, static straps for sensitive electronics and other devices will allow students to see the potential application of our knowledge of the properties of static electricity. By reviewing the atomic theory and Bohr-Rutherford model of the atom, students will make the link between static electricity and matter.

Strands and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2a,b,c; 3b,c,e; 4b

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.01,

Specific Expectations: Students will: PH1.03, PH2.03⌘, PH3.01⌘, PH3.03⌘

Planning Notes

- Use a variety of demonstration items that will link to practical applications of static electricity. Some useful ones may be the Van de Graaff generator, Wimshurst machine, anti-static sprays and laundry sheets, plastic wrap that clings to ceramic bowls but not to plastic bowls.
- Make links to other strands in this course, (e.g. Chemistry Strand, Earth and Space Strand).

Prior Knowledge Required

- Understanding of the structure of the atom.
- Understanding of the scientific model of inquiry

Teaching/Learning Strategies

1. The students will brainstorm various instances in which they have experienced static electricity.
2. The students will be given the opportunity to produce static electricity using various materials and to design an experiment to rate the strength of the static charge.
3. The teacher will demonstrate electrostatic discharge using a device such as a Van de Graaff machine or a Wimshurst machine. Students will observe the demonstration then discuss where they have experienced this type of discharge in their own personal lives.
4. The teacher will describe other applications of static electricity, and wherever feasible, demonstrate such applications.

- Through observation and think/pair/share activity, students will be able to describe everyday devices that attempt to deal with static charge such as lightning rods, electrostatic air filters, anti-static sprays or sheets for clothing and static discharge straps for automobiles.
- Students will write a short explanation of how they believe each of these devices work.

5. Students will review the Bohr-Rutherford model of the atom and through brainstorming in groups they will propose a hypothesis attempting to explain which part of the atom is responsible for creating a charge through its mobility.

Assessment/Evaluation

- Students' ability to design an experiment will be assessed for inquiry using the process rubric A1 (PH2.03).
- Student explanations of static electricity may be assessed and evaluated for knowledge/understanding using observation of the think/pair/share activity and a review of the written explanations. (PH3.01, PH3.03)
- Student explanations of the operation of various devices may be assessed and evaluated for knowledge/understanding and making connections by means of a pen and paper quiz.(PH3.01, PH3.03)

Resources

1. William A. Andrews et al. Science 10 An Introductory Study Toronto: Prentice Hall 1987
2. Hirsch et. al. Science Explorations 10 Toronto: John Wiley & Son 1987

Accommodations

1. Where the student has an IEP, this activity will accommodate the modification(s) as outlined in the IEP plan.
2. Students will have opportunities to demonstrate their learning by alternate means while written English is developing. At the same time, instruction in written, science-specific language must continue.
3. Classroom/laboratory facilities will be modified to permit participation, regardless of impairment, in group and individual activities. Where possible, peers will be encouraged to assist in these accommodations.

Activity # 2: Charging by Friction, Contact and Induction

Time: 150 minutes

Description

This activity should span at least two, if not three, 75 minute periods and requires students to perform at least two separate lab based activities. Students will learn the methods by which a static charge may be transferred between two objects using a pithball electroscope. In particular students will learn the characteristics of a charge transmitted by contact versus one transmitted through induction. Students will first study the characteristics of electrostatic charges using a pith ball electroscope charged by contact. Comparing charge by contact to charge by induction will then follow, using a metal leaf electroscope. In addition, through the use of diagrams, students will apply theoretical information to generate a plausible explanation of the observations made. Finally

students will be able to explain how we use this knowledge in practical daily life by discussing how charges are placed on paper for photocopying or dust for electrostatic air filtration.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2a,b,c; 3b,c,e; 4b

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.01

Specific Expectations:
Students will: PH1.01, PH1.02⌘, PH1.03, PH2.03⌘, PH2.05⌘, PH2.06⌘, PH2.09⌘

Planning Notes

- Use everyday examples for deriving static charge, (balloons, combs, sweaters, etc.)
- Relate to phenomena described in other units such as Earth and Space Systems grade 5 Weather Unit.
- The teacher may wish to have a wide range of common objects made from a variety of materials as an extension of the theory learned in this activity. See Teaching and Learning Strategy # 4 below.

Prior Knowledge Required

- Familiarity with the Bohr-Rutherford model of the atom.
- Familiarity with the Electron Theory of charge.
- Familiarity with the properties of Electrostatic charges.

Teaching/Learning Strategies

1. Students will
   - review the characteristics of the atom as they relate to electrostatic charge.
   - write a short explanation of the structure of the atom and how subatomic particles such as electrons and protons contribute to charge.

2. Students will
   - perform an activity using a pithball electroscope, charged by contact, to experience the behaviour of charged objects with others of like, opposite or no charge.
   - follow up on the hypothesis generated in Activity 1 regarding the part of the atom responsible for creating a charge by testing the hypothesis and recording the data in an acceptable format such as a student journal, an activity log or a notebook.
   - analyze the data and use it to develop the main ideas of the theory of electric charges.
   - using drawings and '-' and '+' signs, students will diagram their understanding of events as observed with the pithball electroscope.

3. Teachers will review the material provided by the students and use it to develop the concept of "induced" charge. In this way, students will be led to develop a working definition of a good conductor versus a good insulator. In addition, teachers will explain how this induction of charge results in a temporary realignment of electrons which can be used to place a permanent charge on an object.

- students will be able to describe an "induced" charge as a temporary charge created through the mobility of electrons and the proximity of a charged object.
- students will explain that a conductor is a material that allows the free movement of electrons and an insulator is a substance that restricts the flow electrons.
- students will define charge as either a deficit or excess of electrons.

4. Students will use the metal leaf electroscope as a device to test the charge on an object and develop their skills in placing a charge on the electroscope either through induction or by contact.
   - Students will apply the theoretical knowledge derived above to the metal leaf electroscope. They will place both a negative and a positive charge on the electroscope by contact. They will observe the behaviour of the leaves as charged objects with the opposite, like or neutral charge are brought near to, but not touching the electroscope. They will record their observations in an organized and acceptable manner
   - Students will use diagrams to depict the position of the leaves and the relative distribution of electric charge as each item is brought next to the charged electroscope.
   - Students will then charge the electroscope, both positively and negatively through induction. They will repeat the tests conducted above and record their observations in an organized and acceptable manner.
   - Students will compare the process of charging an electroscope by induction to contact. Using diagrams, students will depict the orientation and relative charge on the leaves of the electroscope during each stage of the charging process.

5. Students will write formal lab reports outlining their activities, observations and discussing the relevance of their data to the hypotheses they developed.

6. Students may extend their understanding of matter and static charge by testing a variety of common materials to determine an electrostatic series for the materials used. **(Possible Science World Idea)**

7. The teacher may take this opportunity to draw the students' attention to some of the psalms that refer to the wonders of nature as a sign of God's presence and wisdom (Psalms 19:2-7; 29:3-9; 104:1-13; 148:1-10) as well as the work of poets such as Gerard Manley Hopkins (a Jesuit priest) who said "The world is charged with the grandeur of God."

Assessment/Evaluation

- Teachers could assess students' knowledge/understanding of the behaviour of electrical charges by reading the students' journal or activity log. (PH1.02,PH2.03,PH2.05,PH2.06)
- Student lab reports will be assessed and evaluated for inquiry and communication using the lab product rubric found in Appendix A2. (PH2.05, PH2.09)

Resources

1. William A. Andrews et al. Science 10 An Introductory Study Toronto: Prentice Hall 1987
2. Hirsch et. al. Science Explorations 10 Toronto: John Wiley & Son 1987

Accommodations

1. Where the student has an IEP, this activity will accommodate the modification(s) as outlined in the IEP plan.

2. Students will have opportunities to demonstrate their learning by alternate means while written English is developing. At the same time, instruction in written, science-specific language must continue.
3. Classroom/laboratory facilities will be modified to permit participation, regardless of impairment, in group and individual activities. Where possible, peers will be encouraged to assist in these accommodations.

Activity # 3: Voltaic Cells and Other Sources of Current Electricity

Time: 225 minutes

Description

In this activity, students will expand and refine their concept of current electricity by an extension of the water analogy. They will formulate operational definitions of potential difference and current. The SI metric units for measuring these quantities will be introduced. Students will be given an opportunity to view the construction of wet and dry cells and verify that they are sources of electric current by the use of suitable current detectors such as a galvanometer. They will conclude the activity by identifying and comparing various other conventional sources of electricity.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2a,b,c,d,e; 3b,c,f; 4a,b,e,f; 5a,e,f,g; 7i

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.01

Specific Expectations
Students will: PH1.03⌘, PH1.04⌘, PH1.13⌘, PH2.01⌘, PH2.06⌘, PH2.07⌘

Planning Notes

- Students will probably grasp the concept of current(I) more easily than potential difference(V). Alternative analogies could be employed as required. The term "voltage" may be introduced as a synonym of "potential difference".
- Students will be given an opportunity to observe and manipulate several examples of "wet" and "dry" voltaic cells of various types.
- Three or four stations displaying a different type of cell may be set up throughout the classroom or resource centre. Each station should have a guide sheet and a galvanometer for students to be able to verify that the cells produce a current.

Prior Knowledge Required

- grade 6 electricity unit specific expectations
- knowledge of the difference between static and current electricity
- an understanding of the role the electron plays in the transmission of electric charge

Teaching/Learning Strategies

1. Through a suitable cooperative learning strategy such as “brainstorming”, “think/pair/share”, and/or “role-playing”, students will identify and illustrate the role the electron plays in the transmission of electric charge through a solid conductor (i.e. metal wire). A distinction will have to be made between “conductors” and “insulators” with examples given.

2. Students will be provided with the following definitions that they will add to their student journal or notebook:
   - current (I) as the rate of flow of electrons through a conductor, noting that the SI metric unit for current is the ampere, A
   - potential difference (V) as the amount of energy possessed by the electrons flowing through a conductor, noting that the SI metric unit for potential difference is the volt, V

3. The teacher will introduce the voltaic cell as a primary source of current electricity that uses chemical energy to separate electrons from atoms.

4. Students will be provided an opportunity to observe and manipulate various voltaic cell types that have been set up throughout at workstations throughout the classroom. Stations could have the following:
   - a wet primary cell (metal electrodes in dilute acid solution)
   - a potato or lemon wet cell
   - a variety of dry cells (cut in half if possible to show cross-section). AAA, AA, C, D, C, NiCd, and lantern cells may be displayed.

   For each cell, students may verify that the cell produces electric current by providing a correct size analog meter such as a galvanometer.

5. The teacher will distinguish between a single “cell” and a “battery” of cells. Students will enter these terms into their student journal or notebook.

6. Students will be introduced to a suitable co-operative group sharing strategy such as the “jigsaw” technique. They will be assigned group membership and will spend a period in the library to begin research to identify and compare the social and environmental risks and benefits associated with other conventional sources of current electricity such as secondary cells, hydroelectricity, fossil fuel generated thermal power, or nuclear power generation. If the school library is not available teachers should collect resources for classroom use.
   - The teacher will guide the students to focus their research efforts on issues regarding conservation and recycling of non-renewable electrical energy sources and the impact these have on our environment in light of our role as Stewards of God’s Creation (Catholic Citizens of a global community). (Refer to Appendix C for additional information.) Students should explore practical ways of conserving energy at home and at school.
   - Students may employ a variety of print, audio-visual, or electronic (CD-ROM, and Internet) resources to gather information. Notes on pertinent discoveries will be entered into their science journals or notebooks for future reference in the sharing component of the jigsaw activity.
   - Students may produce audio-visual materials such as posters, overhead transparencies, pamphlets, etc. to use in the jigsaw sharing activity. Such products will be submitted for assessment after the sharing activity.

7. Students may extend this activity by continuing researching and/or experimenting on various wet or dry cells or other sources of electricity for entrance in a science fair. **(Possible Science World Idea)**

Assessment/Evaluation

- Teachers can evaluate student inquiry by observations of student participation in the laboratory based activities using process rubric A1. (PH2.01,PH2.07)
- Teachers can evaluate student communication by reading their journal or notebook and listening to their participation in the jigsaw activity. (PH1.13, PH2.06)
- Teachers can evaluate the posters or pamphlets produced for the jigsaw activity for knowledge/understanding using the product assessment rubric A3. (PH1.03, PH1.04, PH1.13)

Resources

1. William A. Andrews et al. Science 10 An Introductory Study Toronto: Prentice Hall 1987
2. Hirsch et. al. Science Explorations 10 Toronto: John Wiley & Son 1987
3. Liem, T.L., Invitations to Science Inquiry, 2nd Ed., page 260
4. Candido et al Heath Science Connections 10 Toronto: D.C. Heath 1988
5. Bennet, B., Rolheiser-Bennet, C., Stevahn, L. Cooperative Learning: Where Heart Meets Mind Toronto: Educational Connections 1991
6. Video Befriending the Earth Dream of the Earth Series Mystic Communications 1990

Accommodations

1. Where the student has an IEP, this activity will accommodate the modification(s) as outlined in the IEP plan.
2. Students will have opportunities to demonstrate their learning by alternate means while written English is developing. At the same time, instruction in written, science-specific language must continue.
3. Classroom/laboratory facilities will be modified to permit participation, regardless of impairment, in group and individual activities. Where possible, peers will be encouraged to assist in these accommodations.

Activity # 4: Properties of Circuits 1: Loads in Series and Parallel

Time: 150 minutes

Description

In this activity, students will investigate aspects of electric circuits. They will identify the basic components of a simple circuit composed of a D.C. source, a switch, a load (light bulb), and the necessary wire conductors. Students will construct circuits with loads in series and parallel, and conduct experiments that reveal the essential characteristics of such circuits. They will be expected to learn how to correctly connect a voltmeter in parallel with a component in order to measure the potential difference across that component and an ammeter in series with circuit components to measure current values. Students are expected to learn to draw and recognize common schematic symbols for basic circuit components.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2a,b,c,d,e; 3b,c,f; 4a,b,e,f; 5a,e,f,g; 7i

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.02

Specific Expectations
Students will: PH1.05⌘, PH1.06⌘ , PH2.01⌘, PH2.03⌘, PH2.06⌘, PH2.07

Planning Notes

- Remind students of lab safety rules regarding the use of electricity. They should be made aware of the sensitivity and fragility of analog electric meters and if using even low voltage variable power supplies, they should be prompted to zero the adjustment knob before turning the power on, then slowly increasing the power until the bulb(s) begin to glow (not too brightly). Alternatively various dry cells could be used.
- Circuit lab activities are best performed in pairs on uncluttered benches.
- Where large group presentations are performed, suitably sized meters should be used . Devices able to be projected onto a screen would be ideal.

Prior Knowledge Required

- grade 6 electricity unit specific expectations 07, 10, 12, 13, 14, 15, 16 (see The Ontario Curriculum Grades 1-8, MET)
- knowledge of voltaic (dry) cells as sources of potential difference and current.

Teaching/Learning Strategies

1. Students participate in a suitable role-playing activity involving the whole group that vividly illustrates the pathway electrons take through series and parallel circuits. Passing caps or balls from person to person could be one way of accomplishing this.

2. Students will be introduced to the voltmeter and ammeter as devices that measure current and potential difference respectively. A suitably sized device of each type will be displayed. The schematic symbol for voltmeter and ammeter should be introduced. The teacher will instruct students how to read each type of device in order to ensure the device's safety in future student centred laboratory activities.

3. The teacher demonstrates to the whole group the correct way to connect an ammeter (in series) and a voltmeter (in parallel) to a circuit in order to measure current and potential difference at various points in the circuit. Emphasize that the polarity of the meter connections must always correspond to the polarity of the source (i.e. positive terminal of voltmeter connected to positive side of the component). Fragility of the devices must be emphasized.

4. Students participate in an inquiry based lab activity investigating qualitative and quantitative characteristics of simple circuits with loads (light bulbs) in series and parallel. These activities are best done in small groups with real components. Computer-based simulation software is useful but not a replacement for exposure to and/or use of real components. If equipment is in limited supply, students could rotate through a series of workstations set up throughout the classroom. Students will be asked to connect various batteries and bulbs in order to make the bulbs as bright or as dim as possible. Then they will be asked to measure the voltage and current in various parts of the circuit and to explain what is happening according to the paths taken by electrons in Teaching/Strategy 1.

5. The teacher summarizes for students the schematic symbols for common circuit components. This may be done as a whole group mini-lesson using a suitable whole group method of delivery. Real components should be demonstrated in association with schematic symbols.

6. A simple circuit diagram may be displayed using schematic symbols for cell, light bulb, switch and wires (connected and overlapped). An equivalent circuit using real components may be demonstrated simultaneously. Students will enter sample schematic circuit diagrams into their science journals or notebooks for practice in drawing such diagrams.

7. Students may extend this activity by designing other possible circuits that perform specific functions such as security alarms. **(Possible Science World Idea)**

Assessment/Evaluation

- Teachers may assess students' inquiry skills by observing and conferencing with small groups while they attempt to perform the tasks in Teaching /Learning Strategy 4 using process rubric A1. PH2.01, PH2.03, PH2.07)
- Teachers may assess students' communication skills by allowing each group to present their method of completing the tasks Strategy 4 using a variation of the lab product rubric A2. (PH2.01, PH2.06)
- Teachers may assess student knowledge/understanding of electrical units and measuring techniques for electrical quantities by setting up a sample circuit and asking students to measure a specific quantity in the circuit at a specific location. (PH1.05, PH1.06)

Resources

1. William A. Andrews et al. Science 10 An Introductory Study Toronto: Prentice Hall 1987
2. Hirsch et. al. Science Explorations 10 Toronto: John Wiley & Son 1987
3. Candido et al Heath Science Connections 10 Toronto: D.C. Heath 1988

Accommodations

1. Where a student has an IEP, this activity will be modified as outlined in the plan.
2. While oral and written English is being developed, students may be provided opportunities to learn and demonstrate their learning by alternative means; spoken English, use of demonstrations, peer interpreters, pictorial illustrations, etc.
3. For physically impaired students, classroom/laboratory activities will be modified to permit participation regardless of impairment, where possible. The student's safety must remain a paramount concern. Furniture, equipment, and the physical setting may be modified to accommodate the student.
4. Extensions for enrichment may be provided through the encouragement of student participation in Science World activities that might extend their knowledge of electrical circuits to include a light controlled from either one of two switches in a circuit or an alarm that goes off when a circuit is broken.

Activity # 5: Properties of Circuits 2: Cells in Series and Parallel

Time: 150 minutes

Description

In this activity students will explore the effects on potential difference and current in circuits where cells are connected in series and parallel. They will conduct an inquiry-based laboratory activity where they measure the potential difference and current in the two arrangements.

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2b,c; 3c; 4a,b,d,e,f; 5a,b,e,f,g; 7b,j

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.02

Specific Expectations:
Students will: PH1.05, PH1.06, PH1.09⌘, PH2.01, PH2.03⌘, PH2.07⌘

Planning Notes

- review schematic circuit diagrams introduced in Activity #4
- review: connecting voltmeters and ammeters properly into a circuit (for the meter's safety)
- ruler drawings must be emphasized

Prior Knowledge Required

- successful completion of Activity 4

Teaching/Learning Strategies

1. Students conduct an inquiry lab activity in small groups where they connect several cells in series and parallel to produce the largest and the smallest potential difference and current in a circuit and then measure the values in each case using a voltmeter and an ammeter.
2. Students write reflections of laboratory activities into their science journals and prepare and submit an informal lab report on their findings for assessment.
3. Students may be given a black box containing unknown combinations of cells and asked to make measurements that enable them to deduce the possible connections,

Assessment/Evaluation

- Journal entries may be assessed for knowledge/understanding and communication according to a product assessment rubric similar to that in Appendix A1.
    - Can the student explain in his/her own words the difference between series and parallel connection of cells? (PH1.09)
    - Can the student identify the parts of a simple circuit and their schematic symbols?
    - Can students manipulate the numerical values?

- Teachers may assess student inquiry by means of observation of students obtaining the appropriate lab materials, care of assembly, constructing the required circuit and making the necessary meter readings as well as and the proper returning of equipment to its appropriate place in the class room. Assessment may be accomplished using the process assessment rubric in Appendix A1. (PH2.01, PH2.03, PH2.07)
- Teachers may assess students' knowledge/understanding of potential difference and current in series and parallel by observing the students' ability to identify the components in a black box. (PH1,05, PH1.06)
- Teachers may assess students' communication about series and parallel cells by collecting the students written procedure and student drawn circuit diagrams for their activity. This may be assessed with lab product rubric as in Appendix A2.

Resources

1. Science 10 An Introductory Study: Andrews et. al. Prentice Hall 1987
2. Heath Science Connections 10: Candido et. al. D.C. Heath, 1988, Canada
3. Science Workshop Series: Physical Science: Volume: Electricity & Magnetism Seymour Rosen, Prentice Hall Ginn Canada, Cambridge
4. See Circuits I

Accommodations

1. Where a student has an IEP, this activity will be modified as outlined in the plan.
2. While oral and written English are being developed, students will be provided opportunities to learn and demonstrate their learning by alternate means; spoken English, use of demonstrations, peer translators, pictorial illustrations, etc.
3. For physically impaired students, classroom/laboratory activities will be modified to permit participation regardless of impairment where possible. Peers will be encouraged to assist needy students. Suitable lab furniture, materials and apparatus will be provided.
4. Suitable extensions for enrichment will be provided as required.

Activity # 6: Properties of Circuits 3: Resistance in series and parallel

Time: 300 minutes

Description

Through experimental investigation, the student will gain an understanding of the relationship among electric current, potential difference, and resistance. They will measure the potential difference and the current in a simple series circuit for an ohmic resistor and plot a graph of the data in order to see that the resistance is the slope of the graph. Simple problems involving the relationship V=IR will be solved mathematically. Simple combinations of identical resistors in series and parallel will be investigated experimentally in order that students may come to know that overall resistance increases in a series circuit and decreases in a parallel circuit.

Strand and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: 2b,c; 3c; 4a,b,d,e,f; 5a,f,g; 7b,j

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.02

Specific Expectations: Students will: PH1.04, PH1.05, PH1.06, PH1.07⌘, PH1.08⌘, PH1.10⌘, PH2.02, PH2.07, PH2.08, PH2.11⌘

Planning Notes

- The use of the electrical meters was just completed as part of the previous activities, it would be convenient to use digital meters if possible for their accuracy and ease of reading. Two meters for each group would be convenient to avoid the need to change the configuration of the circuit, however one may be used if that is all that is available.
- The electrical symbol for resistance should be introduced as part of the activity .
- Use only ohmic resistors (not light bulbs) in order that the results will be linear.
- The concept for the relationship among these quantities will be explained by means of a water analogy, where the potential difference is the water pump, the current is the water flow and the resistance is the opposition to the flow of water due to restrictions of the diameter of the water pipe.

Prior Knowledge Required

- The knowledge of how to connect a simple electrical circuit based upon pictorial or schematic diagrams.
- The proper use of voltmeters in parallel and ammeters in series must be emphasized.
- The production of line graphs and determination slope either by hand or from a spreadsheet program.
- The solution of simple linear equations.

Teaching/Learning Strategies

1. Students will be given several resistors and asked to predict and then measure the resulting current with several different potential differences:
   - the students will plot a graph of potential difference versus current.
   - the students will determine the slopes of the resulting lines.

2. The teacher will lead a discussion of the results and introduce the equation V=IR:
   - the teacher will define the unit of resistance as the "ohm" (3) when the potential difference is in volts and the current is in amperes.
   - several examples of solving the equation for each unknown, given the other two, will be worked out.
   - the students will practice solving similar problems, working in small groups. One student from each group will be asked to present the solution and reasoning on the blackboard.

3. Students will be asked to predict the effect on the current of several resistors in series and parallel and then perform an experiment to check their predictions:

- students will compare quantitatively the effect of several identical resistors in series.
- students will compare quantitatively the effect of several identical resistors in parallel.

4. In their lab groups, the students will summarize the behaviour of electrical circuits with regards to resistance, potential difference and current by means of a water analogy

5. Students will be asked to suggest practical examples of resistors in series and parallel, e.g.; Why switches, fuses, and circuit breakers must be in series.

6. Students may also investigate the use of variable resistors in devices such as volume, brightness or contrast controls on televisions or other devices. **(Possible Science World Idea)**

Assessment/Evaluation

- The results of the experiment relating potential difference and current should be collected and assessed for inquiry and communication
  - are the results within the accuracy range of the resistor (usually 5%or 10%)?
  - is the graph a straight line?
  - are the slopes of the lines determined correctly? (PH2.11)
  - can the students correctly relate current and potential difference? (PH1.07)
- The teacher may assess the written lab report for knowledge/understanding and communication using the lab product rubric Appendix A2.

- The teacher may assess the students' knowledge/understanding of the relationship among resistance, potential difference and current by means of a pen and paper test:
  - successfully use the equation V=IR to solve for one of the variables if the other two are given (PH1.08)
  - use the water analogy to explain the concept of resistance in an electrical circuit
- The teacher may assess the students' knowledge/understanding of the effect of resistance in series and parallel by means of a performance task in which students are asked to reduce or increase the resistance in a given circuit by adding an additional resistor. (PH1.10)

Resources

1. Martindale et. al. Fundamentals of Physics: An Introductory Course: D.C. Heath 1987, Toronto
2. Candido et. al. Heath Science Connections 10: D.C. Heath, 1988, Canada
3. Rosen, S. Science Workshop Series: Physical Science: Volume: Electricity & Magnetism
4. Teacher created activity sheet or as found in the grade nine text book.
5. Various webs sites such as The Virtual Laboratory (http://physicsweb.org/TIPTOP/VlAB/) and use the necessary applets to reinforce this activity.

Accommodations

1. Where the student has an IEP, this activity will be modified to meet the student's needs as outlined in the IEP plan.
2. Students will have opportunities to demonstrate their learning by alternate means while written English is developing. At the same time, instruction in written, science-specific language must continue.
3. Classroom/laboratory activities will be modified to permit participation, regardless of impairment, in group and individual activities. Where possible, peers will be encouraged to assist in these accommodations.

Activity # 7: Energy and Efficiency of Conversion

Time: 225 minutes

Description

The teacher will make the student aware of the relationship among electrical energy transformed, power and elapsed time. Then through experimental investigation, the student will be asked to quantitatively determine the percent efficiency of an electrical device that converts electrical energy into heat energy in an electric kettle. Other examples will be discussed such as the conversion of electrical energy into sound energy or light energy.

Students will be expected to perform mathematical calculations involving the relationship $E=P\Delta t$ and *percent efficiency = (energy output/energy input) x 100%.*

Strand and Expectations

Ontario Catholic School Graduate Expectations:
The graduate is expected to be: 2 b, c, 3 c, 4 a, b, d, e, f, 5 a, f, g, 7 b, j

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.03 ⌘

Specific Expectations
Students will: PH1.06⌘, PH1.11⌘, PH1.12⌘, PH2.01, PH2.03, PH2.05, PH2.08⌘

Planning Notes

- Teachers should collect Energuide information about appliances in order that they have samples of energy consumption available for students to discuss.
- An electrical kettle and other electrical devices should be available in the class in order that data about energy consumption may be collected.
- Digital Electronic Balances are best in order to precisely measure the mass of the water in the experiment.
- Care should be taken when measuring the final temperature of the water inside an electric kettle. If the thermometer comes in contact with a hot element the thermometer may break. It is safer to use a hotplate and beaker combination although the efficiency may not be as great.
- The actual performance of this activity will be difficult for the students since it is highly mathematical in nature. Alternately the teacher could provide students with the necessary data in order to meet the expectations that student quantitatively determine the efficiency of an electrical appliance.

Prior Knowledge Required

- Students have studied heat in grade 7, however students do not know the equation for the heat gained or lost by a substance as $E=mc\Delta T$ or $Q=mc\Delta T$.
- Students have studied mechanical efficiency in grade eight, however not all students may know the equation for the efficiency of an energy conversion as (energy output/energy input) x 100%

- Students should be aware of the information contained on the identification plate of a device, usually the potential difference, the power rating or the electrical current. Students are not aware of the fact that the power is the product of the potential difference and the current (P=VI)
- Students should be aware of how to solve simple equations involving three terms.

Teaching/Learning Strategies

1. Students will examine several electrical appliances and determine the information available on the identification plate:
   - the electrical potential difference required, the current used, the resistance of the device or the power of the device. (Note: usually only two of these are given on the plate)

2. The teacher will explain the relationship among the potential difference, the elapsed time and the energy consumed by an electrical device as well as the relationship among the power, the potential difference and the current:
   - E = P t and P=VI.
   - Students will perform several sample calculations using this relationship.

3. The teacher will review the relationship for efficiency of the energy transformation.
   - The students will apply this equation to determine the efficiency of a kettle through experiment (or from data given by the teacher).
   - The teacher will review other examples of the efficiency of the energy transformation.
   - The students will apply this equation to determine the efficiency of other devices, given the energy input and output.

Assessment/Evaluation

- The teacher will assess the students' ability to read the information from the name plate for making connections by means of an individual conference. (PH1.06, PH2.08)
- The teacher will assess inquiry by observing the student obtaining the appropriate lab materials, care of assembly and the proper returning of equipment to its appropriate place in the class room.
- The teacher will assess the students' ability to evaluate the efficiency of an electrical device and the calculation of energy given power and time used for knowledge/understanding by means of reviewing the data chart produced for the experiment. (PH1.11, PH1.12)
- The teacher will assess the written lab report for knowledge/understanding and communication by means of lab product rubric Appendix A2. (PH1.11, PH1.12, PH2.08)

Resources

1. Martindale et. al. Fundamentals of Physics: An Introductory Course: D.C. Heath 1987, Toronto
2. Teacher created activity sheet or as found in the grade nine text book.
3. Various webs sites such as The Virtual Laboratory (http://physicsweb.org/TIPTOP/VlAB/) and use the necessary applets to reinforce this activity.

Accommodations

1. Where the student has an IEP, this activity will be modified to meet the student's needs as outline by the IEP.
2. Students will have opportunities to demonstrate their learning by alternate means while written English is developing. At the same time, instruction in written, science-specific language must continue.

3. Classroom/laboratory facilities will be modified to permit participation, regardless of impairment, in group and individual activities. Where possible, peers will be encouraged to assist in these accommodations.

Activity # 8: Alternative Energy Sources

Time: 300 minutes

Description

This activity will require students to research and report on one Alternative Energy source. The report will be both a formally written one and an oral presentation using audio-visual aids. The focus of this activity will be to gain a deeper understanding of the alternatives available, their economic and social costs and how these compare to the currently used electric generation systems. Students will be required to reflect on the Church's teachings with respect to one's responsibilities to both, one's brothers and sisters in humanity and to God's creation.

Strand and Expectations

Ontario Catholic School Graduate Expectations:

The graduate is expected to be: 1c, d; 2b, c, d, e; 3c, d, e, f; 4e, f; 5a, e, g; 7a, e, f, i

Strand: Physics

Overall Expectations: At the end of Grade 9, students will: PHV.03

Specific Expectations: Students will: PH1.13⌘, PH2.04⌘, PH2.06⌘, PH3.02⌘

Planning Notes

- This activity should be initiated at the beginning of the Unit, as it will require considerable time to assemble the final product.
- Library/Computer time should be booked in blocks at different intervals to allow students to make the best use of the time to complete their research or to assemble their work. It is suggested that classes be booked in two, two-period blocks, one shortly after the beginning of this unit and one part way through the unit. If the school library is not available teachers should collect resources for classroom use for this activity.
- Have a variety of sources available for student use. These should include various commercially available CD-ROMS, magazine articles, and community resources such as the local hydro authority or a local alternative energy marketing board/agency.
- As part of the activity, students will be required to analyze the energy usage of a typical Ontario setting such as a home, farm or community. It is suggested that, should this not be possible, a review of their family's requirements be conducted.

Prior Knowledge Required

- An understanding of electrical generation systems currently in use.

- An understanding of the collection of written and numerical data for use in a report or essay.
- Research techniques on the Internet.
- Appropriate citation techniques such as parenthetical referencing.
- This activity may be conducted as a group activity depending on the scope and depth of resources available.

Teaching/Learning Strategies

1. Students will research one of the following modes of generating electricity and prepare a minimum five page, written report on this source. (Tidal, Solar, Wind, Geothermal, Hydrogen)
2. Having selected their topic, students will formulate an outline which will cover, but is not restricted to the following points;
   - What are the mechanics involved in generating power for their choice of Alternative Energy?
   - What are the typical costs associated with this form of Alternative Energy Generation?
   - How does this compare with the cost of generating electricity using one of the traditional means?
   - What, if any, are the environmental considerations of this source of Alternative Energy?
   - How does this reflect the Church's teaching on the Environment and on our fellow human beings?
   - A plan that utilizes information gathered to show how a single-family dwelling could use an alternative energy source as the primary source of energy for the household.
3. Students will use a variety of sources to gather their information. Students should have at least one source from each of the categories listed below (depending on availability);
   - Electronic – such as CD-ROM or Internet; both if they are available.
   - Print – articles from recent scientific publications such as Discover or Popular Science.
   - Anecdotal – an interview or survey of a representative from a local power generating authority.
   - Print – a review of publications/marketing materials from a local Energy Provider or expert.
   - Print – a review of materials gathered from traditional print sources such as reference texts or books.
4. In addition to the written report, students will be required to prepare audio-visual materials that compliment their report and will be used in the presentation of their work. These can be of the traditional forms such as overheads and Bristol board drawings and diagrams or use presentation software. These materials should include the following:
   - A representation of the mechanics involved in converting the source of energy into electricity.
   - A summary of relevant environmental, economic or social statistics.
   - A simplified version of their plan for a single-family dwelling.
   - A comparison to traditional electric generation systems.
5. Students will be required to prepare and deliver a minimum five minute oral presentation using the visual aids prepared above. The presentation should include the items listed in 4 above.
6. Alternatively, strategies 4 and 5 could be replaced with the whole group participating in a suitable cooperative small group learning activity such as jigsaw in order to encourage the sharing of discoveries.
7. Teachers will:
   - review/instruct students in the methods of research on the internet, (key word searches, search engines, exploration of hyperlinks, etc.).
   - review the process of outlining a written report and collecting/collating data based on an outline.
   - assign students to heterogeneous groupings if necessary.
   - facilitate search techniques on the Internet.
   - consult with students on the development of outlines.

- consult with students on the organization of information.
- consult with students on the environmental issues and our role as Stewards of God's Creation.
- encourage students to compare Canada's consumption of electricity with that of a third world country.

Assessment/Evaluation

Note: All rubrics used for assessment will be given to the students as part of the original assignment criteria or will be developed in co-operation with the students.

- Student use of time, on task behaviour, cooperation with others and contributions to the team, will be assessed but not evaluated as the project progresses. The process rubric, Appendix A1, may be used.
- Student written reports will be collected and evaluated for knowledge/understanding, communications, and making connections using the product assessment rubric in Appendix A3. (PH1.13, PH2.04, PH2.06, PH3.02)
- Student oral presentations will be evaluated for communication and knowledge/understanding as part of the total evaluation for this activity. A student/teacher developed rubric may be used for this. (PH1.13, PH2.04, PH2.06, PH3.02)

Resources

1. http://zebu.uoregon.edu/1998/phys162.html ; an internet site which provides a good overview of various forms of alternative energy and many links to other useful web sites.
2. http://www.est.gov.on.ca/english/en/en_renew.html ; government of Ontario Ministry Web site with a review of current/past government initiatives, their goals, costs etc. Also contains links to a variety of other web sites.
3. http://www.eren.doe.gov ; United States Department of Energy Web site with excellent overviews of various Alternative Energy sources and links to institutions and organizations either researching or utilizing various types of energy alternatives.
4. Energy Educators of Ontario; 517 College Street, Suite 404; Toronto Ontario; (416) 323-9216; a source of various publications and print materials dealing specifically with Canadian Energy Issues.
5. Teachers can prepare a research log that allows students to list resources they have accessed in each of the main resource categories listed above.
6. Library resources.
7. Multimedia CD ROM available from a variety of Scientific Supply houses.
8. Use of Multimedia presentation tool should be encouraged wherever possible. E.g. Microsoft PowerPoint/ Lotus Freelance Graphics, etc.
9. Church documents on stewardship and the protection of the environment. (Teachers may consult with the Religious Education Department in the school for this information.)

Accommodations

1. Where a student has an IEP, this activity will be modified to meet the student's needs as outlined in the plan.
2. While oral and written English is being developed, students will be provided opportunities to learn and demonstrate their learning by alternate means; spoken English, use of demonstrations, peer translators, pictorial illustrations, etc.
3. Suitable extensions for enrichment will be provided as required.

Appendix A1: Process Rubric

CATEGORY	CRITERION	LEVEL 1	LEVEL 2	LEVEL 3 (Provincial Standard)	LEVEL 4
Inquiry	Planning	• does not demonstrate an understanding of the problem • no preparation is attempted or the preparation is incoherent or unworkable • no controls and variables identified	• demonstrates a partial understanding of the problem • preparation is limited in appropriateness and completeness • some controls and variables identified	• demonstrates a basic understanding of the problem • preparation is complete and appropriate for the activity • most controls and variables identified	• demonstrates a thorough understanding of the problem • preparation is clear, complete and appropriate • all controls and variables identified
	Personal Technical Skill	• limited competence	• moderate competence	• considerable competence	• high degree of competence
	Safety and/or Equipment Care	• safety rules broken • careless use of equipment	• safety compromised • some mishandling or misuse of equipment	• safety rules followed adequately • careful use of equipment	• extra safety practiced • extra care of equipment exercised
	Group Skills	• poor group-work skills • little contribution	• moderate group-work skills • moderate contribution	• good group-work skills • good contribution	• excellent group-work skills • excellent contribution
OCSGE	Catholicity	• lacks respect for the dignity and welfare of others	• occasionally demonstrates respect for the dignity and welfare of others	• adequately demonstrates respect for the dignity and welfare of others	• selflessly strives to respect and affirm the rights and dignity of others

Appendix A2: Lab Product Rubric

CATEGORY	CRITERION	LEVEL 1	LEVEL 2	LEVEL 3 (Provincial Standard)	LEVEL 4
Knowledge and Understanding	Hypothesis Reflects Theoretical Information	• Used terms and ideas but did so inappropriately • Demonstrated limited understanding • Infrequently transferred simple concepts to new contexts	• Used some terms and ideas appropriately • Demonstrated only some understanding • Sometimes transferred simple concepts to new contexts	• Used terms and ideas appropriately • Demonstrated considerable understanding • Able to extend simple concepts and some complex concepts in new contexts	• Routinely used terms and ideas appropriately • Demonstrated a thorough understanding • Able to extend simple and complex concepts to new contexts.
	Used prior knowledge to answer discussion questions				
	Work demonstrates an understanding of the concept(s) being investigated				
Inquiry	Application of the skills and strategies of scientific inquiry	• Applies few of the skills and strategies of scientific activity	• 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	Used the proper format for the lab report	• Had a few elements of the criterion but did not do so clearly or precisely	• Use of terminology evident but not necessarily accurate or appropriate	• Uses terminology and symbols appropriately although does make the occasional error or omission	• Uses terminology and symbols appropriately and at all times.
	Used the proper units for all measured quantities				
	Used the appropriate presentation format for data				
Making Connections					

Appendix A3: Product Assessment Rubric

CRITERION	LEVEL 1	LEVEL 2	LEVEL 3 (Provincial Standard)	LEVEL 4
Knowledge and Understanding				
Accuracy of description of topic	• Description of concepts is rudimentary • very few summaries in the student's own words • Inappropriate use of terms and language • Information predominantly from one source	• Demonstrates some understanding of concepts. • Evidence of summarization and encapsulation of ideas and concepts • Terms and language reflect some understanding • Information from at least two sources	• Demonstrates good understanding of concepts • Summarizes information from a source • Good use of terminology and language • Draws on multiple sources in the development of an idea or concept	•Demonstrates thorough understanding of the concepts • Summarizes all information • Use of terminology reflecting a thorough understanding of the concept • Combines information from multiple sources on an idea or concept
Completeness of topic analysis	• Work demonstrates a limited review of the information available. • Work does not analyze concepts in depth • Facts or data not used to support ideas or concepts • Is unable to make links between two aspects of a topic	• Demonstrates a greater analysis of the information • Some analysis of concepts or ideas is evident • Minimal facts or data are used to support the topic or analysis • Is sometimes able to make links between two aspects of a topic	• Demonstrates a good review of the relevant facts • Good analysis of the concepts or ideas • Uses sufficient facts and data to support each topic or analysis • Is able to make links between two aspects of the topic	• Demonstrates a thorough understanding of the relevant facts or data • Uses a large number of facts or pieces of data to support the topic or analysis • Is continuously linking facts from one aspect of the topic with the next to provide a continuum in the analysis
Comparisons of chosen topic to related ideas	• Does not relate the topic to other areas of relevance • Work reflects a limited perspective of the impact of the topic on society and the environment	• Mention is made of at least one possible link/influence between the topic and another area of relevance. • Demonstrates some perspective of the impact of the topic on society or the environment	• Demonstrates an understanding of the at least two relationships that exist between the topic and other areas of relevance • Discusses the impact of the chosen topic on at least one aspect of society or the environment, (e.g. social, economic, pollution etc.)	• Presents a thorough discussion of at least two relationships/impacts of the topic and other areas of relevance • Demonstrates a thorough understanding of the relationships between the chosen topic and other aspects of society and/or the environment
Discussion of secondary concepts/issues	• Does not discuss secondary issues. • Demonstrates limited awareness of relevant secondary issues • Does not link the concepts within the topic to other ancillary topics or ideas	• Demonstrates some understanding of secondary issues • Makes mention of at least one secondary issue • Demonstrates some awareness of the links between at least one concept within the topic and one other ancillary topic or idea	• Demonstrates considerable understanding of secondary issues related to the topic • Discusses at least one secondary issue • Discusses the links between at least one concept within the topic and one other ancillary topic or idea	• Demonstrates a thorough understanding of secondary issues related to the topic • Discusses at least two secondary issues thoroughly • Makes the link between specific concepts within the topic and specific ancillary topics or ideas

Review of Church teachings on the topic	• Demonstrates a limited understanding of Church teachings with respect to the topic • Makes reference to Moral/Ethical issues with no reference to the teachings of the Church • Demonstrates limited understanding of the links between the teachings of the Catholic Church and the issues in the topic.	• Demonstrates some understanding of Church teachings. • Makes at least one reference to a specific Scriptural or encyclical teachings • Demonstrates some understanding of the links between the teachings of the Catholic Church and the issues discussed in the topic	• Demonstrates a good understanding of Church teachings • Makes at least 3 references to specific Scriptural or encyclical teachings • Where appropriate, links at least one concept/issue in the topic to the teachings of the Catholic Church	• Demonstrates a thorough understanding of Church teachings. • Concepts/issues of the topic are discussed with specific reference to the teachings of the Catholic Church • Where appropriate, links are made between all relevant issues/concepts and the Church's teachings.
Use of diagrams, charts and graphics	• Demonstrates limited appropriate use of diagrams charts or graphics • Diagrams, charts or graphics serve a decorative purpose only	• Demonstrates appropriate use of diagrams, charts or graphics. • Diagrams, charts or graphics are used to enhance a point or concept	• Demonstrates a good understanding of the use of diagrams, charts and graphics to illustrate/reinforce a point or concept • Uses diagrams, charts or graphics to support concepts and to explain ideas • Makes reference to diagrams charts or graphics in explaining a point or concept	• Demonstrates a thorough understanding of the use of diagrams, charts and graphics in the elaboration of ideas and the enhancement of a product • Uses diagrams, charts and graphics to explain/elaborate and reinforce ideas and concepts when necessary • Makes reference to diagrams, charts or graphics throughout the product
Inquiry				
Use of Internet Resources	• Demonstrates limited use of the Internet as a source of information • Uses limited Internet references - some may be inappropriate • Uses "cut and paste" rather than summary and reference	• Demonstrates some use of the Internet as a source of information • Uses some appropriate Internet references • Demonstrates some summarization of information with appropriate referencing	• Demonstrates a good use of the Internet as a source of Information • Uses sufficient and appropriate Internet references • Demonstrates good summarization of information and cross referencing of information	• Demonstrates a thorough understanding of the Internet as a source of Information • Uses extensive and appropriate Internet References • Demonstrates complete summarization of information with extensive cross-referencing of information

Use of other electronic media	• Demonstrates limited use of on-line or CD-ROM sources • Uses Encyclopedic CD-ROM sources • Demonstrates limited understanding of the appropriateness of material	• Demonstrates some use of on- line or CD-ROM sources such as SIRS or similar research tool • Uses Encyclopedic as well as subject specific CD-ROM sources • Demonstrates some understanding of the appropriateness of material	• Demonstrates good use of on- line or CD-ROM sources • Uses a variety of on-line tools and sources/materials • Demonstrates a good understanding of the appropriateness of material	• Demonstrates a thorough use of on-line or CD-ROM sources • Uses a wide variety of on-line tools and sources/materials • Demonstrates thorough understanding of the appropriateness of material
Use of traditional research tools (books, articles)	• Demonstrates a limited understanding of research techniques using traditional sources • Demonstrates a limited understanding of the use of linking information from two or more sources to support a concept or idea	• Demonstrates some understanding of research techniques using traditional sources, (subject search) • Demonstrates some linkage between sources to support a concept or idea	• Demonstrates a good understanding of research techniques. • Demonstrates good linkage between sources in support of an idea or concept.	• Demonstrates a thorough understanding of research techniques. • Demonstrates extensive linkage between sources to support a concept or idea
Communication				
Product organized according to a discernable outline	• Demonstrates a limited understanding of the use of an outline • Product is not coherent or organized in a topical manner • Related concepts are disjointed • Demonstrates no 'flow' from one concept to the next	• Demonstrates some understanding of the use of an outline • Product is organized according to an outline. • Related concepts are grouped together • The flow from one group to the next is not coherent	• Demonstrates a good understanding of the use of outlines to organize material • Product is organized and coherent • Topics are grouped according to the discernable links between them • Flow from one concept to the next is coherent	• Demonstrates a thorough understanding of the use of outlines in organizing both research and product • Product is organized and coherent • Topics within a sub-group are related • Each topic group leads logically into the next.
Making Connections	Use this to develop specific criteria relating the topic to the discussions in class or in society.			

Appendix A4: Collaborative Rubric

Group/Self/Teacher Rating Scale for Group Skills

Circle the number that best demonstrates the behaviour as outlined below.

1 = rarely
2 = seldom
3 = usually
4 = always

	Your Name	Peer Name	Peer Name	Peer Name
STAYED ON TASK _ not easily distracted _ contributed actively _ seen researching, note-taking	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
ACTIVELY LISTENED _ eye to eye contact _ attentive facial expression _ asked for clarifications _ hear one voice at a time	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
FOLLOWED ASSIGNED ROLES _ facilitator _ motivator _ recorder _ task master	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
WORKED COOPERATIVELY _ offered opinions politely _ kept a positive attitude _ accepting of others' ideas _ respected principles of brainstorming	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4
COMPLETED THEIR FAIR SHARE OF THE WORK	1 2 3 4	1 2 3 4	1 2 3 4	1 2 3 4

GROUP ROLES & DESCRIPTIONS

Facilitator: Ensures that everyone understands the work in progress. Keeps the group moving towards the accomplished goal.

Recorder: Writes and pulls together the conclusions of the group so that they can be presented coherently.

Motivator: provides support to the members of the group so that they are more enthused about their participation. Makes helpful suggestions.

Task Master: Keeps the group focussed on the task and monitors the time.

Appendix B: Science World

A Personal Journey Through The World of Science

Science World is an individualized, interdisciplinary, project-based activity that allows students to relate and extend scientific and technological concepts learned in class to everyday life. It will give them an opportunity to explore science beyond the classroom and receive credit for personal activities, interests, and hobbies they may already be engaged in outside the school environment or in departments other than science. Students should keep a log or a student journal to keep track of new words, data from class experiences that may be extended and a record of activities that have been completed.

Students will engage in Science World projects throughout the course. Teachers will provide the necessary student-friendly outlines and guides suggesting possible Science World activities in all units of the course. Students will be free to choose the activities they would like to work on. They will also be given the option to design and perform their own Science World project. The products of their effort will be placed in a personal Science World portfolio. Process and product will be assessed and evaluated according to suitable teacher-developed marking schemes and assessment rubrics (see Appendices A1, A2, and A3 in this document for samples).

Teachers will establish policies regarding timelines available for the design, development, and submission of final products. Flexibility is important in this regard. Students should be allowed to put forth their best effort---not one compromised by unreasonable time constraints (with the provision that projects commenced late in the school year need to be started at a suitable time to ensure completion). Student self-pacing must be encouraged. Teachers must also assist in arranging and scheduling dates, times, and places for staging certain events or large and small group presentations (as Science World extends to other courses, this could become a department-wide activity).

Teachers will assist students develop effective time-management skills, select group members where necessary, and select activities that suit their interests and abilities. They will facilitate the search for required materials and equipment; the search for reference materials; and the search for suitable community-based resources. Teachers must not exert excessive control over the selection, design, or perform/create aspects of the projects. Science World must remain an exclusively student- centered activity.

Science World structure and content may be modified to suit local school conditions, extended community profile, and student population characteristics as well as any possible limitations on the availability of resources.

The present version of Science World allows students to select from five different classes of activities; each assigned a different number of points (these could be adjusted by an individual teacher for a particular school):

1. Mini Explores: These are relatively short projects that are meant to be fun, interesting, and challenging. A sample Mini Explore Guide is found at the end of this appendix. Teachers will be expected to develop others. (10 Points)
2. Major Explores: These are formal science fair projects involving in-depth study done over a longer period of time. They usually require the design and performance of a single laboratory-based research project that usually requires a detailed written report and a project board. (30 Points)
3. School Clubs: Students may obtain Science World credit by joining and making a significant contribution to certain school clubs and associations that have a significant science or technology content. Examples would include audio-visual and stage lighting technicians for school

productions, math club, science club and debating club (if science or technology concerns are debated). (10 Points)

4. Da Vinci's Dilemma or Science Olympics: This would be a large group activity organized in a "Science Olympics" format and taking place over a number of days. Groups of students would compete against one another on challenging problem-solving activities that involve elements of science, technology, art, and mathematics. (20 Points)
5. Major School Field Trips: Various school clubs and associations may from time-to-time organize major (overnight) excursions to distant locations of interest. Some of these may have enough of a science or technology component to qualify for Science World credit. Alternatively, the science department could arrange such an excursion. (20 Points)

In order to complete Science World, students will have to accumulate a particular number of points (e.g. 30) by the end of the school year or semester. Since different classes of activities involve differing amounts of time and effort, a reasonable combination of activities must be selected by students for credit.

Sample Mini Explore Guide

1. **Explain the role male hormones play in the development of "Male pattern Baldness."** 2-3 page report including caused, treatments and possible cures, diagrams, photos, print and internet references. (Biology Unit)
2. **Create a photo album of the moon's phases.** Portfolio of 6-8 photographs of different phases of the moon. The photos must be properly labelled and placed in plastic protectors. (Earth/Space Unit)
3. **Create a Science Board Game.** The game must illustrate a theme, or principle learned in the course. It must have "play-value" and should be artistic and colourful. It should "make sense" and teach as one plays. (Any Unit)
4. **Design and Build a Science Mobile.** The mobile must be light-weight, colourful, and illustrate one of the themes, concepts, or principles learned in the course. (Any Unit)
5. **Write a Science Poem.** The poem must be a rhyming poem composed of a minimum of 4 stanzas containing no less than 4 lines each, or 3 different limericks. The poem or limericks must be original and must explain a science concept or principle learned in the course. (Any Unit)
6. **Build a Solar System Model.** The model must include the sun and the nine planets. Each component must be shaped and coloured to look as realistic as possible. They must also be sized to scale. (Earth/Space Unit)
7. **Produce a Video Clip or Computer Simulation.** You may use video or computer animation and special effects techniques to produce a product that illustrates a scientific principle or concept learned in the course. Audio is optional. (Any Unit)
8. **Construct a Radio that Works.** The radio must be "home-made", not store-bought. Plans may be obtained from the internet or popular science magazines. (Physics Unit)
9. **Participate in the Science Scavenger Hunt.** Groups of students will compete with one another amassing a list of interesting and unusual "sciencey" items that need to be retrieved over a number of days. The list should include esoteric, cryptic items that require some research to identify). (Any Unit)

Appendix C1: A Catholic Perspective on the Applications of Science: Guiding Principles (Teacher)

Stewardship

The biblical story of creation is a revelation of the goodness of all creation. Humankind, as the culminating act in the first creation story, was given dominion over creation. To be given dominion over creation was to be given dominion over the goodness of creation. The human person, the pinnacle of creation, was to exercise this responsibility in a manner that respected the **integrity** (order, substance, goodness, love, life, spirit and soul) of all that was created. The role that humankind assumed, in order to safeguard the integrity of creation, was that of a **steward**. A steward is a caretaker. All human persons are called to tend to the created world with the wisdom of the divine Steward. The divine Steward is the creator of life and people are the custodians of that life. Science and technology, in their methods and applications must safeguard the integrity of life.

Environment

The environment is the contact point between the implicit order of the universe and the physical substance of life. The environment exists in delicate harmony at the junction of order and substance. The **Providence** of God (God's plan and care for the universe) is most evident at this juncture. Life is inextricably rooted in the environment. Destruction of the environment threatens the delicate balance of life. The human and personal call to stewardship requires that safeguards be placed on the environment in order to protect the integrity of life.

Resources

The resources of the earth have been created in order to promote the welfare of all life. Resources by their nature are limited in their availability and renewability. The resources of the earth are part of the established order of the universe and as such serve a role in the maintenance of life on this planet. Humankind in exercising stewardship must use the resources of the earth in such a way as to promote the welfare of all life, while at the same time not jeopardizing the order of life. It must also be recognized that the resources of the earth are to be used to promote the **greater good** of all humankind.

The extraction of resources from the earth must be done in the least environmentally intrusive manner possible. It would also be consistent with good stewardship to regenerate the areas damaged by the processes of extraction. In the processing of various resources safeguards must be in place to minimize damage to the environment by the waste products. It is also incumbent upon employers to safeguard the health and welfare of all workers involved in the extraction and processing of metals and minerals. To ignore these measures would be to deny the **dignity** and value of the human person and to place a higher priority on capital than labour.

Energy

Energy is a necessary commodity for life. Energy must be used to promote the greater good of all life. It must be made available for the fundamental needs of all humanity. Many forms of energy are not renewable. Other forms, while potentially unlimited, carry with them a high environmental cost. Some forms, while not economically viable, are environmentally sustainable. Good stewardship requires that consumption, cost, environmental disintegration and sustainabilty all be considered in making decisions about which forms of energy would best serve the economic, environmental and human needs of the planet. It would also encourage students to envision a world in which consumption, cost, and the environment existed in a sustainable relationship. Once again, the health and safety of workers employed in energy research, transformation or transmission must take a higher priority than considerations for maximizing capital gain.

Economy

All economic systems rely on the goods of the earth in order to function. The Creator is the source of all the **goods of the earth** and has created them to help **sustain life**. Economic systems which reflect the Providential order of the universe will provide for the needs of all of God's

creations. Economic systems that are driven by unbridled personal gain or Godless purpose will lead to exacerbated social inequalities and/or social disintegration.

The **human person and the natural environment** must be at the centre of all economic life. The economy must be placed at the service of the people of God . An economy that finds its purpose in the service of people, will provide opportunities for all members of its society to live according to the plan of God and to grow in **holiness** (wholeness). A humanizing economy will see work as a basic human right. People will not be treated as units of productivity. Wages will not be determined by market forces alone. The interests of individuals will be bridled by the greater common good. Resources will be used for the creation of life-giving communities. The environment will be treated as integral to the life of the community.

Appendix C2: A Catholic Perspective on the Applications of Science: Guiding Principles (Student)

In the story of creation (Genesis 1-2:4) we read that it was God who created the universe. This belief, that we all share as Christians, compels us to look at life in a special way. We see that the entire universe is part of God's larger plan (**Providence**) for our salvation. It also means that all of creation shares in the meaning and purpose of God's plan. God made the **human person** the pinnacle of creation. We read, in the Bible, (Genesis 2:7) that God breathed life-giving breath into humanity. This life-giving breath was the spirit of the Creator. We, as human persons, were created in the image of God. We were given special responsibilities as a result of being given some of the gifts of the Creator. We were to use our gifts of spirit, love, sexuality, intellect, will, imagination and creativity to sustain the life of the planet. When we do so we act with **integrity**. We read in the Bible (Genesis 1:28) that all of humanity was given dominion over life. We were to act as **stewards** (caretakers) of all of creation. To be stewards we had to act in a way that would ensure the survival of life on the planet. When we act in this manner we sustain the **goodness** of creation.

We read in the Bible (Genesis 3) the story of our human weakness. We were given **free will** by our Creator. When we make our own individual interests more important than the **good** of others then we loose our integrity (**disintegration**). In this state we are subject to sin and as we see in the story of Cain and Abel (Genesis 4:1-12), jealousy and anger bring death (loss of wholeness) into our lives.

Science and technology are fruits of the human intellect. Advances in both science and technology have done much to further our understanding of the world in which we live. As students of science, we cannot help but marvel with **wonder and awe** (gifts of the Holy Spirit) at the miraculous nature of the universe. As stewards of the earth, we must make sure that both science and technology work to enhance life on the planet. We now know how **interdependent** the inanimate (non- living) and animate (living) parts of the biosphere are. As caretakers, we must recognize that the exploitation of resources endangers the delicate balance of life. It is our responsibility to make sure that when we extract minerals and metals from the earth that we do not destroy the local ecosystem. We must also be aware that the by-products (pollutants) of our industrial processes pose a significant threat to life. We must safeguard the local and global environments from the toxic effects of pollutants.

As human persons, we have a special obligation to other people in the world (**solidarity)**. In the story of Cain and Abel (Genesis 4:9) we hear the question **Am I my brother's/sister's keeper?** The answer is a resounding yes. We must make sure that we ask certain questions each time we are deciding on the value of an application of science. How will this contribute to the **greater good** of humanity? How will this benefit the **poor?** Does this threaten the **life-sustaining** capacity of the earth?

Appendix C3: References

CATECHISM OF THE CATHOLIC CHURCH. Publications Service, Canadian Conference of Catholic Bishops, 90 Parent Avenue, Ottawa (Ontario),
K1N 1B1. Copyright Concacan Inc.- LIBERIA EDITRICE VATICANA, 1994, for the English translation in Canada.

The Creator 279-281
- Catechesis on Creation 282-289
- Creation-Work of the Holy Trinity 290-292
- The Mystery of Creation 295-301
- God Carries Out His Plan: Divine Providence 302-314

Heaven and Earth
- The Visible World 337-349

Man 355
- In the image of God 356-361
- Body and Soul but Truly One 362-368
- Male and Female He Created Them 373

The Fall
- Original Sin
  - The consequences of Adam's sin for humanity 404, 407, 409

Common Good 1905-1912
Social Justice 1928-1933
Human Solidarity 1939-1942
Christian Holiness 2012-2013
The Fifth Commandment
- Respect for Human Life 2259
  - Abortion 2270-2275
  - Euthanasia 2276-2279
- Respect for the Dignity of Persons
  - Respect for the souls of others: scandal 2286
  - Respect for health 2288-2291
  - Respect for the person and scientific research 2292-2296
  - Respect for bodily integrity 1197-2298
  - Respect for the dead 2299-2301

The Sixth Commandment
- Male and Female He Created Them... 2331-2336
- The Vocation of Chastity 2337
  - The integrity of the person 2338-2345

The Seventh Commandment 2410
- The Universal Destination and the Private Ownership of Goods 2402-2406
- Respect for persons and their Goods 2407
- Respect for the goods of others 2414
- Respect for the integrity of creation 2415-2418
- The Social Doctrine of the Church 2419-2425
- Economic Activity and Social Justice 2426-2434
- Justice and Solidarity Among Nations 2437-2442
- Love for the Poor 2448, 2449

Appendix D1: All That Glitters is Not Gold!

Introduction

Metals have always played an important role in the development and growth of society, for example, eating utensils and ornaments dating back to 3500 BC were made of gold. Our modern society relies on many different metals for making the vast variety of products we require daily.

Metallurgy is the science and technology of metals. It is concerned with the procedures and chemical reactions that are used to separate metals from their ores and to prepare the metals for their practical uses.

The principal steps in the recovery of a metal from its ores are:

- mining ores
- preparation of the ore
- production of the metal
- refining or purification of the metal
- alloying

Canada is among the top producers of minerals and metals in the world, and the leading exporter. A large segment of the Canadian economy depends on mining and metallurgy. Many benefits result from the mining industry and the metals it produces. However, the byproducts of the chemical processes may cause numerous environmental problems.

Purpose

The purpose of this research assignment is to provide you with the opportunity to acquire some of the ethical, scientific, and technological knowledge that you need to make informed decisions and to consider your responsibilities as informed Catholic citizens in a technological society.

Assignment

In this activity you will research and describe methods used in Canada to extract one element, and outline the associated economic, ethical and environmental considerations. The work will be carried out in groups of four students, where individual students will take on the roles of (1) facilitator, (2) motivator, (3) recorder and (4) task master.

1. Do a general search of the topic in encyclopedias and/or texts.
2. As a result of your general search define the topic.
3. a) Brainstorm to identify questions that need to be answered.
   b) Select and prioritize **five** key questions. (Teacher facilitators must approve.)
4. Obtain further information from more in depth sources, e.g. other books, periodicals, electronic aids, and videos. (A minimum of **three** sources **must** be used.)
5. The final product will be in two parts: a) ***a pamphlet,*** and b) ***a presentation*** by the group to the class on the following date:_____.

Suggested Elements: Aluminum, Carbon, Copper, Gold, Nickel, Uranium, Zinc.

Appendix D2: The Particle Theory of Matter: THINK ! PAIR, SHARE

Work cooperatively with a partner to:

1. Summarize the statements of the Particle Theory.

2. Use the Particle Theory to explain the following:

   a. Solids have a hard rigid shape and a definite volume.
   b. A solid substance expands when heated.
   c. A puddle of water disappears on a hot summer day.
   d. Gases take the shape and size of their container.
   e. A balloon filled with helium gas shrinks when taken outside on a cold winter day.
   f. Predict what will happen to the balloon (in e) if it is brought back inside a warm building.
   g. You feel cold after you come out of a warm swimming pool on a hot dry summer day.
   h. A tablespoon of sugar is placed i) in a cup of hot tea ii) in a glass of ice tea. Neither is stirred. In which container will the sugar dissolve faster?
   i. A solid room air freshener is left in a room. After three weeks, it is noted that it is half its original size.
   j. You can smell the sweet odour of apple pie cooking in the oven while you are in your room doing your science homework.

3. Draw a concept map to demonstrate how the Particle Theory can be used to explain the properties of matter.

Appendix D3: The Atomic Theory Update Conference

"If I have seen further than others, it is because I have stood on the shoulders of giants."
-Sir Isaac Newton

INTRODUCTION

The atom is the smallest unit of matter. The first notion of the atom was proposed in 400 B.C., by the Greek philosopher, Democritus who believed that matter could be broken down to a point at which it could be broken down no further. Democritus called this "atomos", which means indivisible in Greek. Although Democritus' ideas were later discarded for the theories of a more renowned philosopher, they resurfaced in the 1800s with the work of Dalton. Dalton's theory of the atom was compatible with the behaviour of matter observed at the time. As technology advanced and resources became more accessible, Dalton's theory was challenged and new ideas about the atom developed.

Models played a key role in the development of the atomic theory, and play a key role in science. Models provide guidelines for research that leads to new knowledge. Each step that has been taken in the investigation of the atom, whether it has been forwards or backwards, has advanced our understanding of the atom and our ability to predict how atoms behave.

PURPOSE

The purpose of this assignment is to explore the different scientists who have contributed to our modern understanding of the atom, as well as the importance of collaborative and cooperative research.

THE ASSIGNMENT

You will represent one of the scientists who was involved in the development of the Atomic Theory. You will be assigned to one of six research teams. As a group, you will research the contributions of your scientist to the development of the Modern Atomic Theory. Consider the following in your investigation:

- The motivation/stimulus for the experiment
- The hypothesis
- The experiments used to test the hypothesis
- The observations that were made
- The conclusions that were drawn
- The effects of the conclusions - what is their significance in the development of the atomic theory.

There are **five** components to this assignment:

Formal Lab Report 25% (Assessed by means of the Lab Product Rubric A2)
Each group must submit a formal lab report which describes the experiments that were performed throughout the investigation. The report must follow the same guidelines as a regular scientific lab report (as done in class).

Fact Sheet 25%
Each group is responsible for creating a fact sheet which summarizes the contributions of their scientist(s). Each student in the class must receive a copy of this fact sheet.

Presentation 20%
Each group will present their research at the Atomic Theory Update Conference. Each group must assume the role of the research team they researched, and all members must be involved in the presentation at the Conference.

News Story 20%
With a partner, you will write a news story that reports the scientific breakthroughs presented at the Atomic Theory Update Conference

Group/Teacher Evaluation 10%
Note: Rubrics for the other components may be developed by the teacher with student input. All rubrics will be given to the students at the start of the assignment.

RESEARCH TEAMS: J. Dalton, W. Crooks, J. J. Thomson, E. Rutherford, J. Chadwick and E. Goldstein, N. Bohr

Appendix D4: News Story

ASSIGNMENT

The media, (radio, television, and newspapers) have a tremendous influence on society. It is their job to inform the general public of issues and scientific findings in a complete, unbiased way. In this assignment, you are a newspaper reporter who is assigned to cover the Atomic Theory Update Conference. Write a news story that accurately and completely reports the latest scientific breakthroughs.

GUIDELINES FOR WRITING A NEWS STORY

- The story should cover the five W's, that is, who, what, where, when, and why.
- In a news story, the information is presented in the form of an inverted pyramid, where the most important information is written at the beginning of the article.
- The headline should catch the readers' attention, yet be truthful, and succinctly contain the most important information.
- Possible ethical, environmental, and societal ramifications of the information should be considered.

EVALUATION

CONTENT:	**POSSIBLE MARKS:**
What (evidence is given to support work)	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Why	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Who	0 1 2 3
Where	0 1 2
When	0 1 2
FORMAT:	**POSSIBLE MARKS:**
Form (story structure)	0 1 2 3
Grammar, Spelling	0 1 2 3 4 5 6 7 8 9 10
Headline	0 1 2 3 4 5
Visuals (impact, layout, graphics, illustrations)	0 1 2 3 4 5 6 7 8 9 10
TOTAL	**/60**