Catholic District School Board Writing Partnership

Course Profile

Chemistry

Grade 11
University Preparation
SCH3U

• *for teachers by teachers*

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Course Overview
Chemistry, Grade 11, University Preparation, SCH3U

Prerequisite: Science, Grade10, Academic

Course Description
This course is designed to provide students with the knowledge and skills they need to meet the entrance requirements for university programs. It emphasizes both independent research skills and independent learning skills. In addition, it focuses on the concepts and theories that form the basis of modern chemistry. Students study the behaviours of solids, liquids, gases, and solutions; investigate changes and relationships in chemical systems; and explore how chemistry is used in developing new products and processes that affect our lives and our environment. Emphasis will also be placed on the importance of chemistry in other branches of science.

How This Course Supports the Catholic Graduate Expectations
This course seeks to further the achievement of Catholic Graduate expectations through integrating Scripture, Catholic Church teaching, and moral and ethical reflection. Students are encouraged to become discerning believers who integrate faith with life. Students develop their decision-making skills by informing their conscience and critically reflecting on the spiritual, moral, and ethical dimensions of issues raised in the course. In addition, as informed Catholic citizens, students acknowledge and accept their responsibility as stewards of the earth and use their knowledge to address pressing environmental issues. Finally, by examining the reactivity of compounds found in nature, students develop a wonder of creation, a respect for the environment, and a need for the wise use of resources.

Course Notes
This course provides students with the prerequisite knowledge and skills needed for the Grade 12 Chemistry University Preparation course and is designed to further equip them to meet the entrance requirements for university programs. In planning, teachers should emphasize the theoretical aspects of the course content, and include relevant and concrete applications. Teachers should include a test at the end of each Unit in addition to any end-of-unit task. Emphasis should be placed on the development and the demonstration of both independent research skills as well as learning skills. Teachers must incorporate the skills essential for scientific investigation (*The Ontario Curriculum, Grade 11 and 12 Science,* p. 45). These skills, coded SIS.01 to SIS.10, must be developed in all course units. Assessment of these skills must be included in the evaluation of students' achievement. Throughout the course, students should maintain a Data Book.

Students build on their prior knowledge from *The Ontario Curriculum, Grades 1 to 8, Science and Technology*, (Pure Substances and Mixtures in Grade 7, and Water Systems in Grade 8), and *The Ontario Curriculum, Grades 9 and 10, Science* (Atoms and Elements in Grade 9, Chemical Processes and Weather Dynamics in Grade 10).

This course is organized into five units which follow a logical development of knowledge, theories, and skills. The units are: Gases and Atmospheric Chemistry; Matter and Chemical Bonding; Quantities in Chemical Reactions; Hydrocarbons and Energy; Solutions and Solubility. These units match the strands used in the *Ontario Curriculum, Grades 11 and 12, Science* document; however, they have been re-ordered to provide a meaningful and relevant framework to study chemistry in a faith-filled context. The unit, Gases and Atmospheric Chemistry, was chosen as the first unit to allow the teacher to introduce chemistry in a very creative, meaningful, relevant way, and at the same time effectively integrate the Catholic Graduate Expectations. The mole concept is introduced and taught in connection with the gas laws in Unit 1, Gases and Atmospheric Chemistry and then further reinforced in Unit 3, Quantities in

Chemical Reactions. The units Matter and Chemical Bonding and Quantities in Chemical Reactions build on the students' prior knowledge of chemistry from Grades 9 and 10 Science. Hydrocarbons and Energy builds on knowledge introduced in the previous units. Finally, since water is essential and vital to both our physical and spiritual well-being, this Catholic course profile ends with Solutions and Solubility. If teachers wish to cluster the expectations differently than suggested in this course profile, they must address all learning expectations, the different categories of learning, and carefully consider the time spent on each unit. When using the Unit Overview Charts, teachers should note that within each cluster one or more of the categories of learning may have a greater focus - this category has been **bolded.**

Throughout the course, the teacher must provide ample opportunities for students to engage in safe, relevant laboratory activities. The health and safety of teachers and students must be routinely addressed when conducting laboratory activities using safe laboratory practices and following Workplace Hazardous Materials Information System (WHMIS) legislation.

It is critical that students develop strong communication skills, including the use of information technology for collecting, organizing, and presenting information. Furthermore, science cannot be taught in isolation but must be linked to other disciplines. Encouraging students to develop an awareness of controversial issues involving science and technology will allow them to make connections to society and the environment. These are the skills that will foster qualities of responsible citizens. Students should be encouraged to keep a Journal for reflections to further the achievement of the Catholic Graduate expectations. (The Catholic Graduate Expectations and the Journal are not to be assessed.)

Teachers are encouraged to incorporate the use of computer technologies such as computer-based simulations, multimedia applications, and computer-assisted laboratory apparatus in the delivery of this course. However, care must be taken to ensure that computer assisted laboratory programs are not used where students' essential scientific skills should be developed.

Units: Titles and Time

Unit 1*	Gases and Atmospheric Chemistry	24 hours
Unit 2	Matter and Chemical Bonding	20 hours
Unit 3	Quantities in Chemical Reactions	23 hours
Unit 4	Hydrocarbons and Energy	20 hours
Unit 5	Solutions and Solubility	23 hours

* This unit is fully developed in this Course Profile.

Unit Overviews

Unit 1: Gases and Atmospheric Chemistry

Time: 24 hours

Unit Description

In the first cluster of this unit, students examine the nature of the atmosphere by identifying its major and minor components, recognize the importance of the atmosphere in supporting life on earth, and determine the relevancy of gases in their lives. As informed responsible citizens, the students reflect on how the use of technological products can enhance the quality of life and contribute to the common good. They explain the intermolecular forces found in different states of matter and describe the gaseous state using kinetic molecular theory. Students describe natural phenomena and technological products associated with gases.

In the second cluster, students use experimental data to develop the mathematical relationships for Boyle's law, Charles' law, and Gay-Lussac's law and incorporate the knowledge of these laws to develop the combined gas law equation. Students use Dalton's law of partial pressure to solve numerical problems that involve the collection of a gas by the downward displacement of water. Through research, students identify technological products and the corresponding safety concerns associated with the use of compressed gases, e.g., propane tanks in the home and workplace.
In the third cluster, students state Avogadro's hypothesis and demonstrate an understanding of Avogadro's number, the mole, and molar mass. Students experimentally determine the molar volume of a gas and solve quantitative problems involving the ideal gas law.
In the fourth cluster, students describe technological advances and applications of gases in other disciplines, examine gas related environmental issues affecting society, and explain Canadian initiatives to improve air quality. Students plan, organize, and participate in the "Gases and Life" conference. Throughout the unit, students recognize their role as stewards of the earth in addressing the environmental concerns and issues relating to Canada's atmosphere.
(**Note:** Expectation **QC1.01** is addressed in this unit and reinforced in Unit 3: Quantities in Chemical Reactions. Expectation **GA2.05** will not be covered in Unit 1, but addressed in Unit 3 with other stoichiometry problems.)

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1	GAV.01, .03, GA1.01, 1.02, 1.06, 3.01, SIS.06 CGE1d,i; 2e; 3b; 7d,i,j	**K**, C, MC	• Concept Map and class discussion • Reflection (atmosphere) • Poster on Natural Phenomena and Technological Products
2	GAV.01, .02, .03, GA1.03, 1.04, 2.01, 2.02, 2.03, 2.04, 3.03, SIS.01, .02, .03, .04, .05, .07, .08 CGE1d; 2e; 3b,c,d,e	**K**, I, **C**, MC	• Conduct labs on: Boyle's, Charles', and Gay-Lussac's laws • Solving gas laws problems • Consumer Pamphlet and Presentation
3	GAV.01, .02, GA1.05, **QC1.01**, GA2.04, 2.06, SIS.05, .07, .09 CGE3c; 4f; 5f,g	**K, I,**	• Counting Activity • Problem solving • Molar volume experiment
4	GAV.03, GA3.02, 3.04, SIS.10 CGE 1d,e; 2e, 3b,c,d,e; 4f; 5e; 7a,b,d,i,j	**K**, I, **C**, **MC**	• Conference: Exhibits and Displays • Air Quality seminars

Unit 2: Matter and Chemical Bonding

Time: 20 hours

Unit Description

Students build on their knowledge of atomic and molecular structures, the properties of elements and compounds, and chemical reactions introduced in the Grade 9 and 10 Science programs. Throughout the unit, students focus on respecting life and safeguarding the environment.

In the first cluster, students use a dry lab to demonstrate an understanding of periodic trends by analysing data involving periodic properties such as ionization energy and atomic radius. They then explain periodic trends by describing electron arrangement and forces in atoms.

In the second cluster, students demonstrate an understanding of the formation of ionic and covalent bonding. They explain how different elements combine to form ionic and covalent bonds, and the properties of ionic and molecular compounds. (**Note:** When explaining bonding using the octet rule, be sure to stress its limitations, since there are many compounds that do not follow the octet rule.)

In the third cluster, students use appropriate symbols and formulae to represent the structure and bonding of chemical substances. Both common names and systematic names of chemical substances are utilized. Students identify chemical substances used in everyday life and those of environmental significance such as fertilizers and greenhouse gases. As students consider the local and global impact of these chemicals on the environment, they reflect on their role as responsible citizens and stewards of the Earth.

In the fourth cluster, students carry out laboratory studies of chemical reactions. They predict the products of synthesis, decomposition, substitution, and double displacement reactions and then test their predictions. In addition, students brainstorm and identify reactions in everyday use and produce a consumer pamphlet that stresses the need for the safe use of chemicals in the home and at work.

In the fifth cluster, students further develop their Scientific Investigative Skills as they investigate the reactions of metals to produce an activity series. By evaluating and comparing the reactivity of metals and alloys, students revisit mining to explain why most metals occur naturally as compounds. Students reflect on the wonder of God's creation and on their responsibility to use resources wisely.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1	MCV.01, .02, MC1.01, 1.02, 2.01, 2.02, **QC2.06**, SIS.05, .06, .08 .09 CGE 2b; 4f; 5a,e	**K**, **I**, **C**	• Dry lab on Periodic Trends • Atomic structure explanation of periodic trends
2	MCV.01, .02, MC1.03, 1.04, 2.03, 2.04 CGE 2b; 4f	**K**, I, **C**	• Chemical bonding • Ionic and Covalent bonding • Lewis Structures
3	MCV.02, .03, MC2.05, 3.01, 3.02, SIS.01, .05, .06, .10 CGE 1d, 7i,j	I, **C**, **MC**	• IUPAC nomenclature
4	MCV.01, .02, .03, MC1.05, 2.01, 2.06, 3.01, 3.04, SIS.01, .02, .03, .04, .05, .06, .07 CGE 1d,e,i; 2e; 3b,d; 4f; 7a,b,i,j	K, I, **C**, **MC**	• Lab on types of chemical reactions • Applications of chemical reactions and safe use of chemicals in everyday life
5	MCV.01, .02, .03, MC1.06, 2.07, 3.03, SIS.01, .02, .03, .05, .06, .07 CGE 1e; 2e; 7d,i,j	**K**, **I**, **C**, **MC**	• Lab investigation to develop Activity Series • Applications of activity of metals

Unit 3: Quantities in Chemical Reactions

Time: 23 hours

Unit Description

Students solve problems involving the mole, a concept introduced in Unit 1, Gases and Atmospheric Chemistry. By analysing chemical systems, the quantitative relationships in balanced chemical reactions are stressed through laboratory experiments and by calculations.

In the first cluster, students demonstrate an understanding of Avogadro's number and the mole concept by solving problems involving the mole, number of particles, and mass. Students also explain the relationship between isotopic abundance and relative atomic mass.

In the second cluster, students determine the chemical composition of a compound both experimentally and by calculation. Students explain the law of definite proportions and distinguish between the empirical formula and the molecular formula of a compound. They identify everyday situations and work-related contexts in which the analysis of substances is important. For example, in considering the quality control of the composition of products and drug analysis in forensics, students reflect on what it means to contribute to the common good. Students explain how different stoichiometric combinations of elements in compounds produce substances with different properties, for example, carbon dioxide and carbon monoxide. Students examine the risks and benefits of various compounds to the environment and quality of life.

In the third cluster, students develop skills in balancing chemical equations and simple nuclear equations. (**Note:** In order to avoid possible misconceptions and confusion between chemical reactions and nuclear reactions, Expectation QC2.06 can be addressed in the first cluster of the Matter and Chemical Bonding unit, when studying isotopes and radio isotopes.)

In the fourth cluster, students perform calculations based on the quantitative relationships in balanced chemical reactions. Through experimentation, students compare the theoretical yield of a reaction to its actual yield. They recognize the importance of chemical quantities and calculations in the home or industry. Students integrate the Catholic faith tradition in responsible decision-making, accountability and promoting the sacredness of life as they consider specific applications of chemical quantities and calculations, for instance, in prescription drug dosages.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1	QCV.01, .02, QC1.01, 1.02, 2.03, SIS.09 CGE 2b; 4f	**K**, **I**	• Avogadro's number and the Mole concept • Solving mole problems
2	QCV.01, .02, .03, QC1.03, 1.04, 2.02, 2.04, 3.02, 3.03, SIS.01, .02, .03, .04, .05, .06, .07, .08, .09, .10 CGE 1d; 2e; 3b,e; 5b; 7a,j	K, **I**, **C**, **MC**	• Chemical composition • Conduct lab on Law of Definite Proportions • Importance of chemical analysis in everyday life
3	QCV.02, QC2.05, 2.06 CGE 2b; 4f	I, **C**	• Balancing chemical and nuclear equations
4	QCV.01, .02, .03, QC1.05, 2.01, 2.07, 2.08, 2.09, 3.01, GA2.05, SIS.01, .02, .03, .05, .06, .07, .08, .09, .10 CGE2e; 4f; 7a,b, d	K, **I**, **C**, **MC**	• Stoichiometric calculations • Conduct lab to determine percentage yield • Applications in everyday life

Unit 4: Hydrocarbons and Energy

Time: 20 hours

Unit Description

Students demonstrate an understanding of the structure and properties of hydrocarbons, and the energy changes that occur during combustion reactions. Students build on their knowledge of chemical reactions and further develop their skills of balancing equations introduced in the last unit.

In the first cluster, students study the origins and major sources of hydrocarbons and demonstrate an understanding of the characteristics of the carbon atom with respect to bonding in aliphatic alkanes, both cyclic and acyclic. Using molecular models and computer simulations, students name and draw structural diagrams of aliphatic hydrocarbons, both cyclic and acyclic, and demonstrate the arrangement of atoms in their isomers. (**Note:** Teachers should recognize that organic compounds are divided into two broad classes: aliphatic compounds and aromatic compounds. Aliphatic compounds are the alkanes, alkenes, and alkynes and all the compounds that can be derived from them replacing the hydrogen atoms with other atoms or group of atoms. Therefore, students should demonstrate an understanding of the characteristics of the carbon atom with respect to bonding in aliphatic alkanes, both cyclic and acyclic.)

In the second cluster, the students describe the physical and chemical properties of hydrocarbons. Through experimentation, they determine the characteristic properties of saturated and unsaturated hydrocarbons. In addition, they identify the products formed during the complete and incomplete combustion of hydrocarbons and write the corresponding balanced equations.

In the third cluster, students compare the energy changes observed when chemical bonds are formed and when they are broken, and relate these changes to endothermic and exothermic reactions. Through lab investigations, students gather and interpret data, and solve problems involving calorimetry and the equation $Q = mc\Delta T$.

In the fourth cluster, students gain an understanding of the importance of hydrocarbons by researching their many applications, including the steps involved in the refining of petroleum. Students identify the risks and benefits of the applications of hydrocarbons on society and the environment. By examining and evaluating their personal choices in their use of hydrocarbons and the impact of their choices on the environment, students are encouraged to act as responsible citizens with strong Catholic moral values.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1	HEV.01, .02, HE1.01, 1.02, 2.01, 2.02, 2.03, SIS.09 CGE2b; 4f	**K**, I, **C**	• Nomenclature and chemical structure of hydrocarbons
2	HEV.01, .02, HE1.03, 2.01, 2.04, SIS.01, .02, .03, .04, .05, .07 CGE5a, e, g	**K**, **I**, **C**	• Conduct lab to determine physical and chemical properties of hydrocarbons
3	HEV.01, .02, HE1.04, 1.05, 1.06, 2.01, 2.05, 2.06, 2.07, SIS.01, .02, .03, .05, .07, .08, .09 CGE3c; 4f; 5a,e	**K**, **I**, **C**,	• Conduct lab to study the combustion of hydrocarbons • Hydrocarbons as a source of energy • Solve calorimetry and $Q = mc\Delta T$ problems
4	HEV.02, .03, HE3.01, 3.02, SIS.06, .10 CGE1d, e, i; 2e; 3b,d; 4f,g	**C**, **MC**	• Organic products and environmental issues

Unit 5: Solutions and Solubility

Time: 23 hours

Unit Description

Students demonstrate an understanding of the properties of solutions, the concept of concentration, and the Arrhenius and Bronsted-Lowry theories of acids and bases, building on the Grade 10 Science Course Expectations.

In the first cluster, students demonstrate an understanding of the importance of water as a solvent and as a symbol in the sacraments and rituals of the Catholic Faith. Students explain the dissolving process, describe examples of solutions from everyday life that involve all three states of matter, prepare solutions of required concentrations, and solve problems involving concentration of solutions. (**Note:** When addressing the properties of water and the importance of water as a solvent, teachers should make students aware that there are many substances that are not soluble in water.)

In the second cluster, students continue to develop their understanding of solutions and practise their Scientific Investigative Skills. Through experimentation, students determine qualitative and quantitative properties of solutions. Lastly, they describe combinations of aqueous solutions that result in the formation of precipitates, and represent precipitation reactions by their net ionic equations.

In the third cluster, students broaden their knowledge of aqueous solutions to include the study of acids and bases, and solve stoichiometry problems involving solutions. Through experimentation, students use titration procedures to determine the concentration of an acid or base.

In the fourth cluster, students demonstrate their independent research and learning skills through a culminating task where they address pressing environmental issues. In this task, students explain the origins of pollutants in natural waters such as landfill leaching, and identify the allowable concentrations of metallic and organic pollutants in drinking water. The task provides students the opportunity to demonstrate an understanding of chemical solutions, their applications, and the technology required for protecting and enhancing the quality of life. Students learn to become part of the solution to pressing environmental and social issues by making decisions based on not only scientific information but also on ethical values. Additionally, this multidimensional task can be used as a culminating activity for research skills.

Unit Overview Chart

Cluster	Expectations	Assessment	Focus
1	SSV.01, .02, .03, SS1.01, 1.02, 2.02, 2.03, 3.01, 3.02, SIS.06, .10 CGE1d,e; 2e; 3b; 4f; 7d,i,j	**K**, **I**, **C**, **MC**	• Water as a solvent • Conduct a lab and solve problems involving concentration of solution • Applications of solutions to everyday life
2	SSV.01, .02, SS1.03, 1.04, 2.01, 2.04, 2.05, SIS.01, .02, .03, .04, .05, .07, .08, .09 CGE2b; 3c; 4f; 5a,e,g	**K**, **I**, **C**	• Factors affecting solubility • Precipitation reactions and net ionic equations • Qualitative analysis lab
3	SSV.01, .02, SS1.05, 1.06, 1.07, 2.01, 2.06, 2.07, 2.08, 2.09, SIS.01, .02, .03, .05, .07, .08, .09 CGE2b; 3c; 4f; 5a,e,g	**K**, **I**	• Theories of acids and bases • Strength of acids and bases • Lab on effects of dilution on pH • Conduct Titration lab • Stoichiometric calculation

4	SSV.03, SS3.03, 3.04, 3.05, SIS.06, .10 CGE1d,e,i; 2e; 3b,d; 4f; 5e,f; 7a,b,d,i,j	K, I, C, **MC**	• Culminating Task • Water: Vital for Life

Teaching/Learning Strategies

In planning this course, consideration should be given to both the course expectations and the needs of individual students. The teacher should provide learning experiences, which promote interest, understanding, and excellence. In order for this course to prepare students to meet the university entrance requirements, the teacher must deliver the rigorous provincial curriculum emphasizing the theoretical aspects of the course, while incorporating relevant applications. The role of the teacher is to establish the conceptual framework to help the students develop specific skills and attitudes while considering the student's individual learning style. By fostering an atmosphere where learning is meaningful, integrative, challenging, active, and value-based, teachers can help their students become excited about learning. Throughout this course, students should be given numerous and varied opportunities to acquire knowledge and develop skills and attitudes through a variety of teaching and learning strategies. The strategies that the teacher uses should provide students with multiple opportunities to develop and demonstrate their learning and skills across all four categories of the Achievement Chart.

Expectations that require Knowledge can be developed through:

- brainstorming, e.g., GA3.02, 3.03; HE3.02; SS3.03
- teacher-directed lessons and discussions, e.g., GA3.02, 3.03; HE3.02; SS3.03
- small group instruction, e.g., GA3.03
- independent research, e.g., GA3.02, 3.03; HE3.02; SS3.03
- self-directed learning, etc., e.g., GA2.03

Expectations that involve Inquiry can be met by:

- conducting and analysing experiments e.g., GA2.03, 2.06; MC2.06, 2.07; HE2.04, 2.05, 2.07
- designing lab investigations e.g., SIS.02, SIS.03
- formulating questions e.g., GA3.02, 3.03; HE3.02; SS3.03
- solving problems e.g., GA2.04, 2.05; QC2.03, 2.04, 2.07, 2.08, 2.09; SS2.02, 2.04

Expectations that encourage Communication can be demonstrated by:

- written reports e.g., GA3.02, 3.03; HE3.02; SS3.03
- group discussions e.g., GA3.02; HE3.02; SS3.03
- debates e.g., HE3.02; SS3.03
- seminars e.g., GA3.01, 3.02, 3.03, 3.04
- student presentations, e.g., oral presentations, video and audio presentations, skits, photo essays etc.

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

- independent research
- exposure to experts in their field (for example guest speakers, or by attending University lectures)
- reflective papers
- portfolios
- participation in science fairs
- reading Church documents (see Resources).

Assessment & Evaluation of Student Achievement

In order for students to demonstrate their mastery of the knowledge and skills required for University entrance, the teacher should establish a balanced assessment plan for the course and select appropriate methods, strategies, and tools. Students will be required to demonstrate that they have developed both independent research skills and independent learning skills.

Assessment is the process of gathering information from a variety of sources that accurately reflects how well a student is achieving the curriculum expectations. As part of assessment, teachers must provide students with descriptive feedback that guides their efforts towards improvement. Evaluation refers to the process of judging the quality of student work on the basis of established criteria, and assigning a value that represents that quality. The primary purpose of assessment and evaluation is to improve student learning. Information gathered through assessment helps teachers to determine students' strengths and weaknesses in their achievement of the curriculum expectations.

Assessment and evaluation must be based on the learning expectations for this course and the achievement levels outlined in the *Program Planning and Assessment, 2000* document. When designing and planning this course, the Learning Expectations were clustered in order to balance the categories within the Achievement Chart. Teachers are encouraged at the beginning and throughout the course, to share the assessment criteria with the students and their parents and give feedback that guides the students' efforts towards improvement. The assessment results should be used to motivate students and help them establish next steps in their learning goals. In order to ensure that assessment and evaluations are valid and reliable, the teacher should use assessment and evaluation strategies that:

- address both what the students learn and how well they learn it;
- are based on both the categories of knowledge and skills and on the achievement levels;
- are varied in nature, administered over a period of time, and demonstrate the full range of learning;
- promote the students' ability to assess their own learning and to set specific goals.

Assessment practices should provide information on what students write, say, and do.

Possible **assessment strategies** include:

- paper and pencil: tests, quizzes, concept maps, essay, written report/lab reports, research paper;
- personal communication: interviews, conferences, journals, classroom discussions;
- performance task: individual presentations, plays/skits, lab performance.

The **tools** used to effectively measure the students' learning and mastery of skills include:

- checklist;
- marking scheme;
- rating scale;
- rubric.

As a university preparation course, we recommend that teachers carefully consider a balanced weighting of the four categories of achievement: Knowledge/Understanding, Inquiry, Communication, and Making Connections throughout all the units and in the final evaluation. This will help to ensure that the students have the opportunity to develop and demonstrate their achievement of the knowledge, and the independent research and learning skills necessary for this university preparation course.

The Provincial Report Card contains separate sections for reporting on achievement of the curriculum expectations and for reporting on demonstrated skills required for effective learning. The student's final grade for this course will be determined as follows:

- **Seventy per cent** (70%) of the grade will be based on evaluations conducted throughout this course. This portion of the grade should reflect the students' most consistent level of achievement throughout the course, although special consideration should be given to the most recent evidence of achievement.

- **Thirty per cent** (30%) of the grade will be based on a final evaluation administered towards the end of the course. The weighting of each of the four categories in the final evaluation should be consistent with the assessment/evaluation practices used throughout the course. It is recommended that the final evaluation for this university preparation course be in the form of a final examination comprised of both a written and lab-based component.

Teachers may choose to encourage students to design and conduct a Science Fair project, which would allow them to further develop their independent research and learning skills. This project could be considered as part of the final thirty percent of the students' grade; however, it must address expectations from several units.

Accommodations

Teachers must consider the needs of exceptional students in the planning of the Science curriculum. Accommodation to the program activities and/or the environment may be necessary. Where the student has an Individual Education Plan (IEP) the teacher must meet the needs of the student as outlined in the Plan.

Exceptional students, as well as other students who are not identified as exceptional but who have an IEP and are receiving special education programs and services, should be given every opportunity to achieve the curriculum expectations set out for this course.

A variety of teaching approaches may need to be used to help exceptional students achieve the learning expectations of this course. Examples of such approaches may include:

- using special resources, e.g., reading material consistent with students' reading levels and learning styles, audio tapes of difficult chapters, adapted computers;
- using specialized equipment and assistance specific to the chemistry lab, e.g., providing access to sinks, burners, balances, etc., assistance with handling of chemicals and reagents;
- using a variety of Teaching/Learning strategies, e.g., special interest groupings for research projects, collaborative groups, mentorship programs, independent study plans;
- collaborating with resource teachers, teacher librarians and other professionals;
- consulting with parents about providing an appropriate study environment in the home;
- allowing more time for the completion of assignments or achievement of the learning expectations;
- providing alternative ways of completing tasks or presenting information (e.g., taped answers);
- simplifying the language of instruction;
- providing alternative homework assignments;
- providing alternative tasks for highly motivated and gifted students, e.g., encourage participation in Science Fair competitions, subject specific university founded competitions, such as, the University of Waterloo Avogadro Contest, or the Chemical Institute of Canada Crystal Growing Competition, attendance at university sponsored activities/lectures, and establishing mentorship programs with local Colleges and Universities.

Assessment procedures and strategies may also need to be modified. Examples include:

- time requirement of assignments or assessment tasks;
- format of the assessment material, e.g., braille;
- use of scribes, tape recorders, word processors etc.

For English as a second language (ESL) students or English literacy development (ELD) students, teachers should provide opportunities for the students to demonstrate their learning by alternate means such as: pairing written instructions with verbal instructions; using key visuals to illustrate definitions; allowing extra time for reading or written assignments; encouraging the use of first language dictionaries for assignments.

For students with physical or learning impairments, classroom and laboratory activities should be altered to permit maximum participation.

Resources

Note: The URLs for the websites have been verified by the writer prior to publication. Given the frequency with which these designations change, teachers should always verify the websites prior to assigning them for student use.

Print

Brady, J. and J. Holum. *Fundamentals of Chemistry*. Toronto: John Wiley and Sons, 1988. ISBN 0-471-84473-X

Bruckman J., and A. Cruickshanks. *Understanding Chemistry*. Toronto: John Wiley and Sons Canada Limited, 1988. ISBN 0-471-79684-0

Burton, G., J. Holman, G. Pilling, and D. Waddington. *Salters Advanced Chemistry-Chemical Storylines*. Oxford: Heinemann Educational Publishers, 1994. ISBN 0-435-63106-3

Catechism of the Catholic Church, Canadian Conference of Catholic Bishops, 1994. (Should be available in all school libraries.)

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Crucible, Magazine of the Science Teachers' Association of Ontario. ISSN –381-8047

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Journal of Chemical Education. ISSN 0021-9584

Chem13 News, University of Waterloo

Origins: Catholic News Service, 3211 4th Str. N.E. Washington D.C. ISBN 200017-1100

Documents from the Ontario Conference of Catholic Bishops:

a) For the Good of All, (1992).
b) The People of the Land, (1989).

Videotapes

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, 1994. CBC. News for Review: 1996 - 1998.

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Chemistry Explorer 3.04, Lewiston: Tangent Scientific, 1999.

Chemistry with Computers, Using Logger Pro, Dan D. Holmquist and Donald L. Volz, Vernier Software.

Interactive General Chemistry, Lewiston: Tangent Scientific, 1999.

Internet Sites

A comprehensive listing of science sites – www.enc.org

Chemical Institute of Canada – http://www.chem-ist-can.org

ChemEd: Chemistry Education Resources – http://www.hpcc.astro.washington.edu/scied/chemistry.html

Chemistry Lesson Plans – http://www.teach-nology.com

Chemistry Resources – http://www.dist214.k12il/users/asander/chemhome2.html

Interactive Chemistry – http://hamer.chem.wisc.edu/chapman/index.html

Journal of Chemical Education – http://www.JChemEd.chem.wisc.edu

SCIENCE IS FUN in the Lab of Shakhashiri – http://scifun.chem.wisc.edu/scifun.html

Science Resource Centre – http://chem.lapeer.org Annotated list of web sites for science educators

STAO Classroom Resources for Science Teachers
– http://www.yorku.ca/faculty/academic/jlibman/staopage.htm

The Why Files – http://whyfiles.news.wisc.edu Explains the science behind current news items

OSS Considerations

Students can benefit from experiences in chemistry-related activities through a Cooperative Education placement related to this course. Students should explore chemistry-related careers throughout the course and consider them when they are developing their Annual Education Plan (AEP).

Students may choose to job shadow. This gives them an opportunity to observe and gain a better understanding of chemistry related careers, for example in the area of chemical research, environmental sciences, health services, etc.

Students should have a safe environment for learning free from harassment of all types, violence, and expressions of hate. Learning activities should be designed to help students develop respect for human rights and dignity, and to develop a sense of personal, social, and civic responsibility.

Students graduating from Ontario schools are expected to be technologically literate. Through the study of this Science course students should be able to understand and apply technological concepts to use computers in various applications and to analyse the implications of technology on individuals and society.

Coded Expectations, Chemistry, Grade 11, University Preparation, SCH3U

Scientific Investigation Skills

SIS.01 · demonstrate an understanding of safe laboratory practices by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials (e.g., safely disposing of hazardous solutions; correctly interpreting Workplace Hazardous Materials Information System [WHMIS] symbols), and using appropriate personal protection (e.g., wearing safety goggles);

SIS.02 · select appropriate instruments and use them effectively and accurately in collecting observations and data (e.g., use a balance to accurately measure the mass of a precipitate);

SIS.03 · demonstrate the skills required to plan and carry out investigations using laboratory equipment safely, effectively, and accurately (e.g., plan and carry out an investigation to determine the percentage composition of a compound);

SIS.04 · demonstrate a knowledge of emergency laboratory procedures;

SIS.05 · select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results (e.g., present a detailed experimental report according to specified standards);

SIS.06 · compile and interpret data or other information gathered from print, laboratory, and electronic sources, including Internet sites, to research a topic, solve a problem, or support an opinion (e.g., research the uses of the most common products of the refining of petroleum);

SIS.07 · communicate the procedures and results of investigations for specific purposes by displaying evidence and information, either in writing or using a computer, in various forms, including flow charts, tables, graphs, and laboratory reports (e.g., draw a graph of the relationship between the volume and pressure of a fixed amount of gas at constant temperature);

SIS.08 · express the result of any calculation involving experimental data to the appropriate number of decimal places or significant figures;

SIS.09 · select and use appropriate SI units (units of measurement of the *Système international d'unités*, or International System of Units);

SIS.10 · identify and describe science- and technology-based careers related to the subject area under study (e.g., describe careers in the area of hydrocarbons and energy, such as chemical engineering, or careers in transportation related to the research and development of new fuels).

Matter and Chemical Bonding

Overall Expectations

MCV.01 · demonstrate an understanding of the relationship between periodic tendencies, types of chemical bonding, and the properties of ionic and molecular compounds;

MCV.02 · carry out laboratory studies of chemical reactions, analyse chemical reactions in terms of the type of reaction and the reactivity of starting materials, and use appropriate symbols and formulae to represent the structure and bonding of chemical substances;

MCV.03 · describe how an understanding of matter and its properties can lead to the production of useful substances and new technologies.

Specific Expectations

Understanding Basic Concepts

MC1.01 – define and describe the relationship among atomic number, mass number, atomic mass, isotope, and radio isotope;

MC1.02 – demonstrate an understanding of the periodic law, and describe how electron arrangement and forces in atoms can explain periodic trends such as atomic radius, ionization energy, electron affinity, and electronegativity;

MC1.03 – demonstrate an understanding of the formation of ionic and covalent bonds and explain the properties of the products;

MC1.04 – explain how different elements combine to form covalent and ionic bonds using the octet rule;

MC1.05 – demonstrate an understanding of the relationship between the type of chemical reaction (e.g., synthesis, decomposition, single and double displacement) and the nature of the reactants;

MC1.06 – relate the reactivity of a series of elements to their position in the periodic table (e.g., compare the reactivity of metals in a group and metals in the same period; compare the reactivity of non-metals in a group).

Developing Skills of Inquiry and Communication

MC2.01 – use appropriate scientific vocabulary to communicate ideas related to chemical reactions (e.g., *electronegativity, chemical bond, periodic trend, ionization energy, electron affinity*);

MC2.02 – analyse data involving periodic properties such as ionization energy and atomic radius in order to recognize general trends in the periodic table;

MC2.03 – predict the ionic character or polarity of a given bond using electronegativity values, and represent the formation of ionic and covalent bonds using diagrams;

MC2.04 – draw Lewis structures, construct molecular models, and give the structural formulae for compounds containing single and multiple bonds;

MC2.05 – write, using IUPAC or traditional systems, the formulae of binary and tertiary compounds, including those containing elements with multiple valences, and recognize the formulae in various contexts;

MC2.06 – predict the products of, and write chemical equations to represent, synthesis, decomposition, substitution, and double displacement reactions, and test the predictions through experimentation;

MC2.07 – investigate through experimentation the reactions of elements (e.g., metals) to produce an activity series.

Relating Science to Technology, Society, and the Environment

MC3.01 – identify chemical substances and reactions in everyday use or of environmental significance (e.g., fertilizers, greenhouse gases, photosynthesis);

MC3.02 – relate common names of substances to their systematic names (e.g., *muriatic acid* and *hydrochloric acid; baking soda* and *sodium bicarbonate*);

MC3.03 – evaluate and compare the reactivity of metals and alloys (e.g., gold in jewellery, iron and stainless steel), and explain why most metals are found in nature as compounds;

MC3.04 – demonstrate an understanding of the need for the safe use of chemicals in everyday life (e.g., cleaners in the home, pesticides in the garden).

Quantities in Chemical Reactions

Overall Expectations

QCV.01 · demonstrate an understanding of the mole concept and its significance in the analysis of chemical systems;

QCV.02 · carry out experiments and complete calculations based on quantitative relationships in balanced chemical reactions;
QCV.03 · demonstrate an awareness of the importance of quantitative chemical relationships in the home or in industry.

Specific Expectations

Understanding Basic Concepts

QC1.01 – demonstrate an understanding of Avogadro's number, the mole concept, and the relationship between the mole and molar mass;
QC1.02 – explain the relationship between isotopic abundance and relative atomic mass;
QC1.03 – distinguish between the empirical formula and the molecular formula of a compound;
QC1.04 – explain the law of definite proportions;
QC1.05 – state the quantitative relationships expressed in a chemical equation (e.g., in moles, grams, atoms, ions, or molecules).

Developing Skills of Inquiry and Communication

QC2.01 – use appropriate scientific vocabulary to communicate ideas related to chemical calculations (e.g., *stoichiometry, percentage yield, limiting reagent, mole, atomic mass*);
QC2.02 – determine percentage composition of a compound through experimentation, as well as through analysis of the formula and a table of relative atomic masses (e.g., composition of a hydrate);
QC2.03 – solve problems involving quantity in moles, number of particles, and mass;
QC2.04 – determine empirical formulae and molecular formulae, given molar masses and percentage composition or mass data;
QC2.05 – balance chemical equations by inspection;
QC2.06 – balance simple nuclear equations;
QC2.07 – calculate, for any given reactant or product in a chemical equation, the corresponding mass or quantity in moles or molecules of any other reactant or product;
QC2.08 – solve problems involving percentage yield and limiting reagents;
QC2.09 – compare, using laboratory results, the theoretical yield of a reaction (e.g., of steel wool and copper II sulfate solution) to the actual yield, calculate the percentage yield, and suggest sources of experimental error.

Relating Science to Technology, Society, and the Environment

QC3.01 – give examples of the application of chemical quantities and calculations (e.g., in cooking recipes, in industrial reactions, in prescription drug dosages);
QC3.02 – explain how different stoichiometric combinations of elements in compounds can produce substances with different properties (e.g., water and hydrogen peroxide, carbon monoxide and carbon dioxide);
QC3.03 – identify everyday situations and work-related contexts in which analysis of unknown substances is important (e.g., quality control of composition of products; drug analysis in forensics).

Solutions and Solubility

Overall Expectations

SSV.01 · demonstrate an understanding of the properties of solutions, the concept of concentration, and the importance of water as a solvent;
SSV.02 · carry out experiments and other laboratory procedures involving solutions, and solve quantitative problems involving solutions;
SSV.03 · relate a scientific knowledge of solutions and solubility to everyday applications, and explain how environmental water quality depends on the concentrations of a variety of dissolved substances.

Specific Expectations

Understanding Basic Concepts

SS1.01 – demonstrate an understanding of the importance of water as a universal solvent and describe the properties of this liquid (e.g., polarity, hydrogen bonding);

SS1.02 – explain solution formation that involves the dissolving of ionic or non-ionic substances in water (e.g., oxygen in water, salt in water) and the dissolving of non-polar solutes in non-polar solvents (e.g., grease in gasoline);

SS1.03 – describe the dependence on temperature of solubility in water for solids, liquids, and gases;

SS1.04 – describe common combinations of aqueous solutions that result in the formation of precipitates;

SS1.05 – demonstrate an understanding of the Arrhenius and Bronsted-Lowry theories of acids and bases;

SS1.06 – explain qualitatively, in terms of degree of dissociation, the difference between strong and weak acids and bases;

SS1.07 – demonstrate an understanding of the operational definition of pH (i.e., $pH = -\log_{10}[H^+]$).

Developing Skills of Inquiry and Communication

SS2.01 – use appropriate scientific vocabulary to communicate ideas related to aqueous solutions (e.g., *concentration, solubility, conjugate acid, precipitate*);

SS2.02 – solve problems involving concentration of solutions and express the results in various units (e.g., moles per litre, grams per 100 mL, parts per million [and billion], mass or volume per cent);

SS2.03 – prepare solutions of required concentration by dissolving a solid solute or diluting a concentrated solution;

SS2.04 – determine, through experiments, qualitative and quantitative properties of solutions (e.g., perform a qualitative analysis of ions in a solution; plot solubility curves for some common solutes in water), and solve problems based on such experiments;

SS2.05 – represent precipitation reactions by their net ionic equations;

SS2.06 – determine through experimentation the effect of dilution on the pH of an acid or a base;

SS2.07 – write balanced chemical equations for reactions involving acids and bases (e.g., dissociation, displacement, and neutralization reactions);

SS2.08 – solve stoichiometry problems involving solutions;

SS2.09 – use a titration procedure to determine the concentration of an acid or base in solution (e.g., acetic acid in vinegar).

Relating Science to Technology, Society, and the Environment

SS3.01 – supply examples from everyday life of solutions involving all three states (e.g., carbonated water, seawater, alloys, air);

SS3.02 – describe examples of solutions for which the concentration must be known and exact (e.g., intravenous solutions, drinking water);

SS3.03 – explain the origins of pollutants in natural waters (e.g., landfill leachates, agricultural run-off), and identify the allowable concentrations of metallic and organic pollutants in drinking water;

SS3.04 – describe the technology and the major steps involved in the purification of drinking water and the treatment of waste water;

SS3.05 – explain hardness of water, its consequences (e.g., pipe scaling), and water-softening methods (e.g., ion exchange resins).

Gases and Atmospheric Chemistry

Overall Expectations

GAV.01 · demonstrate an understanding of the laws that govern the behaviour of gases;

GAV.02 · investigate through experimentation the relationships among the pressure, volume, and temperature of a gas, and solve problems involving quantity of substance in moles, molar masses and volumes, and the gas laws;

GAV.03 · describe how knowledge of gases has helped to advance technology, and how such technological advances have led to a better understanding of environmental phenomena and issues.

Specific Expectations

Understanding Basic Concepts

GA1.01 – explain different states of matter in terms of the forces between atoms, molecules, and ions;

GA1.02 – describe the gaseous state, using kinetic molecular theory, in terms of degree of disorder and types of motion of atoms and molecules;

GA1.03 – describe the quantitative relationships that exist among the following variables for an ideal gas: pressure, volume, temperature, and amount of substance;

GA1.04 – explain Dalton's law of partial pressures;

GA1.05 – state Avogadro's hypothesis and describe his contribution to our understanding of reactions of gases;

GA1.06 – identify the major and minor components of the atmosphere.

Developing Skills of Inquiry and Communication

GA2.01 – use appropriate scientific vocabulary to communicate ideas related to gases (e.g., standard temperature, standard pressure, molar volume, ideal gas);

GA2.02 – use and interconvert appropriate units to express pressure (e.g., pascals, atmospheres, mm Hg) and temperature (e.g., Celsius and Kelvin scales);

GA2.03 – determine through experimentation the quantitative and graphical relationships among the pressure, volume, and temperature of an ideal gas;

GA2.04 – solve quantitative problems involving the following gas laws: Charles's law, Boyle's law, the combined gas law, Gay-Lussac's law, Dalton's law of partial pressures, the ideal gas law;

GA2.05 – perform stoichiometric calculations involving the quantitative relationships among the quantity of substances in moles, the number of atoms, the number of molecules, the mass, and the volume of the substances in a balanced chemical equation;

GA2.06 – determine the molar volume of a gas through experimentation (e.g., calculate the molar volume of hydrogen gas from the reaction of magnesium with hydrochloric acid).

Relating Science to Technology, Society, and the Environment

GA3.01 – describe natural phenomena (e.g., geysers, volcanic eruptions) and technological products (e.g., rocket engine, carbonated drinks, air bags) associated with gases;

GA3.02 – explain Canadian initiatives to improve air quality (e.g., the recycling of chlorofluorocarbons, the Montreal Protocol);

GA3.03 – identify technological products and safety concerns associated with compressed gases (e.g., propane tanks, medical oxygen tanks, welders' acetylene tanks);

GA3.04 – describe how knowledge of gases is applied in other areas of study (e.g., meteorology, medical anaesthetics, undersea exploration).

Hydrocarbons and Energy

Overall Expectations

HEV.01 · demonstrate an understanding of the structure and properties of hydrocarbons, especially with respect to the energy changes that occur in their combustion;

HEV.02 · describe and investigate the properties of hydrocarbons, and apply calorimetric techniques to the calculation of energy changes;

HEV.03 · evaluate the impact of hydrocarbons on our quality of life and the environment through an examination of some of their uses.

Specific Expectations

Understanding Basic Concepts

HE1.01 – identify the origins and major sources of organic compounds;

HE1.02 – demonstrate an understanding of the particular characteristics of the carbon atom, especially with respect to bonding in both aliphatic and cyclic alkanes, including structural isomers;

HE1.03 – describe some of the physical and chemical properties of hydrocarbons (e.g., solubility in water, density, melting point, boiling point, and combustibility of the alkanes);

HE1.04 – compare the energy changes observed when chemical bonds are formed and when they are broken, and relate these changes to endothermic and exothermic reactions;

HE1.05 – explain how mass, heat capacity, and change in temperature of an object determine the amount of heat it gains or loses;

HE1.06 – identify ways in which reactants, products, and a heat term are combined to form thermochemical equations representing endothermic and exothermic chemical changes.

Developing Skills of Inquiry and Communication

HE2.01 – use appropriate scientific vocabulary to communicate ideas related to hydrocarbons and the energy changes involved in their combustion (e.g., organic compound, saturated hydrocarbons, unsaturated hydrocarbons, isomer, heat capacity);

HE2.02 – name, using the IUPAC nomenclature system, and draw structural representations for, aliphatic and cyclic hydrocarbons containing no more than ten carbon atoms in the main chain, with or without side chains;

HE2.03 – use molecular models to demonstrate the arrangement of atoms in isomers of hydrocarbons (e.g., structural and cis-trans isomers);

HE2.04 – determine through experimentation some of the characteristic properties of saturated and unsaturated hydrocarbons (e.g., compare the products obtained when bromine is added to cyclohexane and cyclohexene separately);

HE2.05 – carry out an experiment involving the production or combustion of a hydrocarbon (e.g., formation of acetylene, burning paraffin) and write the corresponding balanced chemical equation;

HE2.06 – write balanced chemical equations for the complete and incomplete combustion of hydrocarbons;

HE2.07 – gather and interpret experimental data and solve problems involving calorimetry and the equation $Q = mc\Delta T$ (e.g., calculate the energy liberated in the combustion of paraffin in J/g).

Relating Science to Technology, Society, and the Environment

HE3.01 – describe the steps involved in refining petroleum to obtain gasoline and other useful fractions (e.g., butane, furnace oil, industrial chemicals and solvents);

HE3.02 – demonstrate an understanding of the importance of hydrocarbons as fuels (e.g., propane for barbecues) and in other applications, such as the manufacture of polymers, and identify the risks and benefits of these uses to society and the environment.

Ontario Catholic School Graduate Expectations

The graduate is expected to be:

A Discerning Believer Formed in the Catholic Faith Community who

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

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

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

A Self-Directed, Responsible, Life Long Learner who

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

A Collaborative Contributor who

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

A Caring Family Member who

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

A Responsible Citizen who

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

Unit 1: Gases and Atmospheric Chemistry

Time: 24 hours (1440 minutes)

Unit Description

In the first cluster of this unit, students examine the nature of the atmosphere by identifying its major and minor components, recognize the importance of the atmosphere in supporting life on earth, and determine the relevancy of gases in their lives. As informed responsible citizens, the students reflect on how the use of technological products can enhance the quality of life and contribute to the common good. They explain the intermolecular forces found in different states of matter and further describe the gaseous state using kinetic molecular theory. Students describe natural phenomena and technological products associated with gases.

In the second cluster, students use experimental data to develop the mathematical relationships for Boyle's law, Charles' law, and Gay-Lussac's law and incorporate the knowledge of these laws to develop the combined gas law equation. Students use Dalton's law of partial pressure to solve numerical problems that involve the collection of a gas by the downward displacement of water. Students use research to identify technological products and the corresponding safety concerns associated with the use of compressed gases, e.g., propane tanks in the home and workplace.

In the third cluster, students state Avogadro's hypothesis and demonstrate an understanding of Avogadro's number, the mole, and molar mass. Students experimentally determine the molar volume of a gas and solve quantitative problems involving the ideal gas law.

In the fourth cluster, students describe technological advances and applications of gases in other disciplines, examine gas related environmental issues affecting society, and explain Canadian initiatives to improve air quality. Students plan, organize, and participate in the "Gases and Life" conference. Throughout the unit, students recognize their role as stewards of the earth in addressing the environmental concerns and issues relating to Canada's atmosphere.

(**Note:** Expectation **QC1.01** is addressed in this unit and revisited in Unit 3: Quantities in Chemical Reactions. In addition, expectation **GA2.05** will not be covered in Unit 1, but addressed in Unit 3 along with other stoichiometry problems).

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Task
1. **Gases and the Atmosphere** 1.1 The Atmosphere 1.2 Explaining Properties of Gases 1.3 Introducing End-of-Unit Task	300 min.	GAV.01, GAV.03, GA1.01, GA1.02, GA1.06, GA3.01, SIS.06 CGE1d,i; 2e; 3b; 7d,i,j	**K**, C MC	- Concept Map and class discussion - Reflection (atmosphere) - Poster of Natural Phenomena and Technological Products
2. **Gas Laws** 2.1 Boyle's Law 2.2 Charles' Law 2.3 Gay-Lussac's Law 2.4 Combined and Dalton's Laws 2.5 Gas Law Game 2.6 Consumer Pamphlet 2.7 Preparing End-of-Unit Task	540 min.	GAV.01, GAV.02, GAV.03, GA1.03, GA1.04, GA2.01, GA2.02, GA2.03, GA2.04, GA3.03, SIS.01, SIS.02, SIS.03, SIS.04, SIS.05, SIS.07, SIS.08 CGE1d; 2e; 3b,c,d,e	K, I C MC	- Experiments: - Boyle's Law - Charles' Law - Gay-Lussac's Law - Problem solving and game - Consumer pamphlet and presentation

3. **Avogadro and Molar Calculations** 3.1 Avogadro's Law 3.2 Mole and Molar Mass 3.3 End of Unit Task 3.4 Molar Volume 3.5 Ideal Gas Law	375 min.	GAV.01, GAV.02, GA1.05, **QC1.01**, GA2.04, GA2.06, SIS.05, SIS.07, SIS.09 CGE3c; 4f; 5f,g	**K** **I**	- Counting Activity - Problem solving - Molar volume lab
4. **Gases and Life** 4.1 Gases in Other Disciplines 4.2 Air Quality	225 min.	GAV.03, GA3.02, GA3.04, SIS.10 CGE 1d,e; 2e,3b,c,d,e; 4f; 5e; 7a,b,d,i,j	K, I, **C**, **MC**	- Conference: Exhibits and Displays - Air Quality seminars

Activity 1: Gases and the Atmosphere

Time: 300 minutes

Description

Students examine the nature of the atmosphere by identifying its major and minor components. Students recognize the importance of the atmosphere in supporting life on Earth, and determine the relevancy of gases in their lives. As informed responsible citizens, the students reflect on how the use of technological products can enhance the quality of life and contribute to the common good. They explain the intermolecular forces found in different states of matter and further describe the gaseous state using the kinetic molecular theory. Lastly, students describe natural phenomena and technological products associated with gases.

Strand(s) & Learning Expectations

Strand(s): Gases and Atmospheric Chemistry

Overall Expectations

GAV.01 - demonstrate an understanding of the laws that govern the behaviour of gases;
GAV.03 - describe how knowledge of gases has helped to advance technology, and how such technological advances have led to a better understanding of environmental phenomena and issues.

Specific Expectations

GA1.01 - explain different states of matter in terms of the forces between atoms, molecules, and ions;
GA1.02 - describe the gaseous state, using kinetic molecular theory, in terms of degree of disorder and types of motion of atoms and molecules;
GA1.06 - identify the major and minor components of the atmosphere;
GA3.01 - describe natural phenomena and technological products associated with gases.

Scientific Investigation Skills

SIS.06 - compile and interpret data or other information gathered from print, laboratory, and electronic sources, including Internet sites, to research a topic, solve a problem, or support an opinion.

Ontario Catholic School Graduate Expectations

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;
CGE1i - integrates faith with life;
CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life;
CGE3b - creates, adapts, evaluates new ideas in light of the common good;

CGE7d - promotes the sacredness of life;
CGE7i - respects the environment and uses resources wisely;
CGE7j - contributes to the common good.

Planning Notes

- Air pollution and environmental issues associated with air quality are introduced in Activity 1 to stress their significance and to provide a focus for the end-of-unit task, "Gases and Life" conference found in Activity 4.
- Photos of atmospheric phenomena, e.g., Aurora Borealis, and information on various forms of air pollution, e.g., smog, acid rain, global warming, or ozone layer, should be gathered in advance to provide students with an appreciation of the Earth's atmosphere and the role of gases in the universe. These should be used throughout the unit, whenever appropriate.
- The end-of-unit task for this Unit is a conference, called "Gases and Life", consisting of student workshops/seminars on Canadian initiatives to improve air quality, and displays/exhibits of applications of gases in their lives. The exhibits should display students' products developed in Activities 1.1 (poster), 2.6 (pamphlet), and 4.1(newspaper flyer). The student groups for Activities 1.1, 2.6, and 4.1 should remain the same throughout the Unit and new groups with specific assigned roles are established for the student workshops/seminars (Activity 4.2). Students should be provided with ample opportunities to research their topics throughout the Unit so that they have sufficient time to prepare and present the finished products for the conference. The time allocated for this conference is 450 minutes, of which 225 minutes is evenly distributed over Activities 1, 2, and 3. The remaining time, (225 minutes) is used in Activity 4.
- Teachers are encouraged to use local resources available from their communities and environmental agencies, and locate web sites directly by researching air quality for their particular area, e.g., www.airqualityontario.com.
- Prepare all materials and equipment as required, e.g., readings, photos, handouts, etc.
- A barometer would be useful for measuring atmospheric pressure. If possible, invite a weather specialist to discuss how barometric readings are used in weather forecasting.
- Make arrangements to have the students visit the school Library/Resource Centre as required. If it is not available, collect resources for classroom use or arrange Internet access through your computer department.
- Review the ethical use of the Internet with the students.
- It is recommended that a Unit test be given before Activity 4.

Prior Knowledge & Skills

- Grade 10 Science: Chemistry and Earth and Space Science
- Grade 9 Science: Chemistry and Earth and Space Science

Teaching/Learning Strategies

Activity 1.1: The Atmosphere

The teacher:

- arranges groups and instructs students to make a concept map for gases using the possible headings: definitions, properties, examples, and uses/applications;
- reviews briefly the formation of the universe outlining the importance of gases;
- reads in unison with the class *A Prayer of Gratitude* (Appendix A);
- introduces Earth's atmosphere as a mixture of gases and identifies the major and minor components of the atmosphere by providing students with atmospheric composition data;
- leads a class discussion on the importance of clean air to life on Earth;

- assists students in identifying possible air pollutants and in recognizing environmental issues in Canada and world-wide related to air quality;
- instructs students to read passages from Scripture, the Psalms especially, and write a reflection on the importance of the atmosphere to life on Earth;
- introduces the end-of-unit task, the "Gases and Life" conference, to be held in Activity 4;
- groups students in pairs and assigns a poster presentation which describes a natural phenomena, e.g., geysers, volcanic eruptions, or a technological product, e.g., rocket engine, pressurized tanks, carbonated drinks, or air bags, associated with gases. The poster should include the following: the specific gases involved (identified as major or minor components of the atmosphere), a labelled diagram of the natural phenomena or technological product, and a written summary describing the chosen topic;
- conferences with groups to ensure their poster topics and content are relevant and appropriate;
- assesses the poster and the presentation;
- instructs students to write a reflection on one of the technological products described commenting on whether its use enhances quality of life and contributes to the common good.

Students:

- brainstorm, in their assigned groups, to create a concept map for gases;
- read the prayer, reflect, and comment on the importance of air to life on Earth;
- identify and record the major and minor components of the atmosphere;
- list air pollutants and identify the environmental issues in Canada and world-wide related to air quality;
- read the passages from Scripture that make reference to wind and air (e.g., Genesis 8:1; Exodus 10:13; Numbers 11:31; Proverbs 11:29; Ecclesiastes 1:6; John 3:8; Acts 2:2; 1Kings 19:11-13);
- write a reflection on the importance of the atmosphere to life on Earth;
- choose, research, and gather information on an approved topic for their poster;
- submit their poster for assessment and present their work to the class;
- write a reflection on one of the technological products described commenting on whether its use enhances quality of life and contributes to the common good.

Activity 1.2: Explaining the Properties of Gases

The teacher:

- reviews the terms atoms, molecules, and ions;
- provides samples of solids, liquids, and gases for visual comparison and instructs students, working in pairs, to compare and contrast the properties of the three states of matter in chart form and asks them to hypothesize why gases are different from liquids and solids;
- defines kinetic energy and reviews the postulates of the Kinetic Molecular Theory, (KMT);
- leads a class discussion on the role of attractive forces between particles;
- defines pressure using familiar examples, e.g., tire pumps, balloons, etc., demonstrates how to measure atmospheric pressure using a barometer, and describes other devices to measure pressure of enclosed gases, e.g., gauges, manometers;
- introduces and states the SI units for volume, temperature, and pressure;
- directs students to use KMT to describe the gaseous state;
- assigns and assesses a student summary sheet describing the gaseous state in terms of intermolecular forces, degree of disorder, and types of motion of atoms and molecules explaining why gases are different from liquids and solids.

Students:

- record the definitions of atoms, molecules, and ions and provide examples;
- prepare a chart to compare and contrast the properties of the three states of matter;
- brainstorm possible reasons for differences between the states of matter;
- define kinetic energy and summarize the postulates of KMT;
- through class discussions, explain the different states of matter in terms of the forces between atoms, molecules, and ions;
- record definitions of relevant terms and units for pressure, volume, and temperature;
- use KMT to explain the gaseous state;
- write and submit a summary describing the gaseous state using kinetic molecular theory and explain the different attractive forces in solids, liquids, and gases.

Activity 1.3: Introduction of the End-of-Unit Task

The teacher:

- presents the workshop/seminar component of the conference involving the Canadian initiatives to improve air quality;
- assigns roles, e.g., government, environment specialists, etc., directs students to work on their end-of-unit task, Activity 4.2, and conferences with each research team to ensure they remain on task.

Students:

- meet throughout the unit to research and conference with each other and the teacher;
- work collaboratively to gather information for the assigned task.

Assessment & Evaluation of Student Achievement

- The poster may be assessed for Knowledge/Understanding, Communication, and Making Connections using a rubric. (GA1.06, GA3.01, SIS.06)
- The summary sheet may be assessed for Knowledge/Understanding and Communication using a marking scheme. (GA1.01, GA1.02)

Accommodations

- See the Course Overview for general accommodations.
- Possible enrichment activities:
  - Investigate and write a report on the role of the atmosphere in determining the weather.
  - Research the reactions involved when an air bag is deployed and explain how they involve oxidation and reduction.
  - Identify the major air pollutants and their sources in your community.
  - Explain what happens when a liquid boils.
  - Apply the KMT to explain the compressibility and diffusion of gases.
  - Explore the use and symbolism of air and wind in Scripture.

Resources

Dunlop, Stewart and Michael Jackson. *Understanding Our Environment*. Toronto: Oxford University Press, 1991. ISBN 0-19-540770-9

Gillespie, R., D. Humphreys, N. Baird, and E. Robinson. *Chemistry*. Massachusetts: Allyn and Bacon, Inc., 1989. ISBN 0-205-11795-3

Rayner-Canham, G., et al. *Chemistry: A Second Course*. Don Mills: Addison-Wesley Publishers.1989. ISBN 0-201-17885-0

Whitman, R., E. Zinck, and R. Nalepa. *Chemistry Today 1*. Scarborough: Prentice-Hall Canada Inc., 1988. ISBN 0-13-129306-0

Internet Sites

Air Quality Ontario – http://www.airqualityontario.com

Chemistry Visualized: The World of Physical Chemistry – http://www-wilson.ucsd.edu/educationeducation.html

Church Documents – http://www.vatican.va

David Suzuki Foundation – http://www.davidsuzuki.org

Environment Canada's Green Lane – http://www.ec.gc.ca

Encyclopedia of the Atmospheric Environment – http://www.doc.mmu.ac.uk/aric/eae/enter.htm

Kinetic Molecular Theory and Gas Laws Table of Contents – http://dbhs.wvusd.k12.ca.us/GasLaw/KMT-Gas-Laws.html

Videotapes

Chemistry of the Environment. British Columbia: Davis Film and Video Productions, 1993. 34 minutes.

Activity 2: Gas Laws

Time: 540 minutes

Description

Through lab inquiries, students develop the quantitative and graphical relationships among the pressure, volume, and temperature of ideal gases. Students use the data collected in these inquiries to develop the mathematical relationships for Boyle's law, Charles' law, and Gay-Lussac's law. They incorporate the knowledge of these laws to develop the combined gas law equation. Students use Dalton's law of partial pressure to solve numerical problems that involve the collection of gas by the downward displacement of water. Through research, students identify technological products and the corresponding safety concerns associated with the use of compressed gases, e.g., propane tanks in the home and workplace. As informed Catholic citizens, students reflect on the use of technological products in enhancing the quality of life.

Strand(s) & Learning Expectations

Strand(s): Gases and Atmospheric Chemistry

Overall Expectations

GAV.01 - demonstrates an understanding of the laws that govern the behaviour of gases;

GAV.02 - investigate through experimentation the relationship among pressure, volume and temperature of a gas and solve problems involving quantity of a substance in moles, molar masses and volume, and the gas laws;

GAV.03 - describe how knowledge of gases has helped to advance technology, and how such technological advances have led to a better understanding of environmental phenomena and issues.

Specific Expectations

GA1.03 - describe the quantitative relationships that exist among the following variables for an ideal gas: pressure, volume, temperature, and amount of substance;

GA1.04 - explain Dalton's law of partial pressures;

GA2.01 - use appropriate scientific vocabulary to communicate ideas related to gases;

GA2.02 - use and interconvert appropriate units to express pressure and temperature;

GA2.03 - determine through experimentation the quantitative and graphical relationships among the pressure, volume, and temperature of an ideal gas;

GA2.04 - solve quantitative problems involving the following gas laws: Charles' law, Boyle's law, Gay-Lussac's law, Dalton's law of partial pressures, the ideal gas law;

GA3.03 - identify technological products and safety concern associated with compressed gases.

Science Investigation Skills
SIS.01 - demonstrate an understanding of safe laboratory practices by selecting and applying appropriate techniques for handling, storing, and disposing of laboratory materials, and using appropriate personal protection (e.g., safety goggles);
SIS.02 - select appropriate instruments and use them effectively and accurately in collecting observations and data (e.g., use a balance to accurately measure the mass of a precipitate);
SIS.03 - demonstrate the skills required to plan and carry out investigations using laboratory equipment safely, effectively, and accurately;
SIS.04 - demonstrate knowledge of emergency laboratory procedures;
SIS.05 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results;
SIS.07 - communicate the procedures and results of investigations for specific purposes by displaying evidence and information, either in writing or using a computer, in various forms, including flow charts, tables, graphs, and laboratory;
SIS.08 - express the results of any calculation involving experimental data to the appropriate number of decimal places or significant figures.

Ontario Catholic School Graduate Expectations
CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity, and the common good;
CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life;
CGE3b - creates, adapts, and evaluates new ideas in light of the common good;
CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;
CGE3d - makes decisions in light of gospel values with an informed moral conscience;
CGE3e - adopts a holistic approach to life by integrating learning from various subject areas and experience.

Planning Notes

- As laboratory experiments are performed for the first time in this activity, the importance of safety, the format of lab reports and/or Data Books should be discussed with the students.
- Homework should be assigned to provide enough opportunity to develop student knowledge and problem-solving skills since the gas laws will not be revisited until university. Students should be encouraged to set goals in order to improve their individual problem-solving skills.
- Due to safety concerns, dry ice should be used for teacher demonstrations only.
- There is available a variety of equipment to illustrate the gas laws, including syringes, probes and sensors that interface with computers, and overhead-projector, teacher-demonstration kits. References for experiments and equipment can be found in the Resources section of this profile.
- It is recommended that a variety of equipment be used for these experiments. For example, if computer interface probes or sensors are available, one computer station could be set up for each of the gas law activities so that students can gain experience using this technology. If an Absolute Zero apparatus is not available, teachers could supply students with dry lab data for Gay-Lussac's law.
- There are a number of different computer simulations available with activities on the gas laws. These programs might be useful if a student was absent or if the above apparatus is not available;
- Teachers are encouraged to use graphing calculators or appropriate graphing software.
- The self-discovery method used in this activity/profile might require modifications depending on time limitations and the needs of particular classes.

- Prepare sets of gas law problems, answer sheets, and prizes for the game in Activity 2.5.
- Prepare the paper-and-pencil quiz on all gas law problems for Activity 2.5.
- The research and assessment criteria for the consumer product pamphlet should be introduced in advance to allow students sufficient time to research and produce the final product.
- In this Activity, the students should be provided with 75 minutes to work on their air quality seminars for the end-of-unit task (Activity 2.7).
- Review the ethical use of the Internet with students.
- Make arrangements to have the students visit the school Library/Resource Centre as required. If it is not available, collect resources for classroom use or arrange Internet access through your computer department.

Prior Knowledge & Skills

- Grade 10 Science: Chemistry and Earth and Space Science
- Grade 9 Science: Chemistry

Teaching/Learning Strategies

Activity 2.1: Boyle's Law

The teacher:

- reviews safety in the laboratory;
- introduces the consumer product pamphlet - Activity 2.6;
- instructs students on the format of a Data Book for observations and calculations and informs students that lab and inquiry skills are being assessed;
- provides lab procedures for an experiment demonstrating Boyle's law using the computer interface and traditional equipment. Sample experiments can be found in most lab manuals.
- reviews the concept of dependent and independent variables;
- ensures that a working barometer is available to determine the atmospheric pressure, if needed;
- directs students to prepare a chart in their Data Books with the following headings: volume (V), pressure (P), 1/V, and PxV, perform the experiment, complete the chart, analyse all data, and compare their experimental results with their peers;
- conferences with individual students as they make their measurements and assesses their completed charts and their lab skills;
- instructs students to plot graphs of V vs. P, and 1/V vs. P, using a graphing calculator or appropriate graphing software, if possible;
- uses the class data to develop the mathematical relationship for Boyle's law;
- uses relevant examples to demonstrate the proper procedure for solving problems and reviews the proper use of significant figures in expressing a numerical answer;
- assigns and takes up problems related to Boyle's law;
- arranges the class into groups of four and distributes the apparatus and instructions needed to make a "Cartesian Diver" (1 empty plastic pop bottle (1L) + lid + 1 eyedropper). The groups make the model and explain "how it works" using Boyle's law and discuss practical examples that illustrate Boyle's law e.g., inflating a tire, using a fire extinguisher, scuba diving, and ear popping with changes in altitude, etc.

Students:

- read the assigned experiment and prepare the chart in their Data Books;
- working in pairs, safely conduct the lab investigation, record all observations, analyse all data and compare their experimental results with their peers;
- plot the graphs, using a graphing calculator, if available; participate in the class discussion to develop the mathematical relationship for Boyle's law; and solve problems related to Boyle's law expressing their numerical answers to the appropriate number of significant figures;
- work cooperatively in a group to construct the Cartesian diver, arrive at a group explanation of the "Cartesian Diver," and record practical examples that illustrate Boyle's law in their notebook.

Activity 2.2: Charles' Law

The teacher:

- sets up a demonstration of a balloon in warm water and ice cold water, and uses the results to discuss the qualitative relationship between temperature and volume.
- chooses an experiment to illustrate the quantitative relationship of Charles' law and sets up a computer lab station, if an interface is available;
- describes the lab procedure, making sure students are aware of the proper handling of equipment;
- directs students to read the lab procedure, perform the experiment, and submit a lab report;
- assigns appropriate questions (found in lab manuals) that direct the students to plot a volume, temperature graph, extrapolate to Absolute Zero, and determine the mathematical relationship for Charles' law;
- conferences with students, while they plot their graphs and answer questions, to provide feedback on their development of the mathematical relationship for Charles' law;
- assigns and corrects practice problems related to Charles' law;
- uses the examples of popping popcorn, hot air balloons, aerosol cans, and anesthetic gas to introduce and discuss practical applications.

Students:

- read and complete the experiment as outlined by the teacher following proper safety guidelines;
- complete the graph of temperature and volume and extrapolate to find the temperature for V=0;
- answer questions to determine the mathematical relationship between Absolute temperature and volume; individually, complete and submit the lab report.
- solve mathematical problems related to Charles' law and express their answers to the appropriate number of significant figures; participate in class discussion of applications of Charles' law summarizing examples in their notebook.

Activity 2.3: Gay-Lussac's Law

The teacher:

- reviews the previous two laws;
- to illustrate and discuss the qualitative relationship between pressure and temperature, uses a variety of demonstrations, e.g., places a beaker of warm water in a vacuum pump and gradually reduces the pressure until the water boils or quickly inverts a steaming pop into a tray of cold water;
- directs students to prepare a temperature, pressure chart in their Data Books;
- sets up an Absolute Zero apparatus or an appropriate computer interface to demonstrate Gay-Lussac's law, and assigns students to prepare water samples at various temperatures for the demonstration;
- conducts the demonstration and instructs students to record the temperature and corresponding pressure in their charts;
  Note: If an Absolute Zero apparatus is not available teachers should supply students with dry lab data;

- directs students to plot the graph of pressure versus temperature, extrapolate to Absolute Zero, and determine the mathematical relationship for Gay-Lussac's law, if graphing calculators are available, students can verify the linear relationship of their hand plotted graphs;
- directs students to peer share their graphs;
- conferences with each student as they develop the mathematical relationship of Gay-Lussac's law;
- instructs students to submit their Data Books to assess their problem solving and graphing skills.

Students:

- participate in the class discussion of the demonstration(s);
- prepare a suitable observation chart in their Data Books, and record the pressure of the gas for each different temperature, graph all data and verify their results using a graphing calculator;
- peer share their results to determine any discrepancies and sources of error;
- arrive at the mathematical relationship for Gay-Lussac's law;
- individually, submit their Data Books to be assessed.

Activity 2.4: Combined Gas Law and Dalton's Law of Partial Pressures

The teacher:

- uses the example of weather balloons to demonstrate how changes in both temperature and pressure will affect the volume of a fixed amount of gas;
- develops the combined gas law using the mathematical relationships from Boyle's law, Charles' law, and Gay-Lussac's law;
- provides examples and assigns problems using the combined gas law;
- demonstrates the collection of a sample gas using the downward displacement of water, and uses an example of a combined gas law problem that gives the pressure of a gas collected over water and discusses the need to correct the pressure for the presence of water vapour;
- introduces Dalton's law of partial pressures;
- assigns related problems and directs students to peer assess the word problems.

Students:

- participate in developing the combined gas law equation;
- solve combined gas law problems and use Dalton's law of partial pressures to correct for pressure when gases are collected by the downward displacement of water, and peer assess assigned problems.

Activity 2.5: Gas Laws Game: Who wants to pass the gas law test?

The teacher:

- prepares five different sets of problems and assembles three stations for each problem set for a total of 15 stations, and sets up simple answer sheets for each set of numerical problems with a point system that increases in value with the level of difficulty of the problem;
- arranges students in pairs to move through all five different stations;
- instructs students that the purpose of the game is to improve problem solving skills, encourages students to answer as many questions as possible in the given time line (4-6 minutes per station);
- runs the game and tallies all the points at the end of the game and arranges prizes for the winners;
- prepares, administers, and assesses a paper-and-pencil quiz on all gas laws.

Students:

- working in pairs move from Station #1 to #5;
- work as a team to solve as many problems as possible in the time allowed and submit answers to the teacher;
- write a quiz on the gas laws.

Activity 2.6: Consumer Product Pamphlet

The teacher:

- introduces the Consumer Product Pamphlet project earlier in the Unit as suggested in the planning notes and arranges time in the Library/Resource Centre or computer labs for access to the Internet or other resources;
- leads a class discussion to identify technological products and safety concerns associated with compressed gases, e.g., propane tanks, fire extinguisher, air conditioners, scuba tanks and undersea exploration, welders' tanks, etc.;
- assigns the Consumer Product Pamphlet that describes a technological product and the safety concerns associated with the product;
- using the input of the class develops the criteria required for the rubric that will be used to assess the Consumer Product Pamphlets and the oral presentations;
- distributes the oral presentation and pamphlet rubrics for peer and teacher assessment (**Note:** peer assessments are not used for student evaluation) and assesses presentations;
- allows students to improve their pamphlet based on peer assessments;
- collects and assesses the final products;
- instructs students to write a reflection on whether the uses of compressed gases have enhanced the quality of life and contributed to the common good.

Students:

- brainstorm to identify possible products of compressed gases and any safety concerns;
- participate in the development of the rubrics;
- working in assigned pairs, choose a topic, research and describe how the product works and the safety concerns associated with the product;
- design and complete the pamphlet and give a presentation on their consumer product;
- participate in peer assessment of the presentations and the pamphlets;
- use the peer assessments to improve their consumer product pamphlets;
- submit their pamphlet for assessment;
- write a reflection on the contributions of compressed gases to the common good.

Activity 2.7: Preparing for the End of Unit Task

The teacher:

- directs students to work on their end-of-unit task – Activity 4.2;
- conferences with each research team to ensure they remain on task.

Students:

- meet throughout the Unit to research and conference with each other and the teacher;
- work collaboratively to gather information for the assigned task.

Assessment & Evaluation of Student Achievement

- Student lab performance skills and charts for Activity 2.1(Boyle's law) may be assessed for Inquiry using a suitable checklist. (SIS.01) (SIS.02) (SIS.03) (SIS.04) (GA2.03)
- The lab report in Activity 2.2 (Charles' law) may be assessed for Knowledge/Understanding, Inquiry and Communication using a lab rubric. (GA1.03)(GA2.03) (GA2.01) (SIS.05) (SIS.07)
- The graphs and calculations for Activity 2.3 (Gay-Lussac's law) may be assessed for Inquiry and Communication using a marking scale. (GA2.03) (SIS.07)
- The paper-and-pencil quiz may be assessed for Knowledge/Understanding using a marking scheme. (GA1.03) (GA1.04) (GA2.04) (SIS.08)
- The consumer product pamphlet and presentation may be assessed for Knowledge/Understanding, Communication, and Making Connections using appropriate rubrics. (GA3.03)

Accommodations

- See the Course Overview for general accommodations.
- Additional practice problems could be assigned to allow students to practise and improve their problem-solving skills. Students can take advantage of the numerous computer tutorials available.
- Graphing calculators and peer reviews can reinforce graphing skills.
- A lab station can be set up for wheelchair access.
- Large print scales on instruments can be used for visually challenged students.
- Possible enrichment activities:
    - Design and create a computer-generated version of the Gas law game.
    - Research and write an editorial on the safety concerns of compressed gases in the home.
    - Design and build a working model of one of the applications, e.g., hot air balloon, airbags etc.
    - Write a biography on one of the scientists in this activity.
    - Design a web page or tutorial to help students improve their problem-solving or graphing skills.
    - Prepare for University bound contests, e.g., Avogadro, Hall of Fame, Chemical Institute of Canada.
    - Visit a nearby automotive service centre, and observe the precautions and techniques necessary for the repair or removal of refrigeration products for automotive air-conditioning systems. Inquire about disposal procedures for these refrigerants.
    - Research the various colour codes used in the shipping of industrial canisters of compressed gases.
    - Compare and explain why commercial dry cake mixes have two different sets of preparation instructions on their packages.

Resources

Harrison, R., D. Fisher, and G. Rayner-Canham. *Laboratory Manual Chemistry A First Course*. Don Mills: Addison-Wesley Publishers, 1988. ISBN 0-201-17881-8

Holmquist, Dan and Donald L. Volz. *Chemistry With Computers Using Logger Pro*. Portland: Vernier Software, 1997. ISBN 0-918731-95-X

Lynn, David. *Understanding Chemistry Laboratory Manual*. Toronto: John Wiley & Sons, 1988. ISBN 0- 471-79695-6

Tocci, Salvatore, and C. Viehland. *Holt Chemistry Visualizing Matter*. Austin: Holt, Rinehart and Winston, 1989. ISBN 0-03-000193-5

Whiteman, R.L., E.E. Zinck, and R.A. Nalepa. *Chemistry Today 1,* 3rd ed. Laboratory Manual. Scarborough: Prentice-Hall, 1989. ISBN 0-13-129321-4

Internet Sites

Scuba Physics – http://www.cei.net/~dvines/laws.html

The Plain Man's Guide to Aerosols – http://www.yorks.karoo.net/aerosol/index.htm

School Science Projects with Hot Air Balloons – http://www.overflite.com/science.html

Activity 3: Avogadro and Molar Calculations

Time: 375 minutes

Description

Students state Avogadro's hypothesis and describe his contribution to our understanding of reactions of gases. In addition, students demonstrate an understanding of Avogadro's number, the mole, and molar mass. Through experimentation, students determine the molar volume of a gas. Furthermore, students solve quantitative problems involving the ideal gas law.

Strand(s) & Learning Expectations

Strand(s): Gases and Atmospheric Chemistry

Overall Expectations

GAV.01 - demonstrate an understanding of the laws that govern the behaviour of gases;
GAV.02 - investigate through experimentation the relationships among the pressure, volume, and temperature of a gas, and solve problems involving quantity of substance in moles, molar masses and volumes, and the gas laws.

Specific Expectations

GA1.05 - state Avogadro's hypothesis and describe his contribution to our understanding of reactions of gases;
QC1.01 - demonstrate an understanding of Avogadro's number, the mole concept, and the relationship between the mole and molar mass;
GA2.04 - solve quantitative problems involving the following gas laws: Charles's law, Boyle's law, the combined gas law, Gay-Lussac's law, Dalton's law of partial pressures, the ideal gas law;
GA2.06 - determine the molar volume of a gas through experimentation.

Scientific Investigation Skills

SIS.05 - select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate scientific ideas, plans, and experimental results;
SIS.07 - communicate the procedures and results of investigations for specific purposes by displaying evidence and information, either in writing or using a computer, in various forms, including flow charts, tables, graphs, and laboratory reports;
SIS.09 - select and use appropriate SI units (units of measurement of the *Système international d'unités*, or International System of Units).

Ontario Catholic School Graduate Expectations

CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;
CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE5f - exercises Christian leadership in the achievement of individual and group goals;
CGE5g - achieves excellence, originality, and integrity in one's own work and supports these qualities in the work of others.

Planning Notes

- Homework should be assigned to develop student knowledge and problem-solving skills.
- Teacher prepares one mole samples of several different substances, e.g., S, Cu, Pb, C, H_2O, etc., labelling each closed container with the chemical symbol/formula, mass, and all necessary WHMIS information (Activity 3.2).
- When stating Avogadro's hypothesis, stress that at constant temperature and pressure the amount of substance relates to the number of particles and not the mass (a common misconception).
- Blowing up a balloon illustrates Avogadro's Law, $V_1/n_1 = V_2/n_2$.

- The mole concept and Avogadro's number are introduced in this activity. Students also solve problems involving molar mass of a substance and the molar volume of gas; however, (GA2.05), stoichiometric calculations involving gases in chemical reactions are covered in Unit 3, Quantities in Chemical Reactions.
- For the counting activity, building blocks, paper clips, magnets, or molecular model kits could be used to represent molecules. Students first build models of the molecules of the reactants placing them in a beaker according to the relationship: one volume of a gas represents four molecules in a beaker. Students begin with one volume of each of the reactants. They then disassemble the models and use the exact same materials to construct the models of the products. (**Note:** Students may need to use more than one beaker of a particular reactant since all the reactant atoms must be used to construct the products.) The students then place the constructed models of the product molecules in beakers according to the same relationship, i.e., four molecules of product per one volume. They then count the number of reactant and product molecules and relate them to the volume, e.g., one volume contains four molecules and two volumes contain eight molecules. The students represent their findings using a schematic diagram showing the molecules and volumes for the reactants and products.
- Teachers should be aware of all the safety precautions involved with the use of gas cylinders and need to follow school board regulations.
- Balloons filled with various gases can be used as a teacher demonstration to reinforce that at the same temperature and pressure, equal volumes of different gases have different masses.
- In this activity students should be provided with 75 minutes to work on Activity 4 in order to prepare for the conference.
- Stress proper mathematical form, SI units, and significant figures when solving word problems.
- When introducing the ideal gas law, stress that "*n*" represents the quantity of gas in moles and not the number of moles (a common misconception). Students should understand that real gases behave ideally only at high temperatures and low pressures (a common misconception).
- Find suitable experiment to determine the molar volume of a gas (Activity 3.4).
- Prepare a Unit test to be administered at the end of this activity.

Prior Knowledge & Skills

- Grade 10 Science: Chemistry – Chemical Processes
- Grade 9 Science: Chemistry – Atoms and Elements

Teaching/Learning Strategies

Activity 3.1: Avogadro's Number

The teacher:

- provides students with balloons to inflate and deflate in order to consider the qualitative relationship between volume and the amount of gas in the balloon;
- describes Gay-Lussac's law of Combining Volumes;
- introduces the counting activity described in the Planning Notes and uses it to illustrate the reaction $A + B \rightarrow AB$;
- leads a class discussion to develop Avogadro's hypothesis and instructs students working in pairs to model Avogadro's hypothesis for specific reactions in their Data Books;
- conferences with students to provide feedback on their understanding of Avogadro's hypothesis;
- collects Data Books to assess their schematic diagrams of the reactions.

Students:

- qualitatively determine the relationship between volume and the amount of a substance;
- summarize Gay-Lussac's Law of Combining Volumes and Avogadro's Hypothesis;
- in their Data Books draw schematic diagrams to model Avogadro's hypothesis for the reactions:

A) $H_{2\,(g)} + Cl_{2\,(g)} \rightarrow 2\,HCl_{\,(g)}$

B) $2\,H_{2\,(g)} + O_{2\,(g)} \rightarrow 2\,H_2O_{\,(g)}$

C) $N_{2\,(g)} + O_{2\,(g)} \rightarrow 2\,NO_{\,(g)}$

- submit their Data Books for assessment.

Activity 3.2: Mole and Molar Mass

The teacher:

- defines the mole and explains the relationship between the mole and Avogadro's number;
- displays one mole samples of several different substances, e.g., S, Cu, Pb, C, H_2O, etc. The samples should be in closed containers labelled with chemical symbol/formula, mass, and all necessary WHMIS information, and instructs students to prepare a table with the headings: name of substance, chemical symbol/formula, mass;
- distributes periodic tables and instructs students to compare the mass given on each container to the atomic mass or molecular mass obtained/calculated from the periodic table, in order to determine the relationship between the mass of one mole of each substance and its corresponding atomic/molecular mass;
- to illustrate the concept that equal volumes of different gases at the same temperature and pressure have different masses, poses the question: Why does a balloon filled with helium rise, but one filled with an equal volume of carbon dioxide does not?;
- defines molar mass and distributes a worksheet on molar mass calculations;
- administers a quiz on the mole concept and molar mass.

Students:

- record the chemical symbol/formula and the masses for each of the samples on display, and compare these to atomic masses/molecular masses obtained/calculated from the periodic table;
- examine balloons filled with equal volumes of helium and carbon dioxide and hypothesize why the helium balloon rises;
- complete assigned molar mass calculations and find a partner to check their calculations;
- write a quiz on the mole concept and molar mass.

Activity 3.3: End-of-Unit Task

The teacher:

- explains the requirements for Activity 4.1, the newspaper flyer assignment;
- directs students to collect research materials and monitors their progress.

Students:

- work collaboratively to research and prepare the newspaper flyer assignment.

Activity 3.4: Molar Volume of a Gas

The teacher:

- discusses the experimental procedures to determine the molar volume of hydrogen gas produced by the reaction of magnesium metal with a dilute solution of hydrochloric acid;
- defines standard temperature and pressure (STP) and reviews Dalton's law of partial pressures;
- prepares a set-up of the apparatus for students to model;
- discusses safety precautions related to the use of hydrochloric acid;

- conferences with students during the lab investigation to check that students are following procedures and to assist with calculations, and guides students in sources of error;
- collects student Data Books and assesses the experimental data and calculations.

Students:

- in pairs, conduct the lab investigation to determine the molar volume of hydrogen gas, and perform calculations using experimental data; peer share the results of the experiment with other groups in order to compare and discuss possible sources of error;
- submit their individual data analysis for assessment.

Activity 3.5: Ideal Gas Law

The teacher:

- reviews previous concepts by asking students the following questions: If samples of two different gases, A and B, are at the same temperature and pressure, sample A contains 6.022×10^{23} particles and sample B contains 6.022×10^{23} particles, should they each occupy the same volume? Would they each have the same molar mass?;
- guides students in deriving the ideal gas law, PV=nRT;
- shows a sample calculation using the ideal gas law for determining the quantity of a gas in moles;
- asks students to calculate the molar volume of a gas at STP, using the ideal gas law. This value could be compared to the experimental results obtained in Activity 3.4;
- instructs students to create and solve two appropriate and relevant numerical problems involving the ideal gas law. Each problem should solve for a different variable;
- directs students to peer share, peer edit and solve a variety of student prepared ideal gas problems;
- assesses the word problems and solutions.

Students:

- use Avogadro's hypothesis, Boyle's law and Charles's law to derive the ideal gas law;
- calculate the molar volume of a gas at STP using the ideal gas law, and compare this value to the molar volume determined for hydrogen gas in Activity 3.4, suggesting possible reasons for discrepancies;
- compose and then answer two original realistic numerical problems involving the ideal gas law;
- peer edit and comment on the creativity, clarity, and level of difficulty of the questions;
- peer share and solve a variety of student created ideal gas law problems;
- submit individual ideal gas law problems with solutions.

Assessment & Evaluation of Student Achievement

- The schematic diagrams modelling Avogadro's hypothesis can be assessed for Knowledge/Understanding using a rating scale. (GA1.05)
- The quiz can be assessed for Knowledge/Understanding using a marking scheme. (QC1.01)
- The data analysis for Activity 3.4 can be assessed for Knowledge/Understanding, Inquiry, Communication, and Making Connections using a lab rubric. (GA2.06,SIS.05,SIS.07)
- The student created gas law problems can be assessed for Knowledge/Understanding and Communication using a rating scale. (GA2.04, SIS.09)

Accommodations

- See the course overview for general accommodations.
    - Computer tutorials can be used for additional practice in problem solving.
    - A lab station can be set up for wheel-chair access.
    - Large print scales can be used for the visually challenged students.

- Possible enrichment activities:
  - Prepare a biography of Avogadro, outlining his achievements and impacts on chemistry.
  - Estimate the number of moles of water drops in the Great Lakes using the area, average depth, and the number of water drops in 1 mL.
  - Ammonia is used in the manufacture of fertilizers. How is it produced? Why it is stored as a liquid?

Resources

DiSpezio, M., T. Hall, D. Morrison, C. Schrader, D. Scodellaro, and J. Young. *Heath Chemistry Laboratory Experiments*. Canada: D.C. Heath Canada Ltd., 1987. ISBN 0-669-95291-5

Herron, J., D. Kukla, C. Schrader, D. Morrison, M. DiSpezio, J. Erickson, and D. Scodellaro. *Heath Chemistry*. Canada: D.C. Heath Canada Ltd., 1987. ISBN 0-669-95289-3

Whitman, R., E. Zinck, and R. Nalepa. *Chemistry Today 1*. Scarborough: Prentice-Hall Canada Inc., 1988. ISBN 0-13-129306-0

Internet Sites

Avogadro's Hypothesis – http://www.carlton.paschools.pa.sk.ca/chemical/molemass/avogadro.htm

Mole – www.dist214.k12.il.us/users/asanders/mole.html

Activity 4: Gases and Life Conference

Time: 225 minutes

Description

Students describe technological advances and applications of gases in other disciplines. In addition, gas related environmental issues are examined as students research and explain Canadian initiatives to improve air quality. Students plan, organize, and participate in the "Gases and Life" conference. They set up displays/exhibits on the applications and uses of gases and participate in seminars addressing Canadian initiatives on air quality. Lastly, students recognize their role as stewards of the Earth in addressing the environmental concerns and issues relating to Canada's atmosphere.

Strand(s) & Learning Expectations

Strand: Gases and Atmospheric Chemistry

Overall Expectations

GAV.03 - describe how knowledge of gases has helped to advance technology, and how such technological advances have led to a better understanding of environmental phenomenon and issues.

Specific Expectations

GA3.02 - explain Canadian initiatives to improve air quality;
GA3.04 - describe how knowledge of gases is applied in other areas of study.

Science Investigation Skills

SIS.10 - identify and describe science- and technology-based careers related to the subject area of study.

Ontario Catholic School Graduate Expectations

CGE1d - develops attitudes and values founded on Catholic social teaching and acts to promote social responsibility, human solidarity and the common good;
CGE1e - speaks the language of life... "recognizing that life is an unearned gift and that a person entrusted with life does not own it but that one is called to protect and cherish it." (Witnesses to Faith);
CGE2e - uses and integrates the Catholic faith tradition, in the critical analysis of the arts, media, technology and information systems to enhance the quality of life;

CGE3b - creates, adapts, evaluates new ideas in light of the common good;
CGE3c - thinks reflectively and creatively to evaluate situations and solve problems;
CGE3d - makes decisions in light of gospel values with an informed moral conscience;
CGE3e - adopts a holistic approach to life by integrating learning from various subject areas and experience;
CGE4f - applies effective communication, decision-making, problem-solving, time and resource management skills;
CGE5e - respects the rights, responsibilities, and contributions of self and others;
CGE7a - acts morally and legally as a person formed in Catholic traditions;
CGE7b - accepts accountability for one's own actions;
CGE7d - promotes the sacredness of life;
CGE7i - respects the environment and uses resources wisely;
CGE7j - contributes to the common good.

Planning Notes

- The end-of-unit task for this unit is an in-class student conference titled "Gases and Life." The conference consists of exhibitions of students' work compiled throughout the unit and student seminars focusing on Canadian initiatives to improve air quality. For the first 75 minutes of this activity students prepare their materials and presentations for the conference. The conference takes place during the remaining 150 minutes.
- The exhibits/displays demonstrate a visual representation of all the applications and uses of gases studied in this unit. The displays include the following: the poster on a natural phenomena or the poster on a technological product from Activity 1.1, the consumer product pamphlet from Activity 2.6, and the newspaper flyer prepared in this activity. Science fair backdrop boards can be used for the displays and should be purchased in advance. These exhibits/displays could also be presented to the entire student body or at an open house.
- The newspaper flyer assignment for the end-of-unit task describes a related career and illustrates how the knowledge of gases has made possible many technological advancements in other areas of study.
- While attending the exhibits in the conference, students prepare a fact sheet using the information obtained from their classmates' displays. Students are encouraged to choose different topics of interest, e.g., natural phenomena if their poster involved a technological product, and vice versa, a topic that they did not research.
- Students present the seminars and workshops focusing on Canadian initiatives to improve air quality. They are encouraged to play the role of members of government (local, regional, provincial, and federal), environment specialists, industrialists, and environmentally conscious citizens. In order to have a better understanding of the environmental issues related to air quality, students need to research and present information on the following types of air pollution: smog, acid rain, greenhouse gases, and ozone layer depletion. They should research recent Canadian initiatives in improving air quality such as Canada's involvement in the Kyoto Agreement.
- The workshops and seminars could involve multi-media presentations. Teachers should organize the conference so that there is representation from all groups listed. In addition, teachers should assign the type of air pollution for the groups to study to ensure that all areas of concern are addressed.
- Ensure the Library/Resource Centre, Internet, and career programs are available for student use.

Prior Knowledge & Skills

- Grade 10 Science, Chemistry – Chemical Processes
- Grade 9 Science, Chemistry – Atoms and Elements

Teaching/Learning Strategies

Activity 4.1: Gases in Other Disciplines (Exhibits/Displays)

The teacher:

- leads a class discussion to create a concept map for disciplines, e.g., meteorology, marine or undersea exploration, environment, medical, etc., careers, and technological advancements related to gases;
- arranges for students to visit the Library/Resource Centre;
- assigns the newspaper flyer assignment in which students working in pairs prepare: (a) a career profile including the educational requirements, a description of the career, and future outlooks of the career; (b) an illustration of a technological advancement in the field (photograph, model, diagram, or computer web page, etc.); and (c) a written article describing the benefits of the technological advancement to society; dialogues with groups to ensure that their topics are relevant and appropriate;
- introduces the display/exhibit component of the "Gases and Life" conference as a visual exhibition of the application of gases in their lives;
- instructs students that as they circulate through the displays, they are required to complete a fact sheet summarizing information obtained from one poster, pamphlet, and newspaper flyer;
- assesses the fact sheet and the individual exhibit/displays;
- instructs students to write a reflection summarizing the benefits and risks of technological products associated with gases.

Students:

- participate in a class discussion to create a concept map for the applications of gases;
- research and gather information on their approved topic for the newspaper flyer;
- arrange all required work (poster, pamphlet, flyer) on a display board, bulletin board or Bristol board in preparation for the display/exhibit portion of the "Gases and Life" conference;
- on a rotation basis, circulate, visit, and study other displays, and prepare a fact sheet on each of the topics outlined;
- submit their individual fact sheet and group display for assessment;
- write a reflection on the impact technologies have had on society and the environment. Students will select a Psalm that speaks of nature and creation as manifesting the wonders and grandeur of God. Students will reflect on what scholars call "de-creation."

Activity 4.2: Air Quality (Workshops/Seminars)

The teacher:

- discusses smoking by-laws in the local community to raise the issue of air quality;
- organizes groups according to assigned role and outlines the workshop/seminar component of the conference. The focus of the research task could include the following:
  - What are the major sources of the air pollution?
  - What natural events and human activities are responsible for the atmospheric problems?
  - Explain how each type of air pollution affects air quality.
  - What are the effects of damaging the atmosphere? What specific health concerns are associated with poor air quality?
  - What technological advancements are currently being used to monitor the pollutant(s) that affect the atmosphere?
  - Identify and assess the Canadian initiatives taken to improve air quality.
  - What are the economic implications of the proposed initiatives?
  - Suggest ways for citizens to reduce their contribution to the problem(s) in order to improve air quality.

- conferences with each group to ensure they remain on task;
- assesses the workshop/seminar component of the conference;
- leads a discussion on the need for the implementation of the proposed initiatives to improve air quality, and compiles suggestions for future challenges;
- directs students to write a reflection discussing the impact of the conference on their lives. Students may be invited to reflect on Deut. 30:19: "I have set before you life or death… Choose life." How does this choice relate to today's reality?

Students:

- in groups of four, work collaboratively to brainstorm, research, and conference with each other and the teacher to prepare their chosen mode of presentation for the workshop/seminar component of the conference;
- prepare worksheets and activities for the seminar/workshop they lead;
- participate in the workshops/seminars;
- write a reflection commenting on the impact the conference has made on their understanding of gases and how they will use this knowledge in making choices in the future, i.e., steps that they can take to improve air quality.

Assessment & Evaluation of Student Achievement

- The exhibit/display can be assessed for Communication using a suitable rubric.
- The newspaper flyer can be assessed for Knowledge/Understanding, Communication, and Making Connections using a rubric. (GA3.04, SIS.10)
- The fact sheet can be assessed for Communication using a rating scale.
- The air quality workshop/seminar can be assessed for Knowledge/Understanding, Communication, and Making Connections using a rubric. (Appendix B) (GA3.02)

Accommodations

- See the course overview for general accommodations.
- Possible enrichment activities:
    - Acting as a reporter for the school newspaper, students write an article for the next edition of the paper, which describes the highlights of the "Gases and Life" conference.
    - Prepare a video along with a narrative of the conference that includes the exhibits and displays as well as highlights of the seminars;
    - Research air pollution in developing countries and report your findings in a local paper; commenting on the role and responsibility of industrialized nations for improving their air quality;
    - Investigate international responses to protect the atmosphere and compare them to Canadian initiatives.

Resources

Draper, D. *Our Environment: A Canadian Perspective*. Toronto: International Thomson Publishing Company, 1998. ISBN 0-17-605552-5

Chemistry of the Environment. British Columbia: Davis Film and Video Productions, 1993. 34 min.

Internet Sites

Climate Change – http://www.davidsuzuki.org
Ministry of the Environment – http://www.ene.gov.on.ca

Appendix A

A PRAYER OF GRATITUDE

St. Francis of Assisi

Most High, all powerful, good Lord,
to you all praise, glory and honour
and all blessing;
to you alone, Most High, they belong
and no man is worthy of naming you.

Praised be you, my Lord,
with all your creatures,
especially Milord Brother Sun,
who brings day, and by whom you enlighten us;
he is beautiful, he shines with great splendour;
of you, Most high, he is the symbol.

Praised be you, my Lord,
for Sister Moon and the Stars:
in the heavens you formed them,
clear, precious and beautiful.

Praised be you, my Lord, for Brother Wind
and for the air and for the clouds,
for the azure calm and for all climes
by which you give life to your creatures.

Praised be you, my Lord, for Sister Water,
who is very useful and humble,
precious and chaste.

Praised be you, my Lord, for Brother Fire,
by whom you enlighten the night:
he is beautiful and joyous,
indomitable and strong.

Praised be you; my Lord,
for Sister our mother the Earth
who nourishes us and bears us,
and produces all kinds of fruits,
with the speckled flowers and the herbs.

Appendix B

End-of-Unit Task Performance Rubric

Criteria	Level 1 (50-59%)	Level 2 (60-61%)	Level 3 (70-79%)	Level 4 (80-100%)
Knowledge of types and sources of air pollution, and Canadian initiatives to improve air qualities **(K)**	- demonstrates limited knowledge of types and sources of air pollution and Canadian initiatives	- demonstrates some knowledge of types and sources of air pollution and Canadian initiatives	- demonstrates considerable knowledge of types and sources of air pollution and Canadian initiatives	- demonstrates thorough knowledge of types and sources of air pollution and Canadian initiatives
Use appropriate scientific vocabulary to communicate ideas related to gases and air quality **(C)**	- uses appropriate scientific vocabulary to communicate ideas related to gases and air quality with limited clarity and precision	- uses appropriate scientific vocabulary to communicate ideas related to gases and air quality with moderate clarity and precision	- uses appropriate scientific vocabulary to communicate ideas related to gases and air quality with considerable clarity and precision	- uses appropriate scientific vocabulary to communicate ideas related to gases and air quality with high degree of clarity and precision

Understanding of connections between advanced technology due to knowledge of gases and environmental issues related to gases and air quality **(MC)**	- shows limited understanding of connections between advanced technology due to knowledge of gases and environmental issues related to gases and air quality	- shows some understanding of connections between advanced technology due to knowledge of gases and environmental issues related to gases and air quality	- shows considerable understanding of connections between advanced technology due to knowledge of gases and environmental issues related to gases and air quality	- shows thorough understanding of connections between advanced technology due to knowledge of gases and environmental issues related to gases and air quality
Analysis of social and economic issues involving air quality, and Canadian initiatives to improve air quality **(MC)**	- analyses social and economic issues involving air quality and Canadian initiatives to improve air quality with limited effectiveness	- analyses social and economic issues involving air quality and Canadian initiatives to improve air quality with moderate effectiveness	- analyses social and economic issues involving air quality and Canadian initiatives to improve air quality with considerable effectiveness	- analyses social and economic issues involving air quality and Canadian initiatives to improve air quality with high degree of effectiveness
Assessment of impact of Canadian initiatives to improve air quality **(MC)**	- assesses the impact of Canadian initiatives to improve air quality with limited effectiveness	- assesses the impact of Canadian initiatives to improve air with moderate effectiveness	- assesses the impact of Canadian initiatives to improve air quality with considerable effectiveness	- assesses the impact of Canadian initiatives to improve air quality with high degree of effectiveness
Proposing of courses of practical action on improving air quality **(MC)**	- extends analyses of gas related environmental issues into courses of practical action on improving air quality with limited effectiveness	- extends analyses gas related environmental issues into courses of practical action on improving air quality with moderate effectiveness	- extends analyses of gas related environmental issues into courses of practical action on improving air quality with considerable effectiveness	- extends analyses of gas related environmental issues into courses of practical action on improving air quality with high degree of effectiveness

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