Public District School Board Writing Partnership

Course Profile

Chemistry

Grade 11
University Preparation
SCH3U

• *for teachers by teachers*

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

Spring 2001

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Course Overview
Chemistry, Grade 11, University Preparation, SCH3U

Prerequisite: Science, Grade 10, Academic

Course Description

This course focuses on the concepts and theories that form the basis of modern chemistry. Students will 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. This profile offers one set of suggestions for achieving the learning expectations of the SCH3U. Teachers must adapt the profile to suit their circumstances and to match the students' needs while ensuring that all learning expectations of the course are addressed fully.

Course Notes

Scientific Literacy for All Students

The paramount task of science education is to equip all students with scientific literacy – the combination of knowledge, skills, and habits of mind that enable them to think creatively, reason logically, evaluate information critically, and communicate effectively. This is an essential base for making productive and ethical decisions, not only about scientific and technological issues but in all areas of life.
The Ontario Curriculum, Grades 11 and 12, Science notes that, "Achieving excellence in scientific literacy is not the same as becoming a science specialist." The focus in Grade 11 chemistry is scientific literacy for *all* students, with preparation for further studies in chemistry and related disciplines for *some* students. The policy document goes on to note, "The newer aspects of the science curriculum – especially those that focus on science, technology, society, and the environment (STSE) – call for students to deal with the impacts of science on society and the environment, which includes both the natural environment and the workplace environment. This requirement brings in issues that relate to human values. Science can therefore not be viewed as merely a matter of "facts"; rather, it is a subject in which students learn to weigh the complex combinations of fact and value that developments in science and technology have given rise to in modern society." (p. 4) This perspective is consistent with the vision advanced in this profile. The challenge in delivering the course is to find ways to bring to the classroom an STSE focus from which the facts and chemistry specific skills derive naturally.

Curriculum Directions

The Ontario Curriculum, Grades 11 and 12: Science contains recommendations regarding teaching approaches and curriculum expectations that are reflected in this profile and should be evident in courses developed using this profile as a template. (pp. 8-10)

- "The expectations in science courses call for an *active, experimental approach* to learning, and require *all students* to participate regularly in laboratory activities;"
- "Where opportunity allows, students might be required, as part of their laboratory activities, to design and conduct research on a real scientific problem for which the results are unknown;"
- "Where possible, *concepts should be introduced in the context of real-world problems and issues;*"

- "In all courses, a list of expectations is given that precedes the strands. These expectations describe skills that are considered to be essential for scientific investigation (e.g., skills in research, in the use of materials, and in the use of units of measurement), and skills required for investigating possible careers in the subject area. These skills apply to all areas of course content and *must be developed in all strands* of the course…. Assessment of students' mastery of these skills must be included in the evaluation of students' achievement of the expectations for the course." These expectations are called *Science Investigative Skills*. When developing detailed course plans, we recommend that teachers use these SISs as a primary guide.

The Goals of Grade 11 Chemistry

As in the Grade 1 to 8 Science and Technology courses, and the Grade 9 and 10 Science courses, SCH3U is based on three goals:

- To relate science to technology, society, and the environment;
- To develop skills, strategies, and habits of mind required for scientific inquiry;
- To understand basic concepts of science.

As a prerequisite for SCH4U, Chemistry SCH3U must develop a large number of basic chemical concepts. Nevertheless, the activities and assessment tasks in this profile reflect a balance among the three goals. Teachers are encouraged to ensure that their detailed plans do not focus to excess on 'understanding basic concepts' at the expense of the other goals. In all science courses every attempt should be made to place learning in an STSE context – inquiry skills should be built through issues first, with content assembled later. In addressing STSE Expectations such as 'evaluate technologies…', 'analyse relationship with issues…', 'analyse costs and benefits….' and 'analyse impacts….' students should have opportunities to discuss issues, examine values and attitudes, and propose solutions and actions. In this profile, topics include water treatment in Ontario, technology involved in reducing air pollution, fractional distillation of petroleum and radioisotopes in the medical and food industries.

Planning and Implementing Grade 11 Chemistry

- When planning and delivering SCH3U, try to introduce each activity with a question or story which connects the key concepts to be learned with a context from the world outside the school (e.g., "If salt, sugar and snow are all white solids made of atoms, why are their properties so different?") (Unit 1); "Is the calcium in hard water and limestone the same as the calcium in milk and in your teeth?" (Unit 1); "Why is it claimed that the future of Dry Cleaning is in the use of liquefied carbon dioxide?" (Unit 3 - CO_2 (l) is a non-polar solvent - like current dry cleaning fluids, but is less toxic.); "What does the chemist mean by the saying, 'Like Dissolves Like'? Like all generalities, it is not perfect – why not?" (Unit 3)
- A number of activities in this profile have a research focus, which requires accessing information beyond the laboratory or field trip. Students should be taught explicitly how to use all available sources of information – people, print, online sources, and other media, both in school and in the community. They should be given opportunities to use those skills, and to overcome the frustrations that invariably accompany the location and acquisition of quality information. However, care must be taken that *student time is spent primarily on processing information rather than accessing information*, so that the search does not become an end in itself.
- The expectations are central to all aspects of this profile. The context in which each unit is delivered, the skills and concepts developed and the assessment tasks used must be interconnected, and linked to the expectations. The assessment data accumulated throughout the course must be sufficient (in variety and number) to permit teachers to evaluate the *consistent level of performance* for each student in each of the categories in the Achievement Chart for Science.

- Some of the expectations in the guideline and the SISs (*Science Investigative Skills*), are so critical to the development of scientific literacy that they are given special emphasis in learning activities and are often revisited in other units (e.g., those related to bonding and the mole concept). These are expectations that are taught, assessed, evaluated and revisited using alternate instructional strategies in a cyclic process that stops only when students have *achieved* them. They describe *curriculum priorities/enduring learnings/core learnings* which students must be given opportunities to explore in depth rather than just to acquire familiarity.
- *Each student interprets new information in terms of what he or she already knows*. The student tries to make sense of what is taught by trying to fit it with his or her experience. Understanding a key concept results when the student has opportunities to develop skills and construct understanding through concrete experiences and then to create generalizations from those personal experiences, e.g., Boyle's Law and ears that 'pop' on an airplane; non-polar solvents and 'dry' cleaning. Teachers must be aware of the experiences that students have already had from their work prior to Grade 11, and use those as building blocks to new and more complex concepts. Students may also arrive with misconceptions from their experience that will interfere with their ability to understand new concepts. Identifying and eliminating misconceptions through concrete experiences may be required at times.
- *Terminology, formulae and algorithms should be viewed by students as tools for solving problems and communicating ideas, not as problems to be solved*, and should not dominate the curriculum. SCH3U is intended to promote scientific literacy and to build a background in a science discipline. It is important to emphasize key skills and concepts without obscuring them by expecting students to memorize a multitude of facts, equations, and formulae. (For example, the nomenclature of inorganic and organic chemicals should be limited to what is helpful to understand key concepts, but should not be an end in itself.) Students could be encouraged to develop reference sheets of significant formulae, algorithms and concepts for use in class and on tests or examinations. When the size of the sheet is limited, (to a single sided sheet of paper, handwritten, for example) preparation requires that students review their work, then identify and summarize critical information. Such reference sheets may be submitted for assessment and evaluation as part of an End-of-Unit Task or a component of the Final Summative Assessment Tasks for the course. Use of reference sheets allows teachers to move the focus of assessment away from factual recall and toward higher level thinking skills.
- This profile describes a chemistry course in which students are encouraged to ask their own questions, and in some cases to find their own answers by inquiry – through experiment, research or the innovation of a device or process. Fundamental to the skill set of a scientifically literate person is the ability to ask quality questions, and to interpret the answers critically, including identifying unstated assumptions. For example, when the popular media report on an incident involving chemicals, students could discuss the issue, identify assumptions, consider alternatives, and assess the degree of bias in the report. They could consider the extent to which the general population is influenced by the report and whether that influence is modified in light of greater understanding of chemistry. Students must see that there is a tension between the benefits and hazards associated with chemicals and the chemical industry. They should emerge as informed citizens who will demonstrate healthy skepticism when confronted with the opinions of others about, for example, the 'evils' of chemicals, the 'good' of all things 'organic' in the marketplace, or the 'safety' of chemical waste materials and disposal systems.

- In this profile, there is a reduced emphasis on traditional laboratory activities in which students are provided step-by-step instructions, and more emphasis on developing students' ability to devise and carry out components of procedures within well-defined limits. The teacher's role is to decide what knowledge and skills students must have to proceed safely and successfully in a laboratory setting, without reducing their part in the process to being followers of recipes with entirely predictable results. Many traditional laboratory exercises can be opened up by rewording statements into questions, and replacing detailed procedures with a teacher-led class discussion. This could be followed by a challenge, which requires students to devise a procedure and have its safety confirmed before carrying it out. By making decisions regarding what data to collect and which format to use for reporting both data and results, students develop skills of inquiry and communication essential in science.

Rationale for the Unit Sequence of the Course Profile

Unit 1 serves as an introduction to Grade 11 Chemistry. Starting with a set of observations of common substances, the course is structured to move through bonding and periodicity as students attempt to explain their observation of physical properties. The Periodic Table as a central organizer from which properties of matter and bonding can be predicted is central to this course. Essential chemical terminology is reviewed from earlier courses and extended in the context of student investigations, discussions and teacher direction. Chemical reactions lead to a discussion of nomenclature and an introduction to moles to facilitate and quantify the discussion of chemical reactions. The quantitative nature of chemistry is the common thread linking to solutions and gases. The process of solution consolidates bonding concepts and is linked to reactions through the quantitative concentration of materials. The course ends with an introduction to hydrocarbons. This final unit is used to review the key concepts introduced earlier in the course and to lay a basis for concepts in SCH4U and SBI4U.

Units: Titles and Times

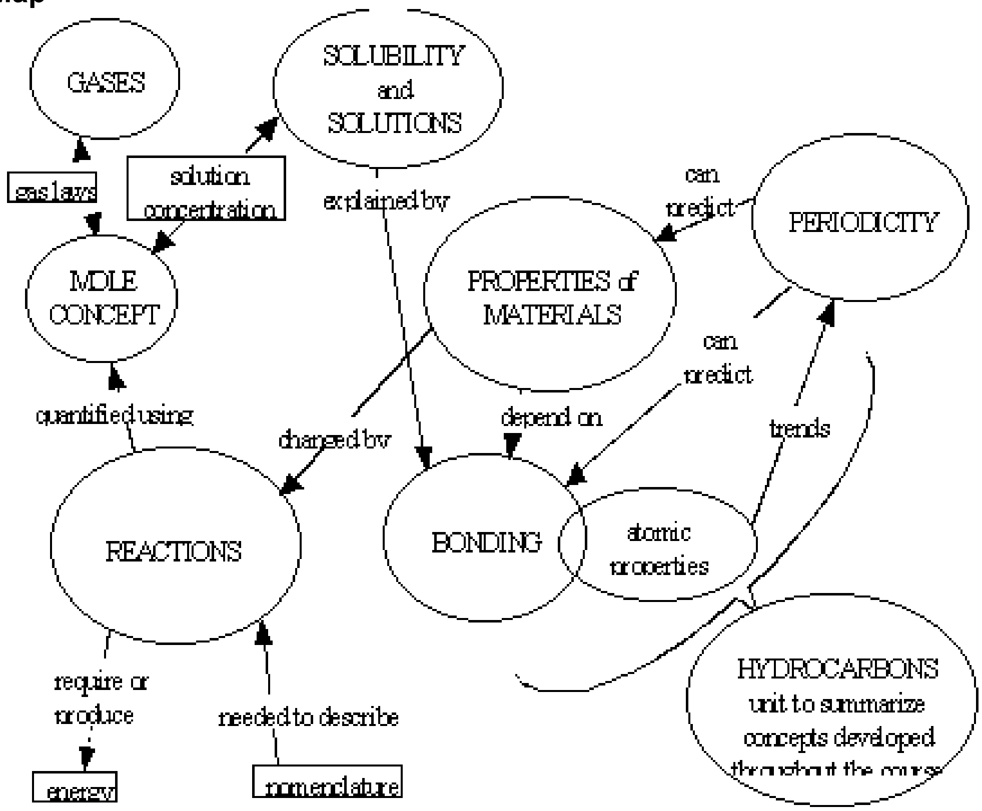
Unit 1	Matter and Chemical Bonding	20 hours
Unit 2	Quantities and Chemical Reactions	20 hours
Unit 3	Solutions and Solubility	22 hours
Unit 4	Gases and Atmospheric Chemistry	18 hours
* Unit 5	Hydrocarbons and Energy	20 hours
	Final Assessment	10 hours

* This unit is fully developed in this Course Profile.

Unit Overviews

Key to Abbreviations used in Unit Overview Charts	
AC = Achievement Chart	**LS = Learning Skills**
which has these assessment categories:	*found on the Provincial Report Card which are:*
K = Knowledge/Understanding I = Inquiry C = Communication MC = Making Connections	WI = Works Independently WH = Work Habits/Homework O = Organization TW = Team Work

Concept Map



Unit 1: Matter and Chemical Bonding

Time: 20 hours

Unit Description

This unit serves as the introduction to Grade 11 Chemistry. Essential chemical terminology is reviewed from earlier courses and extended in the context of student investigations, discussions and teacher direction. The Periodic Table as a central organizer from which properties of matter and bonding can be predicted is central to this unit. Qualitative information observed in simple chemical reactions is formalized through writing balanced chemical equations.

Unit Overview Chart

Activity/ Time	Title	Expectations	Assessment AC	LS
1.1 3 h	Properties of Materials	MCV.01, MC1.01, MCV.03, MC3.04	K, I, C	TW, O
1.2 3 h	Periodicity	MCV.01, MC1.02, MCV.02, MC2.01, MC2.02	K, I	WI, TW, O
1.3 4 h	What Holds Atoms Together in Materials?	MCV.01, MC1.03, MC1.04, MCV.02, MC2.03, MC2.04	K, I	WI, WH
1.4 8 h	Predicting and Describing Chemical Reactions	MCV.01, MC1.05, MC1.06, MCV.02, MC2.05, MC2.06, MC2.07, MCV.03, MC3.01, MC3.02, MC3.03, MC3.04	K, I, C	WI, TW, O, WH
1.5 2.0 h	End-of-Unit Task	MCV.01, MCV.02, MCV.03	K, I, MC, C	WI, O, WH, I

Details of Activities

Activity 1.1 In this set of activities students are reacquainted with safe and effective laboratory work which reviews a number of concepts from earlier chemistry work, including WHMIS. The teacher uses student work and responses as diagnostic information to adjust the time and depth of treatment required for the remaining activities. With this activity students begin to answer a question such as, "If sand, salt, sugar, and snow are white solids all made of atoms, why are they so different from one another?"

Start the unit by outlining what students will be expected to demonstrate in the Final Assessment Tasks for the course and for this unit (see Activity 1.5). Reporting orally to a group or whole class in 1.1.2 is an example of practising a skill that will be required in the Final Assessment Tasks for the course in Unit 5.

1.1.1 Students observe materials at various stations and record qualitative information on physical properties such as: melting point, solubility, conductivity, hardness, and odour.

1.1.2 In whole class or cooperative groups students explain the properties observed using prior knowledge of the structure of matter. **Assessment** of reports or oral discussions will provide diagnostic information to direct future activities.

1.1.3 The teacher reviews key terms and concepts as required e.g., atomic symbols, the octet rule, Bohr diagrams, ionic and molecular compounds, fundamentals of laboratory work (equipment and safety). Part of this discussion should emphasize the safety issues that arise from using common chemicals in the home and workplace.

Assessment: Students can be provided feedback on their skills by presenting orally to a group, and their skills at contributing to a team effort in cooperative small groups.

Activity 1.2 Students learn through these activities the utility of the Periodic Table as an organizer and predictive device for atomic properties.

1.2.1 Students are supplied with a blank periodic table on which they enter information and show trends, beginning with what they know from previous courses and adding as they progress through the unit.

1.2.2 Laboratory investigation – observation of reactions of representative metals with non-metals to review knowledge of the order of reactivity of elements in groups and across periods and to recognize and explain the order in terms of periodic trends in ionization energy and atomic size. Graphs of atomic properties may be plotted, or provided, as appropriate.

1.2.3 Periodic trends disclosed in 1.2.2 are entered on the Periodic Table begun in 1.2.1.

Assessment: Students place fictitious elements on a blank periodic table based on sets of properties provided by the teacher, e.g., a set of playing cards, one per fictitious element (Knowledge, Inquiry)

Activity 1.3 Ionic and covalent bonding is extended from previous work to include polar bonds and interparticle bonds. (Be clear and consistent in the use of the terms 'bonds' and 'forces'. They are sometimes used interchangeably - especially when addressing weaker bonds, between neighbouring molecules, for example, and can cause confusion for students.) The special properties of water explained here will be applied in later units where solubility and solutions are addressed.

1.3.1 Students use Periodic Table trends to predict and explain forces of attraction between atoms that result in ionic, covalent and polar covalent bonds. Electronegativity is introduced and added to the Periodic Table started in Activity 1.2.1.

1.3.2 Students practise a variety of methods of representing the internal structure of simple compounds – for example structural formulae and Lewis diagrams for ionic and molecular compounds, including indicators for polarity. Some examples should include multiple bonds.

1.3.3 The properties of common materials are correlated with the kinds of bonds that exist within and between particles of the materials. A teacher-led discussion of simple examples of ionic crystals, network solids and molecular solids culminates in a consideration of the special properties of water and ice explained by both types of internal bonds.

Assessment: A written test – include the writing of various representations of the bonding in common compounds; given formulae or the placement of constituent atoms on the Periodic Table, predict inter- and intra-particle bond types, and physical properties such as those observed in Activity 1.1. (Knowledge)

Activity 1.4 Students review and consolidate work from Grade 10 on types of chemical reactions, then extend that work to the writing of balanced chemical equations. Students then apply their knowledge to describe reactions which lead to trends in reactivity in metal and non-metal elements in the Periodic Table.

1.4.1 Students in groups do different samples of simple chemical reaction types in the laboratory – synthesis, decomposition, single and double replacement, the formation of acids and bases from reactions of oxide with water and the complete combustion of a hydrocarbon fuel (such as wax). In a teacher-led discussion, students identify the products of the reactions and generate word equations. From the results, students generate a list of generic types of reactions that can be predicted from knowledge of the reactants.

1.4.2 To further describe chemical reactions, students learn to write formulae for common compounds and to combine those formulae into skeleton equations. The Law of Conservation of Mass is reviewed and used to balance chemical equations by inspection. Care should be taken to limit the time spent on learning chemical nomenclature to that required to describe reactions that students have done and their analogues and other common reactions such as: corrosion of metals; neutralization of stomach or battery acid; precipitation; decomposition of an explosive compound; decomposition of hydrogen peroxide; formation of acid rain; removal of hard water deposits in the home or workplace (kettle, coffee maker) photosynthesis and cellular respiration.

1.4.3 Students use their knowledge of reaction types and chemical equations describing them to develop an activity series of metals. A laboratory investigation in which metals react with solutions of metal ions, done in micro scale (for example, using spot plates and dropper quantities), provides the observations for which reaction equations are written and an order of reactivity determined for metals within and across groups in the Periodic Table. From related reactions using solutions of group VIIA elements and ions of those elements and a non-polar solvent as indicator, an order of reactivity of non-metals is developed. Part of the discussion of the results should include the chemical stability of the jewellery metals and common alloys (pewter, sterling silver).

Assessment

1. Formative assessment of formula/name writing and writing and balancing equations for reaction types studied. (Knowledge)
2. Students produce a written argument, with diagrams, to explain the relative reactivity of metals and nonmetals in a group or across a period using atomic properties. Sample elements could be assigned to different students. Students on IEPs may be given additional time or resources to complete the task. (Inquiry, Communication)
3. Assess the Periodic Table assigned in Activity 1.2.1 for completeness and accuracy. (Communication)

Activity 1.5 Students should be expected to respond to both paper-and-pencil, and laboratory performance challenges to demonstrate their achievement of the Expectations in this unit.
Examples include:

- Given the physical properties of other elements in the immediate vicinity of an unknown element on the periodic table, predict the corresponding physical properties of the unknown element. (Knowledge)
- Given a blank periodic table, mark on it atomic property trends, trends in reactivity in groups and across periods, and write formulae of compounds predicted to form in reactions between elements in the A-groups. (Knowledge)
- Design and demonstrate a procedure which would identify an unknown substance as being molecular, covalent network, metallic or ionic in structure. The sample chosen for this task should be clearly within one of these classifications. Materials could include natural or synthetic fibres, building materials (e.g., concrete, ceramic tile), and other substances from the home and workplace in addition to elements and compounds common in the laboratory. (Inquiry, Making Connections)
- Provide a chemical answer to a question like the one posed in the introduction to section 1.1 which includes reference to inter- and intra-particle bonding, simple chemical properties, and physical properties for common chemicals. (Knowledge, Making Connections, Communication)

Unit 2: Quantities in Chemical Reactions

Time: 20 hours

Unit Description

In this unit, students are introduced to the mole concept. The quantitative treatment of chemical equations and reactions moves from mole-mole and mass-mass relationships to percent yield and limiting reagent calculations. Additional quantitative topics include the theory of average atomic mass and its calculations as well as percent composition and the Law of Definite Proportion.
Whenever possible, the theory is complemented by experimental work.

Unit Overview Chart

Activity/ Time	Title	Expectations	Assessment AC	LS
2.1 0.5 h	Need for Quantities in Chemical Reactions	QCV.03		
2.2 4.0 h	The Mole Concept	QCV.01, QCV.03, QC1.01, QC1.02, QC1.05, QC2.01, QC2.03, QC3.01	K, I, C	WI, TW, O, WH, I
2.3 8.5 h	Chemical Equations	QCV.01, QCV.02, QCV.03, QC2.01, QC2.03, QC2.05, QC2.06, QC2.07, QC2.08, QC2.09, QC3.01, MC1.01, MC1.05, MC2.06	K, I, MC, C	WI, TW, O, WH, I
2.4 6.0 h	Definite Proportions	QCV.01, QCV.03, QC1.03, QC1.04, QC2.01, QC2.02, QC2.03, QC3.01, QC3.02, QC3.03, MC1.05, MC2.06	K, I, MC, C	WI, TW, O, WH, I
2.5 1.0 h	End-of-Unit Task	QCV.01, QCV.02, QCV.03	K, MC	

Details of Activities

This unit is a foundation for the work in Units 3 and 4 and is critical to success in the Unit 4 End-of-Unit task which is a component of the Final Assessment Task for the course.

2.1.1 Write a balanced chemical equation for a chemical reaction which involves solid(s), solution(s) and gas(es). An appropriate reaction would be a metal-acid reaction or the removal of calcium carbonate deposits from a kettle using vinegar. In a teacher-led discussion review what the students know qualitatively about the equation, e.g., bonding, reaction type, balancing, properties of materials, etc. and lead from that to introduce the need for quantitative information ("What volume of gas at a given temperature and pressure will be produced when x grams of the solid react with the solution in this reaction?")

Activity 1.2 Use knowledge of atomic masses to review the definition of "isotope" and extend to calculate average atomic mass, Avogadro's Number, and molar masses. There is an opportunity to discuss the use of significant digits where measurements are used.

2.2.1 Students calculate average atomic mass given abundance and mass of isotopes of a given element. Compare results to those on the Periodic Table. Have students calculate the formula mass of some common chemicals in atomic mass units using the Periodic Table. Introduce Avogadro's number as the conversion factor which connects atomic mass units to grams. By analogy emphasize the size of that number. Define the mole as the unit which defines the amount of substance in Avogadro's number of particles.

2.2.2 Lab Activity: Moles of Common Substances. Using a variety of materials measure the mass and calculate the number of moles and the number of particles of each sample.

Assessment: Short quizzes throughout this activity. (Knowledge)

Activity 2.3 Stoichiometry is the major focus of this activity. It will be necessary to review balancing chemical equations before introducing quantitative aspects.

2.3.1 Review the balancing of chemical equations by inspection. Extend to more complex equations and include nuclear equations and the use of radioisotopes in medical and food technology.

2.3.2 Relate the coefficients in the balanced equation to ratio of moles. Perform a lab activity that permits the student to verify the mole ratio in a chemical reaction, e.g., PbI_2, AgI. Introduce the "mole bridge" or "mole island" as a device for solving problems in chemistry.

2.3.3 Discuss theoretical and actual yield and extend the discussion to percent yield calculations. Students perform a lab activity to predict theoretical yield and compare to actual yield. Students calculate percentage yield and discuss sources of errors for their lab results.

2.3.4 With the use of practical analogies, discuss and provide examples of limiting reagents extend the discussion to include chemical reactions and perform stoichiometric calculations which include limiting reagents.

2.3.5 Students practise solving problems involving stoichiometry using the mole concept as their tool for connecting reactants to products through a balanced equation.

Assessment: quiz (Knowledge), lab report (Inquiry, Communication)

Activity 2.4 Use chemical reactions to calculate percent composition, confirm Law of Constant Composition and calculate empirical and molecular formulae.

2.4.1 Use a laboratory activity such as the thermal decomposition of sodium carbonate to illustrate the concept of percentage composition.

2.4.2 Extend discussion to percentage composition by collecting class data to develop the Law of Constant Composition (Definite Proportions). Provide examples of different compounds made up of the same elements, but with different compositions (carbon monoxide/carbon dioxide/water, hydrogen peroxide) to arrive at the Law of Multiple Proportions.

2.4.3 Discuss the need for the use of chemical analysis (unknown identification, trace analysis) and demonstrate the calculation of empirical and molecular formula from percent composition and molecular mass data. Have students solve problems.

Assessment: Students perform a lab activity to determine the formula of a compound (a hydrated compound –magnesium sulfate heptahydrate or magnesium oxide). (Inquiry, Communication); Assess problem sets (Knowledge)

Activity 1.5 Unit test (Knowledge, Making Connections)

Unit 3: Solutions and Solubility

Time: 22 hours

Unit Description

This unit begins with a review of the characteristics of solutions and dissolving. Experimental work forms the foundation for qualitative analysis and selective precipitation. Quantitative work from the previous unit is carried forward into solution calculations and the concepts of concentrations and dilution. The discussions of acids and bases from previous courses are extended to pH calculations, titrations and various acid base theories.

Unit Overview Chart

Activity/ Time	Title	Expectations	Assessment AC	Assessment LS
3.1 2.5 h	A Backgrounder: Characteristics of Solutions	SSV.01, SSV.02, SSV.03, SS1.01, SS1.02, SS1.03, SS2.01, SS3.01, SS3.02, SS3.03, SS3.05, MC1.03, MC2.03	K, I, MC, C	O, I, TW, WH
3.2 5.0 h	Qualitative Analysis: Theory Put to Use	SSV.02, SSV.03, SS1.02, SS1.04, SS2.01, SS2.04, SS2.05, SS2.07, SS3.01, SS3.05, MC1.03	K, I, MC, C	WH, TW I, O
3.3 5.0 h	Concentration	SSV.02, SSV.03, SS2.01, SS2.02, SS2.03, SS2.08, SS3.01, SS3.02, QC2.07, QC2.08	K, I, MC	WH, TW, O, I, WI
3.4 6.0 h	Acids and Bases	SSV.01, SSV.02, SSV.03, SS1.01, SS1.02, SS1.05, SS1.06, SS1.07, SS2.01, SS2.02, SS2.03, SS2.06, SS2.07, SS2.08, SS2.09, SS3.01, SS3.02, SS3.03, QC2.07, QC2.08	K, I, MC, C	WH, TW, O, I, WI
3.5 2.5 h	Drinking Water in Ontario	SSV.01, SSV.03, SS1.04, SS2.01, SS3.02, SS3.03, SS3.04	I, MC, C	I, TW, WH
3.6 1.0 h	End-of-Unit Task	SSV.01, SSV.02, SSV.03		

Details of Activities

Students studied solutions and the basics of solubility in Grade 7. The extent of this background knowledge should be assessed before requiring them to link solubility to the bonding found in solutes and solvents.

3.1.1 The nature of the solute and solvent determine whether a solution will form. A demonstration or a laboratory activity to illustrate the solubility of different substances in water, alcohol and kerosene could lead into a discussion of chemical bonding and why “like dissolves like”, and environmental considerations in disposing of waste materials, e.g., dry cleaning chemical; problems of persistence of chemicals in the environment; bioconcentration of pesticides through a food chain.

3.1.2 Temperature affects the solubility of a substance. By plotting data regarding the solubility of various substances in water at different temperatures the resulting curves can be analysed and problems can be solved based on the data.

3.1.3 Water is considered to be a universal solvent; the concepts learned in Activity 3.1.1 can be examined in more detail with respect to the solubility of salts in water. Students can prepare a solubility chart in a laboratory activity and use it to predict the solubility of a variety of salts. The concept can be extended to include environmental applications

Assessment: Quiz covering Activities 3.1.1 and 3.1.3 (Knowledge, Making Connections), Graph 3.1.2 (Communication, Making Connections)

In order to predict the outcome of a reaction in quantitative terms it is essential to know the concentration of the solution. To carry out controlled reactions in solution it becomes necessary to prepare solutions of known concentration.

Activity 3.2 The background knowledge obtained in the first section of this unit is put to a practical use – the isolation and identification of ions in solution.

3.2.1 The dissociation of ionic substances in water is expressed in the form of a balanced ionic equation and the mixing of solutions to produce a precipitate is reviewed and illustrated in a net ionic equation. The state of the reactants and products are to be included in the balanced equation. Practise writing balanced ionic and net ionic equations will reinforce student’s understanding of bonding and the dissolving process. A laboratory activity in which the student is required to predict and then confirm the formation of a precipitate based on information found in a solubility chart will reinforce the topic even further.

3.2.2 The concept of selective precipitation can be introduced here and students should be able to suggest a method of isolating and precipitating selected ions from a solution containing several ions. The use of a flow chart to illustrate the process will enable the student to communicate in a clear and simple manner.

3.2.3 Investigate the methods by which the presence of Cu^{2+}, Hg_2^{2+}, Pb^{2+} are identified and how they can be separated from each other. Illustrate the process in a flow chart.

3.2.4 Analyse a solution containing one or more of the following ions: Cu^{2+}, Hg_2^{2+}, Pb^{2+} and report observations and findings.

3.2.5 A discussion on practical applications of this process would be appropriate. Examples include detection of trace quantities of elements for forensic, medical, environmental or quality control purposes.

Assessment: Quiz 3.2.1 (Knowledge, Making Connections), Flow chart 3.2.3 (Communication), Lab 3.2.4 (Inquiry)

Activity 3.3 In order to predict the outcome of a reaction in quantitative terms it is essential to know the concentration of the solution. To carry out controlled reactions in solution it becomes necessary to prepare solutions of known concentration.

3.3.1 The terminology associated with concentration (%mass, %volume, g/L, molarity) should be reviewed, extended and used in an everyday context. Solving problems of a practical nature will reinforce the concepts and definitions.

3.3.2 The knowledge and skill involved in the preparation of solutions of known concentration can be achieved by demonstration or in a laboratory activity. A follow up problem set would allow students to solidify their understanding. An example of a laboratory assignment that could be carried out in two parts or assigned to one pair of lab partners would be to prepare a solution by: (1) dissolving a solid in water (Prepare 150 mL of 0.60 mol/L solution of NaOH.) and (2) dilution of an existing solution with water (Prepare 150 mL of 0.40 mol/L HCl from an existing 1.0 mol/L HCl solution.) Both solutions could be used in a titration lab and the concentrations confirmed at a later date.

3.3.3 A problem set would be appropriate at this point and could be used to review the methods by which solutions are made as well as extending the concepts to deal with the mixing of solutions and the resultant concentrations.

3.3.4 It will be possible to integrate solutions into equations and solve stoichiometric problems. This will serve as a review and extension of material learned in Unit 2.

Assessment: Quiz on Problems 3.3.1/3/4 (Knowledge), *Lab Activity 3.3.2 (Inquiry) (see 3.4.5)

Activity 3.4 Acids and bases are two types of solutions that are frequently used in the laboratory and were studied in the Grade 10 course. Therefore a review would be appropriate to assess the students knowledge before moving into new areas.

3.4.1 The pH scale is not a new concept; however, the meaning of pH may have to be clarified. A demonstration to illustrate the difference between electrolytes and non-electrolytes would allow the students to deduce the concept that percent dissociation/ionization is the basis for distinguishing between strong and weak electrolytes. By using/citing examples of strong (weak) acids, pH could be reviewed before solving problems relating the concentration of hydronium ions to pH.

3.4.2 What is the effect of dilution on the pH of an acid or a base? This would provide an opportunity to use probe-ware (if available) to do this lab.

3.4.3 Students are expected to move beyond Arrhenius' theory of acids and bases to understand the Bronsted-Lowry Theory. There are numerous practical examples, which could be introduced to enhance their understanding.

3.4.4 Chemical reactions in which acids and/or bases play a major role could be demonstrated or reviewed. Reactions such as the displacement of hydrogen by an active metal and the neutralization of an acid by a base or a carbonate give rise to a number of practical examples.

3.4.5 Students should perform one or more titrations – to determine the concentration of a previously prepared acid or base and/or vinegar by using prepared solutions of known concentration.

3.4.6 A problem set including stoichiometric problems involving acids and bases (include pH) would incorporate many of the concepts learned in Units 2 and 3.

Assessment: Lab Report: *3.3.2, 3.4.5 (Inquiry, Communication) Quiz: 3.3.3 (Knowledge)

Activity 3.5 The technologies involved in providing potable water will allow the students to use a number of concepts studied in this unit. Questions such as the following could be addressed:

1. What substances are dissolved in the water (nitrates, phosphates, heavy metals)? In what concentrations are they dangerous? How is their presence detected? How are they removed from drinking water sources? What are their origins?

2. What chemicals are used to remove biological pathogens? In what concentrations?
3. "What goes in must come out." How do we treat waste water streams which will eventually become the sources of our drinking water?

These and similar questions would make an excellent "online" research assignments and provide an opportunity for oral presentations in preparation for the Final Assessment Task of the course.
Assessment: (Inquiry, Communication)

Activity 3.6 Unit Test (Knowledge, Making Connections, Communication) with emphasis on making connections to concepts learned.

Unit 4: Gases and Atmospheric Chemistry

Time: 18 hours

Unit Description

This unit begins with a review of the properties and uses of some common gases. A review of the kinetic molecular theory leads to a discussion of gas properties and their measurement. Experimental work forms the foundation for quantitative work on the gas laws, including the law of partial pressure. Mole calculations from earlier units are extended to the Ideal Gas Law and standard molar volume. The unit culminates with a laboratory investigation, which will utilize the skills and knowledge from Units 2, 3 and 4.

Unit Overview Chart

Activity/ Time	Title	Expectations	Assessment AC	LS
4.1 5.0 h	Gases in the Atmosphere	GAV.03, GA1.06, GA3.01, GA3.02, GA3.03, GA3.04, MC3.04, QC2.05, HE2.05	K, I, MC, C	O, I, TW, WH, WI
4.2 0.5 h	The Kinetic Molecular Theory of Gases	GA1.01, GA1.02, GA2.01, MC1.03	K, MC	WH
4.3 5.0 h	The Gas Laws	GAV.01, GAV.02, GA1.03, GA2.01, GA2.02, GA2.03, GA2.04, GA3.01	K, I, MC, C	WH, TW, O, I, WI
4.4 6.0 h	Moles of Gases	GAV.01, GAV.02, GA1.03, GA1.04, GA1.05, GA2.04, GA2.05, GA2.06, QC2.05, QC2.07, QC2.08	K, I, MC, C	WH, TW, O, WI
4.5 0.5 h	Technology and Gases	GAV.03, GA3.04	I, C	I, WH
4.6 1.0 h + 3.0 h in the Final Assessment Tasks)	End-of-Unit Tasks	SSV.02, SS2.03, SS2.07, SS2.08, GAV.01, GAV.02, GA1.03, GA1.04, QC2.05, QC2.07, QC2.08, QC2.09, QCV.01, QCV.02, QCV.03	K, I, MC, C	I, WH, O, TW

Details of Activities

Before delving into the theories and laws that are associated with the study of gases students review topics that they studied in Grades 9 and 10. The topics and laboratory activities outlined in this section provide students with a general or practical knowledge of gases. It might not be necessary to do every activity since the students may have already done it. This section would fit equally as well at the end of the unit.

4.1.1 Depending on the amount of time one can allot to this section the abundance, distribution, sources and uses of atmospheric gases could be reviewed, taught, or given to the students as a research topic.
4.1.2 The chemical and physical properties of carbon dioxide and oxygen can be reviewed, demonstrated or examined in the laboratory. Practical applications could include fire extinguishers, carbonated beverages, aerosol propellant, global warming, acid precipitation.
4.1.3 By observing the complete and incomplete combustion of acetylene in a laboratory setting, with careful attention to safety, the students will be able to discuss industrial pollution, the incineration of waste materials as well as relate back to the concept of limiting reagents.
4.1.4 The Montreal Protocol can be researched online. A discussion of the sources and chemistry of as well as the methods of reducing air pollution would be appropriate.
Assessment: Anecdotal Observation (Knowledge, Making Connections, Communications)

Activity 4.2 Explaining the physical properties of matter using the Particle Theory of Matter is prior knowledge expected for this course. The students should be able to elaborate by providing information learned in Unit 1.
4.2.1 The Kinetic Molecular Theory is used to describe the physical behaviour of gases. The distinction between a real gas and an ideal gas can be discussed at this time.
Assessment: Anecdotal Observations (Knowledge, Making Connections, Communications)

Activity 4.3 The relationship that exists between the volume of a given mass of gas and its temperature and/or pressure can be examined in a variety of ways.
4.3.1 The methods used to measure the volume, temperature and pressure of gases, the associated definitions, the units (L, kPa, K), and the conversion of units (to/from: K/^{o}C, atm or torr or kPa) should be addressed.
4.3.2 Laboratory activities or computer simulations are available to teach Boyle's Law (P vs. V), Charles' Law (T vs. V) and Gay-Lussac's Law (P vs. T).
4.3.3 With teacher assistance students use data collected in Activity 4.3.2 to develop the combined gas law equation PV/T = a constant.
4.3.4 A problem set involving application of the laws in practical settings, e.g., carbonated pop rocks and in terms of mathematical solutions would reinforce the concepts learned. Students should be strongly encouraged to solve problems by logic, not by memorization of an algorithm.
Assessment: Quiz on 4.3.1, 4.3.5 (Knowledge, Making Connections) Lab Report 3.3.2 (Inquiry, Making Connections, Communications)

Activity 4.4 In order to predict the amount of gas produced in a chemical reaction the students must revisit mole concept and apply it to ideal gases.
4.4.1 Gay-Lussac's Law of Combining Gas Volumes and Avogadro's hypothesis lead into molar volume and the ideal gas law equation.
4.4.2 What is the molar volume of hydrogen gas at STP? This could be done as a laboratory activity and Dalton's Law of Partial Gas Pressures would be part of the pre-lab discussion.
4.4.3 If students are given sample (straightforward) data they should be able to derive the ideal gas law equation and use it to solve problems.
4.4.4 Review stoichiometric calculations and solve chemical equation problems, which include gases among the reactants and/or products. The "mole bridge" or "mole island" model is expanded to include gases.
Assessment: Lab Report 4.4.2 (Knowledge, Making Connections, Inquiry, Communications);
Quiz 4.4.3,4 (Knowledge, Making Connections)

Activity 4.5 It might be good to look at some modern technology and research methods by which elements and compounds are analysed and identified.
A connection with the Weather unit in Grade 10 could be made with technologies associated with properties of atmospheric gases in meteorology – air circulation, pressure systems, cyclonic waves, etc.
Assessment: Quality of Information Found (Inquiry, Communications)

Activity 4.6 Students perform a reaction, which involves a solid and a solution as reactants and releases a gas as a product. They could be asked to predict what volume of gas should be produced at room conditions, design and carry out an investigation to examine the reaction in a laboratory setting. Numerous concepts could be built into this investigation and it would serve as a review of learned skills and concepts.
4.6.1 Test (Knowledge, Making Connections, Communications)
4.6.2 Culminating Activity: Units 2, 3, 4
Assessment: (Knowledge, Making Connections, Communications, Inquiry)

Unit 5: Hydrocarbons and Energy

Time: 20 hours

Unit Description

The intent of this unit is to introduce students to the world of organic chemistry. The unit begins with an exploration of the sources of hydrocarbons and moves on to an examination of their properties and characteristics. Simple reactions of hydrocarbons, calorimetry and thermochemical equations are used to investigate the energetics of bond making and breaking. The nomenclature of organic chemistry is also introduced. Throughout, students should be thinking about and discussing the benefits and risks of hydrocarbons in use today.
This unit is expanded in detail in this profile.

Unit Overview Chart

Activity/ Time	Title	Expectations	Assessment AC	LS
5.1 4.0 h	An Introduction to Organic Chemistry	HE1.01, HE1.02, HE1.03, HE1.04, HE2.04, HE3.01, HE3.02, MC2.04, MC3.01. MC3.04	K, I, MC, C	TW, WH, WI, I, O
5.2 3.0 h	Naming Hydocarbons	HE1.03, HE2.01, HE2.02, HE2.03, MC2.04	K, I, MC	TW, O, I, WH
5.3 2.0 h	Properties of Hydrocarbons	HE1.03, HE2.01, HE2.06, MC1.03	K, I, MC, C	TW, I, WH, WI, O
5.4 6.0 h	Hydrocarbons as Fuels	HE1.04, HE1.05, HE1.06, HE2.01, HE2.05, HE2.06, HE2.07, MC3.01, QC1.05, QC2.01, QC2.09, QC3.01	K, MC, C	TW, I, WI, WH, O
5.5 5.0 h	End-of-Unit Tasks Hydrocarbon Research Assignment	HE3.02	K, I, MC, C	WI, I, WH

Final Assessment Tasks

Time: 10 hours

By curriculum policy, the Final Summative Evaluation of the course accounts for 30% of the final grade recorded for the course. The Final Assessment Tasks must take place towards the end of the course, but do not have to be limited to an end-of-year project or single event, such as an examination. The tasks suggested in this profile include a laboratory activity which pulls together content from Units 2 to 4, a written component that should be designed as described in the OAC Teacher Inservice Program and Examination Review for chemistry, and a research project described in Unit 5.

Time	Assessment Focus		Assessment Activity
2 h	K, I, MC, C	WI, O, I, WH	**Written Component** This component should consist of a variety of assessment instruments, such as: multiple choice, extended response, short answer, laboratory-based questions, e.g., design an experiment, analyse a procedure for errors, and data analysis (determine mathematical relationship between two variables from sample data). Content should come from all units of the course and focus on key concepts and skills that can be assessed on paper.
3 h	K, I, MC, C	WI, O, I, WH	**Practical Component** See End-of-Unit Task 4.6.2 Since students may be assigned different reactions, this component can be done over a period of time.
5 h	K, I, MC, C	WI, O, I, WH	**Research Component** Refer to the model unit, Activity 5.5.2 for details.

Teaching/Learning Strategies

Need for Variety and Balance

Since the over-riding aim of this course is to develop scientific literacy in all students, a wide variety of instructional strategies is needed to provide learning opportunities that accommodate a variety of learning styles, interests and ability levels.

In planning activities for chemistry class make sure that your students will have:

- opportunities to work individually, in pairs and small groups, and in large groups;
- direct-instruction as well as open-ended exploration;
- opportunities to develop concepts themselves from observed data;
- tasks in which they define some of the parameters (such as scope or procedure);
- opportunities to acquire knowledge and apply that knowledge in a variety of contexts;
- opportunities to communicate using standard formats (such as lab reports) as well as opportunities to choose and develop the format.

Skills are Developed through Experience and Refined with Practice

Many of the Learning Expectations describe Inquiry Skills. Give students repeated opportunities to carry out genuine inquiries in which *they* are responsible for defining one or more of the components of the inquiry: the topic or question, the methodology, the mode of presentation, the criteria of success. Within Chemistry students should have multiple opportunities to practise a variety of inquiry styles, including the following:

- Research involves *accessing information* that has already been gathered elsewhere*, selecting* what is needed, and *analysing* that information for patterns and meaning. This will require instruction and practice in techniques for effective use of Library/Resource Centre resources, searching the Internet and interviewing experts.
- Experimentation involves *identifying controls and variables, designing the experimental procedure, observing and measuring and analysing* the data for patterns and meaning. This may occur in laboratories or the field. Laboratory techniques and safety procedures must be taught and assessed.
- Design/Innovation in which knowledge is applied to *define a problem or challenge, set criteria* for a satisfactory solution, devise and execute a procedure, and assess the result.

Every inquiry should be driven by a clear *question* that is manageable and has relevance to the students. Students must be given instruction and repeated practice in: identifying and refining good inquiry questions; developing testable hypotheses; setting the parameters of the solutions to be sought; assessing results.

All forms of inquiry as well as other activities throughout the course develop Communications Skills. Although the traditional written report is one form of communication, students need to describe what they do and what they learn in other formats – poster presentations; computer presentations, video, music. Through various formats of cooperative learning they discuss, debate and reflect on their own thinking and learning.

In addition to key chemical concepts, every learning activity should identify a technique or skills that will be taught or reinforced and assessed. Over the length of the course, all skills required to meet the Expectations should be practised repeatedly in a variety of contexts.

Use of Computer Technology

Computer applications should be taught and used whenever they enhance learning by enabling students to do something more efficiently or that they could not otherwise do. A wide variety of software tools should be used to record and display information, including *word-processing* (e.g., reports) *spreadsheets* (e.g., class data from measurements of energy released in combustion of a hydrocarbon) *graphics* (e.g., flow charts, concept maps, diagrams in place of written reports of investigations), *databases* (e.g., class observations of properties of materials to show clusters with similar properties, reactions, bonding; collections of data from replicated experiments), and *presentation programs* (e.g., an alternative for reporting on investigations, particularly by groups). *Probe-ware* should be used to collect data (e.g., to permit replications of experiments where wet chemistry procedures would limit students to single experiments). *Simulations* may substitute for experiences but should not be used to replace direct experiences that are safe, ethical and available (e.g., nuclear reaction simulations; reactions that are either too fast or too slow to observe directly). The portability of calculator based laboratory systems makes them useful for work outside the classroom.

Learning Skills

While not evaluated for marks, learning skills - Works Independently, Teamwork, Organization, Work Habits/Homework, Initiative – are keys to success in school and beyond. As with other skills, they should be taught, practised, and assessed in the chemistry classroom. Variety is essential: individual assignments foster independence; small-group cooperative learning (including laboratory work done in pairs) provides opportunities to develop teamwork. Cooperative Small Group Learning (CSGL) structures are discussed in some detail in Appendix OV-3, beginning on p. 18 of the Overview to the Grade 9 Science, Essential, profile. – http://www.curriculum.org/occ/profiles/9/9essential.htm#science).

A summary of CSGL structures has been included as Appendix 1 in the Public profile for Grade 11 Science, SNC3M.

Making Connections

The knowledge expectations of this course have intrinsic worth as useful information, but they also serve as vehicles for developing other expectations.

- Acquisition of knowledge through inquiry develops inquiry skills;
- Connecting chemical concepts to social and environmental issues develops the habits of mind for making connections;
- Applying scientific knowledge to practical problems makes connections to technology; considering how scientific knowledge is acquired brings understanding of the role that technology plays in scientific discovery.
- During their study of chemistry students should be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment. Foundation 4 of the Common Framework of Science Learning Outcomes (the "Pan-Canadian Science Document" sponsored by the Council of Ministers of Education, Canada) supports this view and expands on it in sets of General Outcomes throughout the document. – http://www.cmec.ca/science/framework/index.htm

Assessment & Evaluation Of Student Achievement

Assessment is a systematic process of collecting information or evidence about student learning; evaluation is the judgment we make about the assessments of student learning based on established criteria.

The purpose of assessment is to improve student learning. This means that judgments of student performance must be criterion-referenced so that feedback can be given that includes clearly-expressed next steps for improvement. This can be facilitated by tools of varying complexity.

- Where completion or non-completion is the issue, a checklist is sufficient;
- Where quality of performance is easily identifiable, a rating scale can be used;
- For more complex tasks, the criteria may be incorporated into a rubric where levels of performance for each criterion are stated in language that can be understood by students. Rubrics describe performance of a generalized skill (such as Inquiry) or can be task-specific.

Checklists, rating scales and rubrics become powerful tools for improving learning when students understand the criteria and levels of performance before they undertake the task. Discussion of the criteria for success should be part of every learning task. Wherever possible, involve your students in the development of the rating scale or rubric (identifying criteria and setting levels of achievement in terms they understand).

The following references are useful in expanding both teacher and student understanding of rubrics as a powerful tool in assessment.

Generic rubrics, e.g., for a lab report or an oral presentation – See Teacher Support Materials, Grade 9 Academic Public Science Profile, pp. x-xviii for examples).

Task-specific rubrics See TSM 5C: Developing Task-Specific Rubrics, p.16 of the Teacher Support Materials in the Grade 10 Science, Public Profile, Academic.

Assessment must be embedded within the instructional process throughout each unit rather than being an isolated event at the end. Often, the learning and assessment tasks are the same, with formative assessment provided throughout the activity. In every case, the desired demonstration of learning is articulated at the beginning and the learning activity is planned to make that demonstration possible. When planning learning activities for Chemistry, this process of beginning with the end in mind helps to keep focus on the Expectations and to reduce the inclination to expand what is taught beyond what is required by the guideline.

Assessment, Evaluation and Reporting are tied to the Learning Expectations and Achievement Chart for Science, pp. 172-175 in *the Ontario Curriculum, Grades 11 and 12: Science, 2000*. Every learning activity and its assessment should collect data for making judgments about performance in one or more of the Achievement Categories: Knowledge/Understanding, Inquiry, Communications and Making Connections. Within each unit and across the course, teachers must collect sufficient data (in kind and number) to make valid judgments about each student's performance in all Categories.

In the end, the evaluation of the assessment data is expressed as a percentage based on Achievement Chart levels. That judgment must be based on each student's performance based on the criteria, not relative to other students' performances. Final evaluations should reflect the teacher's informed, professional judgment of each student's most consistent level of performance in each category of the Achievement Chart.

A wide and balanced range of assessment strategies is needed to accommodate the varied learning styles of all students, to meet the needs of students with special needs, and to encompass a broadened range of knowledge and skills expectations.

There must be opportunities for students to demonstrate learning at all levels of the Achievement Chart. Strategies include:

- diagnostic, formative and summative assessments;
- performance tasks and pencil-and-paper instruments. Both are needed to assess the full range of expectations;
- both teacher assessment and student (self and peer) assessment. With clearly articulated criteria, students become partners in the assessment process;
- both individual and group assessment. When students are engaged in group tasks it is appropriate to consider group interaction as an indicator of each student's learning skills. However, assessment must focus primarily on each student's individual demonstration of the learning expectations.

By curriculum policy, the Final Summative Evaluation of a course accounts for thirty percent of the final grade recorded for the course. In this course, it is recommended that one component of that grade will be based on a final examination. The format of the examination should conform with suggestions in the OAC Ontario Teachers Inservice Program. All secondary schools in Ontario participated in the OAC Examination review process in the 1990's in both chemistry and physics, and the documents distributed for the review have advice on assessment and evaluation practices. [Contact your board's Superintendent of Program for information about the OAC TIP program if documents are not located in your school.] Examination questions should be equally distributed across the course units, and consideration should be given to a range of question types, such as multiple-choice, short and extended answer, laboratory-based and higher-order questions.

Accommodations

Students with special needs, whether identified formally or not, need additional supports to succeed in Grade 11 Chemistry. For each identified student, read the Individual Education Plan (IEP) for information about specific accommodations designed to compensate for specific disabilities.
The following are examples of accommodations and aids that may be helpful. Where there are specific accommodations required in an activity, the suggestions are noted with the activity description.

- Ensure that peer helpers are available when students are working in small groups;
- Provide handout sheets with sample calculations and specific skill instructions;
- Help students create data charts into which they record information;
- Advise special education staff in advance when students are working on major assignments;
- Record key words on the board when students are expected to make their own notes;
- Allow students to report verbally to a scribe (teacher or student) who can then help in note making;
- Permit students a wide range of options for recording and reporting their work to utilize student strengths (drawings, diagrams, flow charts, concept maps);
- Timelines may be extended for students to process language and put their thoughts into words;

Where an activity requires reading, give it in advance or provide materials at different reading levels.
Students in English as a Second Language/English Literacy Development programs may require additional supports.

- Have students keep a science dictionary of terms using pictures and first language words;
- Where an activity requires reading, give it in advance to students;
- Permit the use of a translation dictionary on assessments;
- Provide additional time on assessments for dictionary use and processing language;
- Have the library staff identify resources with appropriate reading level when research is required;
- Advise ESL/ELD staff in advance when significant written work is required;

Resources

Students will need assistance in the selection of online resources, which are reliable. Teachers should continue to monitor what is available from commercial suppliers and online sources. Teachers should also be encouraged and supported in attending workshops and conferences where program content relates to the new curriculum and where displays of commercial materials, which support the curriculum are exhibited.
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.

A General References on Science Education

Armstrong, Thomas. *Multiple Intelligences in the Classroom*. Alexandria, VA: Association for Supervision and Curriculum Development. 1994. ISBN 0-87120-230-1

Brown, John L. *Observing Dimensions of Learning in Classrooms and Schools*. Alexandria, VA: Association for Supervision and Curriculum Development. 1995. ISBN 0-87120-255-7

Burke, Kay. *How to Assess Thoughtful Outcomes*. Palatine, Illinois: IRI/Skylight Publishing, Inc., 1993. ISBN 0-932935-58-3 (1-800-348-4474)

Council of Ministers of Education, Canada. *Common Framework of Science Learning Outcomes* (the "Pan-Canadian Science Document"). – http://www.cmec.ca/science/framework/index.htm

Driver et al. *Making Sense of Secondary Science: Research into Children's Ideas*. New York: Routledge. 1994. ISBN 0-415-09765-7

Herman, Aschbacher and Winters. *A Practical Guide to Alternative Assessment*. Association for Supervision and Curriculum Development. 1992. ISBN 0-87120-197-6

McDonald, Joseph P. et al. *Graduation by Exhibition: Assessing Genuine Achievement*. Alexandria, VA: Association for Supervision and Curriculum Development. 1993. ISBN 0-87120-204-2

Osborne, Roger and Peter Freyberg, eds. *Learning in Science: The Implications of Children's Science*. Portsmouth, NH: Heinemann Publishers. 1985. ISBN: 0-86863-275-9

Project 2061 (AAAS). *Benchmarks for Science Literacy (Benchmarks for Science Literacy* On-line is also available. See the AAAS site listing). New York: Oxford University Press. 1993.
ISBN: 0-19-508986-3

Slater, Alan and Geoff Rayner-Canham. *Microscale Chemistry Laboratory Manual.* Don Mills, ON: Addison-Wesley Publishers Ltd., 1994. Teacher's Edition ISBN 0-201-60216-4 and Student's Edition ISBN 0-201-60215-6

Zemelman, Daniels and Hyde. *Best Practice: New Standards for Teaching and Learning in America's Schools*. Portsmouth, NH: Heinemann. 1993. ISBN 0-435-08788-6

Internet Resources

Schools should develop and maintain websites on which selected resources are listed, particularly those which have links to other science references. One excellent site, with very extensive links, is The Internet Public Library (– http://www.ipl.org – lower case necessary).

Other useful science sites include the following.

About - The Human Internet: Science/Chemistry – links to many chemistry topics and other science topics – http://chemistry.about.com/science/chemistry/mbody.htm

American Association for the Advancement of Science – http://www.aaas.org/

Association for Supervision and Curriculum Development – variety of high quality publications and videos on a wide variety of topics -- many principals and superintendents have memberships and can purchase materials at reduced rates. Also the home of Educational Leadership magazine.
– http://www.ascd.org/

Canadian Environmental Solutions (Industry Canada) – http://strategis.ic.gc.ca/SSG/es00001e.html

Canadian government and research sites related to science and engineering
– http://www.nserc.ca/relate.htm

CBC Educational Resources – http://www.cbc.ca/insidecbc/educational/

Education Network of Ontario – http://www.enoreo.on.ca/

Education Resources on the web (Canadian site)
– http://www.educ.uvic.ca/depts/snsc/pages/weblinks/weblinks.htm

EDU Web Index – to find anything on the Ministry's website.
– http://www.edu.gov.on.ca/eng/webmap.html

Environment Canada – http://www.ec.gc.ca

Environmental Education Resources on the Internet – http://eelink.net

Gateway to Educational Materials – http://www.thegateway.org/

Green Ontario – http://www.greenontario.org/

Kathy Schrock's Guide for Educators. – http://discoveryschool.com/schrockguide/

Midwest Mathematics and Science Consortium (MSC) – http://www.ncrel.org/msc/msc.htm

National Science Foundation (USA) – http://www.nsf.gov/

National Staff Development Council – issues of implementation – http://www.nsdc.org/

Online Resources for Assessment – http://www.rmcdenver.com/useguide/assessme/online.htm

Ontario Ministry of Education (EDU) – curriculum documents page
– http://www.edu.gov.on.ca/eng/document/curricul/curricul.html

Regional Education Laboratories in the USA – focus on educational research
– http://www.sedl.org/RELs.html

Science Museum, London, England – http://www.nmsi.ac.uk/science_museum_fr.htm
Science Museum, Munich, Germany (Deutsches Museum) – http://www.deutsches-museum.de/e_index.htm
Science Teachers Association of Ontario (STAO) links to science sites – http://www.stao.org/hotlinks.htm
STAR Centre for Academic Renewal (Texas) – http://www.starcenter.org/
USA National Academy of Sciences – http://www.nas.edu/

OSS Considerations

Students can apply and refine the skills, knowledge and habits of mind they acquire in SCH3U through Cooperative Education, work experience and service placements within the community. They also have the opportunity to explore various science related careers related to the course and consider them when they are developing their Annual Education Plan (AEP).

A work site placement must be directly connected to the Expectations of SCH3U if it is to contribute to a student's perspective of future careers or educational opportunities. The wording in the document *Cooperative Education and Other Forms of Experiential Learning* (Ontario, Ministry of Education, 2000) provides clear direction, and should be the focus of the personalized learning plans for students. "The personalized learning plan *must* include the following: the curriculum expectations of the related course that describe the knowledge and skills the student will *extend and refine* through application and practice at the workplace" (p. 23, emphasis added). The placement is not intended to introduce the student to the Expectations, but should connect closely enough that significant expectations are clearly extended and refined in a workplace setting. Both workplace and community experiences may offer unique opportunities for students to achieve the goal of SCH3U "To relate science to technology, society, and the environment" and to gain experience in the Science Investigative Skills defined at the beginning of the course description in the guideline. The personalized placement learning plan of a student who has an Individual Education Plan (IEP) must be developed with direct reference to the IEP.

Students are required to complete 40 hours of community involvement activities prior to graduation. Volunteer work options include elementary school science and technology classrooms; municipal recycling, hazardous waste, or water pollution control or testing facilities; or a hospital laboratory. These options would provide connections to the goals of SCH3U while supporting the intent of the service to encourage students to develop awareness and understanding of civic responsibility and the role they can play in supporting and strengthening their communities.

Students graduating from Ontario schools must be technologically literate. Through the study of this Science course students must come 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 = –log10[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.

Unit 5: Hydrocarbons and Energy

Time: 20 hours

Unit Description

The intent of this unit is to introduce students to the world of organic chemistry. The unit begins with an exploration of the sources of hydrocarbons and moves on to an examination of their properties and characteristics. Simple reactions of hydrocarbons, calorimetry and thermochemical equations are used to investigate the energetics of bond making and breaking. The nomenclature of organic chemistry is also introduced. Throughout, students should be thinking about and discussing the benefits and risks of hydrocarbons in use today. The unit culminates with a research activity on the uses of hydrocarbons in society.

Unit Synopsis Chart

Activity	Time	Expectations	Assessment	Task/Focus
5.1 Introduction to Organic Chemistry	240 min	HEV.01, HEV.02, HEV.03, HE1.01, HE1.02, HE1.03, HE1.04, HE2.04, HE3.01, HE3.02, MCV.02, MCV.03, MC2.04, MC3.01, MC3.04	K, I, MC, C	Teacher-led discussions; student model building; laboratory investigations
5.2 Naming Hydrocarbons	180 min	HEV.01, HEV.02, HE1.03, HE2.01, HE2.02, HE2.03, MCV.02, MC2.04	K, I	Teacher lessons on nomenclature; student practice exercises and model building.
5.3 Properties of Hydrocarbons	120 min	HEV.01, HEV.02, HE1.03, HE2.01, HE2.06, MCV.01, MC1.03	K, I, MC, C	Student laboratory exercise; teacher-led discussion;
5.4 Hydrocarbons as Fuels	360 min	HEV.01, HEV.02, HE1.04, HE1.05, HE1.06, HE2.01, HE2.05, HE2.06, HE2.07, MCV.03, MC3.01, QCV.01, QCV.03, QC1.05, QC2.01, QC2.09, QC3.01	K, I, MC, C	Teacher demonstrations; teacher led lessons on heat; calorimetry experiments; student design, build and use apparatus for investigation of heat of combustion
5.5 End-of-Unit Tasks	300 min	HEV.03, HE3.02	K, I, MC, C	Student research and presentations

Unit Planning Notes

- Teachers should be aware of the Organic Chemistry unit found in the SCH4U course. There should be a smooth transition from the 3U to the 4U course.
- It will be necessary to book time in both the Library/Resource Centre and the computer lab for the students to work on the culminating Activity 5.5.
- This unit should have a balance between presented material and laboratory explorations.
- Several activities in this unit involve organic chemicals that may or may not be permitted in any given school board. Be sure to check your board's policies and be prepared to make substitutions.
- Peer feedback/self-evaluation can be used as a component of the assessment of Activity 5.5.
- Proper laboratory safety (goggles, gloves, ventilation) must be observed for all lab activities.

- Follow WHMIS and board regulations for the disposal of organic chemicals. Although the quantities involved often do not require special attention under WHMIS legislation, students should see that the issue of safe disposal of organic chemicals is given special consideration. Sealed containers of "mixed organics" retained in ventilated storage for pickup as hazardous waste, for example, sends a clear message that environmentally responsible behaviour is expected in the laboratory.
- Wherever possible, re-enforce topics from Units 1 – 4.
- Seek out community resources, where possible, in the form of local industry, post-secondary institutions, or sites like Science North or the Ontario Science Centre, to support this unit.
- This unit is "content rich". Careful planning will be essential. Consult with other chemistry teachers regarding the level of detail required for the transition between 3U and 4U chemistry.
- Review the Appendix on Rubric Development at the end of this unit before beginning the unit. Take advantage of opportunities for students to participate in the development of assessment tools, which will be applied to their work.

Unit Resources

Standard university introductory organic chemistry textbooks will be useful.

BioChemLinks – http://biochemlinks.com/

This site has a vast set of organic sites listed – everything from nomenclature to reactions and software.

Advanced Chemistry Development – http:www.acdlabs.com

ChemSketch is a powerful modelling program available free from ACD. Also available is support documentation and other chemistry software.

Molecular model kits. One inexpensive option is the Framework Molecular Model kit available from Prentice Hall Canada – (http://www.prenticehall.ca/list_ac/searches/MC0511.html). Other kits are available from various suppliers.

Online tutorials in bonding and stereochemistry can be located with search engines. One Canadian example can be found at – http://redbaron.bishops.ntc.nf.ca/science/chem/html/bondstoc.htm

ERIC (Educational Resources Information Centre) resources of all kinds can be found through links at – http://www.accesseric.org:81/home.html.

Of particular use is the ERIC Clearinghouse for Science, Mathematics and Environmental Education at – http://www.ericse.org/

Slater, Alan and Rayner-Canham, Geoff. *Microscale Chemistry Laboratory Manual*. Don Mills, ON. Addison-Wesley Publishers Ltd., 1994. Teacher's Edition ISBN 0-201-60216-4 and Student's Edition ISBN 0-201-60215-6

Activity 5.1: An Introduction to Organic Chemistry

Time: 240 minutes

Description

This activity introduces students to the ubiquitous nature of organic molecules in general and to the sources of hydrocarbons in our world. The purification of crude oil by fractional distillation is outlined. Students review bonding concepts from earlier in the course and then extend these ideas by examining the structure of hydrocarbon molecules. Molecular shape is introduced for methane. Using molecular models, students review single, double and triple bonds as applied to carbon. The differences in reactivity for alkanes and alkenes are investigated in the laboratory. Throughout the unit, the focus is on the incredible variety of hydrocarbons, and the links between their properties – and hence uses – and their structure. Wherever possible, real examples must be used. While the primary focus of this unit is an introduction to hydrocarbons, the unifying theme running through the unit is a review of material covered in previous units. In a sense, the "nuts and bolts" of the course are covered in the earlier units, and the hydrocarbon unit ties it all together with authentic examples and applications.

Strand(s) & Learning Expectations

Strand(s): Hydrocarbons and Energy; Matter and Chemical Bonding

Specific Expectations

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;
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;
HE2.04 - determine through experimentation some of the characteristic properties of saturated and unsaturated hydrocarbons;
HE3.01 - describe the steps involved in refining petroleum to obtain gasoline and other useful fractions;
HE3.02 - demonstrate an understanding of the importance of hydrocarbons as fuels and in other applications, such as the manufacture of polymers, and identify the risks and benefits of these uses to society and the environment;
MC2.04 - draw Lewis structures, construct molecular models, and give the structural formulae for compounds containing single and multiple bonds;
MC3.01 - identify chemical substances and reactions in everyday use or of environmental significance;
MC3.04 - demonstrate an understanding of the need for the safe use of chemicals in everyday life.

Prior Knowledge & Skills

- Students should be well versed in bonding from the first unit. This particular activity relies on all aspects of bonding taught in Unit 1.
- Throughout this unit an effort is made to review, through real examples, key concepts from earlier units.

Planning Notes

- Have a variety of materials derived from hydrocarbons available for examination and discussion.
- Some students may be sensitive to some organic compounds. Excellent ventilation during laboratory work with organics is essential. Students with sensitivities may have to be excused from direct contact with particular compounds. Teachers should consult Material Safety Data Sheets for appropriate treatment of sensitivities to substances being used in the laboratory.
- There is a close connection between this unit in the Grade 11 course and the Organic Chemistry unit in the Grade 12 course. Discuss the placement of topics and the depth of treatment of topics with colleagues teaching the Grade 12 course.
- Have a variety of appropriate models available – marshmallows and toothpicks for the Activity 5.1.2 and formal models for Activity 5.1.3
- Database and spreadsheet software used should be consistent with programs with which the students are familiar from their computer courses.
- Ensure that chemicals for Activity 5.1.4 are appropriate for your site. Substitute substances may be required.
- Students are instructed to collect newspaper/magazine articles for Final Assessment Task.
- The definition of "organic" should be addressed at the outset of this unit to avoid confusion with popular terms such as "organic" farming and "organic" shampoo.

- Throughout the unit students must see that there is a tension between the benefits and hazards associated with the chemistry of hydrocarbons and organic chemistry in general. They should emerge as informed citizens who will demonstrate healthy skepticism when confronted with the opinions of others about, for example, the “evils” of chemicals, the “good” of all things “organic” in the marketplace, or the “safety” of chemical waste materials and disposal systems.

Teaching/Learning Strategies

5.1.1 Student Activity: Students participate in a discussion of organic molecules, their origins as well as their importance in today’s society. Both the benefits and risks will be brainstormed, discussed and noted. The sources of hydrocarbon materials, the refining of these materials, as well as their modification and manipulation by the chemical industry, should be included. The eventual fate of these molecules, their persistence in the environment, and the possibilities of recycling should be discussed as well. Students have an opportunity here to develop their skills at persuasive argument, working as members of a team, consensus building and respecting the views of others. There should be diverging opinions about the benefits and risks associated with organic chemicals. These diverging opinions should be aired and discussed in both large and small groups.

Teacher Facilitation: Have a variety of examples of organic molecules in mind for the discussion. A few “starters” such as gasoline, plastic bags and bottles, and over-the-counter medications should get students started. The key idea will be to brainstorm as many examples as possible of materials derived from hydrocarbon raw materials. Student discussion can then be lead in the direction of how these materials can be derived from the same crude oil starting material. Separation of materials by fractional distillation can be outlined, leading to the concept of homologous series; as molecular weight increases, so does boiling point. Be sure to point out for discussion the problems society faces as a result of hydrocarbon use, such as pollution, oil spills, and the difficulties associated with the transportation and manufacturing of organic chemicals. This activity could be used for students to practise presenting their views and information to the class orally, a skill that can be applied in the Final Assessment Tasks.

5.1.2 Student Activity: Students use simple model kits, Styrofoam balls or marshmallows and toothpicks to build molecular models of hydrocarbons of up to six carbons with as many hydrogen atoms as necessary. The need for some kind of systematic recording of structures should emerge. Students should encounter multiple bonds as well as rings as they explore the bonding of carbon. Students who are more comfortable with computers may use molecular modelling software.

Teacher Facilitation: Be prepared to provide hints to students regarding multiple bonds and rings as additional ways that carbon atoms can bond. Ensure that students are checking each molecule to ensure that carbon atoms are obeying the rules of bonding. Teach the students a systematic method of recording the structure on paper, such as molecular structures. Examples of hydrocarbon molecules and their structure can be shown to students.

5.1.3 Student Activity: Students participate in a discussion of bonding and examine the shape of a tetravalent carbon atom. Double and triple bonds are introduced. Students will soon see the need for an organized system of nomenclature of hydrocarbons, as a way of facilitating discussion of organic molecules. Students classify the molecules as alkanes, alkenes and alkynes, as well as saturated, or unsaturated. Aliphatic cyclic compounds are introduced

Teacher Facilitation: Review and re-enforce chemical bonding from earlier in this course, as well as the idea of molecular polarity. Discuss with students the variety of bonding that carbon undergoes, extending the tetrahedron to alkene and alkyne compounds. Illustrate the value of a systematic classification system for hydrocarbons.

5.1.4 Student Activity: Students perform a simple activity to explore the differences in reactivity of saturated versus unsaturated hydrocarbons. They are introduced to the concept of functionality in organic molecules.

Teacher Facilitation: In selecting a lab activity, be aware of any board restrictions on chemicals and ensure adequate ventilation. Small "micro chemical" experiments should be considered. The bromination of cyclohexane and cyclohexene or the reaction of permanganate with similar compounds could be used. Follow all board regulations for the safe handling and disposal of organic chemicals.

Assessment & Evaluation of Student Achievement

A laboratory report for the experiment would be appropriate. Short quiz questions based on the classification of organic molecules should be used to determine the students' abilities. Students could construct all of the isomers of a simple hydrocarbon, and record their list of isomers in the format determined by the teacher. This activity provides an opportunity to assess and give feedback to students on their group work skills, and the oral communication skills, which they may apply in the Final Assessment Tasks.

Accommodations

- Extensions should be selected to avoid topics covered in the Grade 12 Organic Chemistry unit.
- The slight distinction in spelling among such terms as alkane, alkene and alkyne may be a challenge for some students and should be clearly emphasized during instruction. The same issue will arise in Activity 5.2. Give students many opportunities to see, say, and write the terms, which may cause problems, while linking the differences to differences in properties and reactions throughout this unit.

Resources

Molecular modelling software; molecular models; online tutorials (See Unit Resources)

Activity 5.2: Naming Hydrocarbons

Time: 180 minutes

Description

This activity introduces students to the IUPAC nomenclature system. The concept of isomers, both structural and geometric is introduced. Hands-on approaches are emphasized by using molecular models. Computer-based molecular modelling should be used to illustrate technology's role in visualizing molecules.

Strand(s) & Learning Expectations

Strand(s): Hydrocarbons and Energy; Matter and Chemical Bonding

Specific Expectations

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;
HE2.01 - use appropriate scientific vocabulary to communicate ideas related to hydrocarbons and the energy changes involved in their combustion;
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;
MC2.04 - draw Lewis structures, construct molecular models, and give the structural formulae for compounds containing single and multiple bonds.

Prior Knowledge & Skills

- The introduction to bonding begun in Activity 5.1
- A knowledge of bond polarity

Planning Notes

- Have a variety of appropriate, formal models available.
- Students should not be overwhelmed with an exhaustive treatment of nomenclature. Limit discussion to molecules up to ten carbon atoms.

Teaching/Learning Strategies

5.2.1 Student Activity: Students learn the names of the first ten hydrocarbons. Their knowledge is extended to include alkenes and alkynes, paying careful attention to specifying the location of these unsaturations. Students can work with partners to practise nomenclature; one student draws a molecule for the other to name, then trading roles.

Teacher Facilitation: Teach the students the names of the first ten hydrocarbons. Explain the system used by IUPAC to specify the location of double and triple bonds. Allow students an opportunity to practise aspects of nomenclature as they are discussed. Worksheets with numerous examples should be available for additional practice.

5.2.2 Student Activity: Students use formal molecular models, or computers if they are more comfortable, to discover the number and variety of isomers that can be constructed for a given hydrocarbon formula. Starting first with simple molecules, students gain experience with the concept of isomers, before moving on to more complex examples.

Teacher Facilitation: Guide the students through the variety of branched chain isomers of a given formula. Limit the examples used to one or two branches of one or two carbons. The emphasis is on the concept of isomers, not an exhaustive treatment of nomenclature. Students who master this concept can be given the opportunity to try more sophisticated examples.

5.2.3 Student Activity: Students complete their investigation of isomers by exploring the cis and trans isomers possible for simple molecules containing a double bond. The relationship between structure and polarity is discussed. Starting with dichloroethene, students should be able to construct the three possible isomers. Cyclic compounds may be discovered and discussed.

Teacher Facilitation: Allow the students to discover the isomers that can be formed when a molecule contains a double bond. Dichloroethene is a good starting molecule. Again, the need for a systematic nomenclature system will arise. Teach the IUPAC system for cis/trans isomers.

Assessment & Evaluation of Student Achievement

Students should be required to build models for a given formula and to provide its name. Students should also be able to construct all of the possible isomers for a given formula.

Accommodations

Students should be offered the opportunity to work with either physical or computer-based models. Chemical nomenclature is very precise and uses similar words such as alkane and alkene that may be challenging for some students. Emphasize these distinctions. Students who encounter difficulties might create ‘flash cards’ for themselves to practise with outside class.

Resources

Molecular modelling software; molecular models (See Unit Resources)

Activity 5.3: Properties of Hydrocarbons

Time: 120 minutes

Description

This activity requires students to collect data on the physical properties of hydrocarbons. This data will be entered into a data base or spreadsheet, so that trends between carbon chain length and various properties can be graphed. The concept of a homologous series is introduced. The chemical properties of various classes of hydrocarbons are discussed.

Strand(s) & Learning Expectations

Strand(s): Hydrocarbons and Energy; Matter and Chemical Bonding

Specific Expectations

HE1.03 - describe some of the physical and chemical properties of hydrocarbons;
HE2.01 - use appropriate scientific vocabulary to communicate ideas related to hydrocarbons and the energy changes involved in their combustion;
HE2.06 - write balanced chemical equations for the complete and incomplete combustion of hydrocarbons;
MC1.03 - demonstrate an understanding of the formation of ionic and covalent bonds and explain the properties of the products.

Prior Knowledge & Skills

- Hydrocarbon nomenclature
- Reactivity of hydrocarbons from Activity 5.1.4
- Writing balanced chemical equations

Planning Notes

- Resources should be available to students for the collection of physical property data. The library staff should be consulted.
- Appropriate software for the collection and display of data should be chosen. Ideally, software that the students are familiar with from computer courses should be used.
- Access to computers should be arranged in advance of this activity. As alternatives, charts and graph paper could be used.

Teaching/Learning Strategies

5.3.1 Student Activity: Students collect physical property data for a homologous series of hydrocarbons from reference works such as *The Merck Index*, *the CRC Handbook of Chemistry and Physics*, from online sources or other reference books. Students then use the database to prepare a graph of the property versus chain length. The relationships are summarized and shared with the class.

Teacher Facilitation: Assign properties to be studied to various groups of students. Melting point, boiling point, density and physical state would be appropriate. While good correlations exist for homologous series of hydrocarbons, it might be appropriate to include a property that doesn't correlate well, to show students that, just like periodic table properties, there are exceptions here as well. Review solubility ideas from Unit 3.

5.3.2 Student Activity: Students participate in a discussion of the chemical reactions of hydrocarbons. The addition reactions from Activity 5.1.4 serve as a starting point to addition reactions in general. Students review the balancing of equations and write equations for the combustion of hydrocarbons. The value of manipulating organic molecules for the construction of larger more complex molecules (organic synthesis) is discussed.

Teacher Facilitation: Discuss with students the addition reactions studied earlier. Expand the discussion to combustion reactions. Include the processing of crude oil and cracking of alkanes. The hydrogenation of oils can be discussed. Review the balancing of chemical equations. Introduce students to the concept of organic synthesis. Discuss with students the motivation to design new molecules, and that by altering the molecule, the properties can be changed. Polymers can take on new properties by changing the formula of the monomers. Drugs can be altered by modifying their structure. These types of manipulations may lead to polymers with improved biodegradability, or drugs with reduced side effects.

Assessment & Evaluation of Student Achievement

- Student presentation of their database graphs
- Quizzes on the balancing of chemical equations involving hydrocarbons

Accommodations

- Students could explore patterns in properties beyond those assigned by the teacher. Reactions such as substitutions could be examined.

Resources

Lide; David R. *CRC Handbook of Chemistry and Physics*. The Chemical Rubber Company.

Susan Budavari, ed. *The Merck Index*. Whitehouse Station, N.J.: Merck Research Laboratories.

Various online nomenclature packages, for example: Simple Organic Nomenclature: A Self Study Exercise – http://www.ucdsb.on.ca/tiss/stretton/chem1/organicx.htm

Activity 5.4: Hydrocarbons as Fuels

Time: 360 minutes

Description

Students are introduced to the key concepts in the energetics of chemical reactions. Exothermic and endothermic reactions are discussed and demonstrated. Thermochemical equations are introduced as a way of recording the energetics of these reactions. The relationship between energetics and the making and breaking of chemical bonds is explored and explained. Students are introduced to calorimetry and ultimately design their own experiments to measure the heat of combustion of a hydrocarbon fuel. Error analysis and experimental design are discussed.

Strand(s) & Learning Expectations

Strand(s): Hydrocarbons and Energy; Matter and Chemical Bonding; Quantities in Chemical Reactions

Specific Expectations

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.
HE2.01 - use appropriate scientific vocabulary to communicate ideas related to hydrocarbons and the energy changes involved in their combustion;
HE2.05 - carry out an experiment involving the production or combustion of a hydrocarbon 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 $Q = mc\Delta t$;
MC3.01 - identify chemical substances and reactions in everyday use or of environmental significance;
QC1.05 - state the quantitative relationships expressed in a chemical equation;
QC2.01 - use appropriate scientific vocabulary to communicate ideas related to chemical calculations;
QC2.09 - compare, using laboratory results, the theoretical yield of a reaction;
QC3.01 - give examples of the application of chemical quantities and calculations.

Prior Knowledge & Skills

- Students will likely need to be taught some of the basic concepts in heat. Review and expand upon the heat concepts taught in the weather unit from Grade 10. Heat and the particle theory are also covered in Grade 7.
- Proper handling of significant digits.
- The inter-conversion of mass to moles using molar mass.
- Mathematics teachers should be consulted, so that the handling of calculations is consistent.

Planning Notes

- Demonstrations of exothermic and endothermic processes should be prepared. The dissolving of $CaCl_2$ (exothermic) and NH_4NO_3 (endothermic) can be used.
- A variety of hydrocarbon fuels needs to be collected. These could include paraffin wax candles, butane barbecue lighters, natural gas and Sterno fuel. There is a good opportunity here to relate properties such as state to the structure of the molecule.
- Equipment for calorimetry will be necessary for the student designed lab. The basic “soup can” can be used, although students may wish to upgrade their apparatus to minimize heat loss by adding a “juice can” chimney around their apparatus.
- Teachers need to be aware of possible student misconceptions that may exist about heat.
- Ensure that students understand that thermochemistry can be applied to any type of chemical reaction, and that it is not limited to hydrocarbon reactions.

Teaching/Learning Strategies

5.4.1 Student Activity: Students observe a series of demonstrations of exo- and endothermic processes. The applications of these sorts of reactions are discussed. Students relate the energy changes of these reactions to the bonds that are being broken and reformed. Students learn to record energetics information in the form of thermochemical equations.

Teacher Facilitation: Demonstrate a series of exo- and endothermic reactions and processes. Solicit from the students’ examples of practical applications of these reactions. Guide the students to the explanation of energetics through the making and breaking of chemical bonds. Review the concept from bonding that atoms bonded together as molecules are more stable than individual atoms, and that this stability is achieved by releasing energy. The combustion of acetylene can be included as an example of complete and incomplete combustion.

5.4.2 Student Activity: Students participate in a teacher-led lesson on heat. The measurement of heat is discussed, along with the idea that heat lost somewhere in a system equals heat gained somewhere else. The factors that determine heat transfer are discussed. Specific heat capacity is explained. The quantitative measurement of enthalpy is explained using $Q = mc\Delta t$. Students practice these calculations before proceeding.

Teacher Facilitation: Teach a lesson on heat. Assess prior knowledge from the weather unit in Grade 10, and probe for misconceptions. Explain the quantitative treatment of energetics. Introduce students to the terminology associated with thermochemistry, including specific heat capacity. Provide students with opportunity to practice solving numerical problems.

5.4.3 Student Activity: Students perform experiments involving calorimetry. The proper design of such experiments is discussed with regard to practical problems. Simple examples might include the melting of ice, the mixing of quantities of water of differing temperatures or the addition of various hot materials into water. In all cases, students record mass and temperature data and calculate the heat lost and gained within the system.

Teacher Facilitation: Provide the students with a variety of calorimetry experiments to perform. Monitor their ability to properly perform the experiment and record the necessary data. Experimental error within these experiments should be discussed and means of reducing this error explored.

5.4.4 Student Activity: Students design their own apparatus to measure the heat of combustion of a variety of hydrocarbon fuels. Their heat data should be reported in both joules per gram and joules per mole of fuel. Experimental error is discussed.

Teacher Facilitation: Assist students with the design of their experiments. Review and re-enforce moles and equations from Unit 2. Provide materials and suggestions. A variety of fuels should be available. Encourage students to reduce experimental error. Be aware of the dangers associated with this experiment.

Assessment & Evaluation of Student Achievement

- Quizzes based on numerical problem solving and definitions
- Lab report for Activity 5.4.4

Accommodations

- The safety associated with a combustion experiment must be considered.
- Students are encouraged to improve the design, once data has been collected and analysed.
- Additional types of fuels could be made available for measurement.

Resources

Take particular care that any resource given to students uses SI Units.

Activity 5.5: Hydrocarbon Research Assignment

Time: 300 minutes

Description

This assignment constitutes a portion of the final assessment task. Students choose a topic within the theme of Hydrocarbons in Society. Sample topics could include; oils spills, tar sand extraction, refining of crude oil, sources of hydrocarbons, global warming, or alternative fuels. Students prepare a presentation which might take the form of a poster presentation, a webpage, or use of presentation software. Within the limitations of available resources, students should be allowed to use a format that caters to a strength or addresses a skill set to be developed. Global and social issues, such as environmental impact, transportation and de-regulation, must be included. An oral component to the presentation should be considered.

Strand(s) & Learning Expectations

Strand(s): Hydrocarbons and Energy

Specific Expectations

HE3.02 - demonstrate an understanding of the importance of hydrocarbons as fuels and in other applications, such as the manufacture of polymers, and identify the risks and benefits of these uses to society and the environment.

Prior Knowledge & Skills

- This assignment will potentially cover any topic in the Hydrocarbon Unit.
- If an electronic presentation is required, students will need to be familiar with presentation software or some HTML editing program.

Planning Notes

- Students should be reminded of this activity throughout the unit, so that they can collect resources and select a topic.
- Discuss potential topics with the library staff so that resources may be collected and managed.
- Ensure that if electronic presentations are required that the facilities are available for students to both prepare and present their work. Students should be familiar with the software that they will be using. Whenever possible, suggest that they use programs that they have used in previous courses.
- Be familiar with the resources in the school, should students have ideas for topics that are not on your list.
- Students may need some guidance in addressing some of the global, environmental, and social issues.

Teaching/Learning Strategies

5.5.1 Student Activity: Students select a topic for research, either from a list suggested by the teacher or by creating one of their own. Students use information from earlier in the course, as well as materials from the Library/Resource Centre and the media to prepare a presentation on their topic.

Teacher Facilitation: Outline the project with students. Distribute possible project ideas and the marking scheme or rubric to be used. Allow students time to work on their projects. Expect that students may require assistance with their topic selection, or with the collection of materials. It may be necessary to book some time for the class in the Library/Resource Centre or computer lab.

Assessment & Evaluation of Student Achievement

Using the marking scheme or rubric distributed earlier, evaluate the students presentations. If time permits, in-class presentations and/or peer feedback could be used.

Accommodations

Students could be given the option to do a more traditional poster project.

Resources

Appropriate resources for the projects should be located in libraries (school, public, university and college, industrial) and found using search engines on the Internet. Encourage use of Canadian sources where possible.

EDU Web Index has links to assessment sites – http://www.edu.gov.on.ca/eng/webmap.html

Online Resources for Assessment – http://www.rmcdenver.com/useguide/assessme/online.htm

ERIC Clearinghouse for assessment, evaluation and research – http://ericae.net/

Appendix 1

Rubric Development

Complex performance tasks involve the use of knowledge and the application of skills in a context, and must be judged/evaluated using well defined criteria. The vehicle for guiding that judgment is the rubric. It consists of a set of criteria in one dimension, and a fixed scale in the other dimension. For *The Ontario Curriculum*, the most convenient scale is a four-point scale, which parallels the four levels in the Achievement Chart. In the body of the rubric there is a list of characteristics describing performance for each criterion under each of the points on the scale. Many generic samples of rubrics have been developed which can be modified to apply to different situations.
Most importantly, *students should be given the information in the rubric prior to undertaking the task*, so that it is entirely clear to them what a good performance must embody.
The power of rubrics in promoting student achievement is realized when students are directly involved in the development of a rubric for the assessment of an activity they are about to undertake. The samples below may be useful as models to begin that process.

Generic Rubric for Declarative Knowledge

The first Overall Expectation in each unit of all Grade 11 Science courses refers to student understanding of key concepts. A generalized rubric to evaluate content, concepts and generalizations on a four point scale is below. To be useful, it must be changed to reflect what the content, concepts and/or generalizations are to be achieved by students in the performance task they are to undertake.

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Declarative Knowledge	- shows a lack of understanding, and significant misconceptions about the content, concepts and/or generalizations in the task	- has some misconceptions, and lacks a complete understanding of the content, concepts and/or generalizations in the task	- shows a largely complete and accurate understanding of the content, concepts and/or generalizations in the task	- thoroughly understands all content, concepts and/ or generalizations in the task, and demonstrates insightful extensions to some aspects of the information

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

Appendix 1 (Continued)

Generic Rubric for Procedural Knowledge

Below is a generalized rubric for evaluating those skills that are described in the second Overall Expectation in each unit of all Grade 11 Science courses. Again, it is necessary to revise this rubric to make it apply to the specific skills that are involved in the performance task, whether they are manipulative skills or thinking and reasoning skills.

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Procedural Knowledge	- only selects appropriate skills and/or strategies required by the task with much assistance and makes critical errors in applying them	- selects with some assistance, and applies the skills and/or strategies required by the task, but makes a number of non-critical errors in doing so	- selects and applies the appropriate strategies and/or skills specific to the task without significant errors	- selects and applies appropriate strategies and/or skills specific to the task without conscious effort and without error, and applies some in innovative ways

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

Collaborative Group Work

This rubric applies to a Learning Skill, and therefore does not lead to a mark on the Provincial Report Card. Refer to the section on Learning Skills (See Overview) for a discussion of the purpose of using this rubric.

Criteria	Level 1	Level 2	Level 3	Level 4
Interpersonal Skills in Group Work	- limited interaction within a group, and shows lack of sensitivity to others' feelings and abilities in opinions expressed	- some interactions with other group members, but sometimes expresses opinions which are insensitive to the abilities and feelings of others	- interacts with all group members spontaneously and contributes in a way that is sensitive to the abilities and feelings of others	- interacts positively with all group members, encourages such interaction in others, and is always sensitive to the abilities and feelings of others in contributions
Participation to Achieve Group Goals	- shows limited commitment to group goals and often fails to perform assigned roles	- demonstrates some commitment to group goals, but has difficulty performing assigned roles	- demonstrates commitment to group goals and carries out assigned roles effectively	- actively helps to identify group goals and works effectively to meet them in all roles assumed

Appendix 1 (Continued)

Criteria	Level 1	Level 2	Level 3	Level 4
Contribution to Group Maintenance	- has difficulty identifying changes needed in group processes, and is reluctant to participate in making those changes identified by others	- identifies some changes needed to improve group processes if prompted, and is minimally involved making those changes	- identifies and helps to make adjustments needed in group processes to improve group effectiveness	- actively works to identify and carry out changes in group processes necessary to maximize group effectiveness
Roles Performed in the Group	- is limited in inclination or ability to perform roles in the group	- willing and able to perform some group roles effectively	- is willing and able to perform most group roles effectively	- volunteers to perform any group role, and does so effectively and creatively

Partial Rubric for an Experimental Inquiry

In this sample, four criteria are listed for a scientific inquiry. In the first criterion, Initiating and Planning, four components are listed. Only one of those components, "*designs fair test*" is expanded in the body of the rubric. A completed rubric would show all four components expanded in detail for all three criteria. For a particular purpose, however, this partial rubric may be all that is needed – *it is not necessary to assess every component of every criterion in every activity the student undertakes*! Over the whole course, however, a student should be assessed on all significant criteria which define a scientific inquiry, and all components of each criterion.

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Initiating and Planning • formulates question • make hypothesis • *designs fair test** • selects equipment and materials	*- few variables are identified or controlled.*	*- some variables are identified; not all significant variables are controlled.*	*- variables are identified; some significant variables are controlled.*	*- significant variables are identified and controlled.*
Performing and Recording • follows procedures • *collects, records and organizes information** • uses appropriate vocabulary • follows safe procedures	*- collects limited appropriate quantitative and qualitative information; data is poorly organized and displayed*	*- collects some appropriate quantitative and qualitative information; data is displayed in a partially organized form*	*- collects sufficient and appropriate quantitative and qualitative information; data is displayed in an organized form*	*- collects all appropriate qualitative and quantitative information in a skillful manner; data is displayed in a student created and well organized form*

Appendix 1 (Continued)

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Analysing and Interpreting • draws valid inferences • forms a conclusion which responds to the hypothesis • *generalizes from experimental results and conclusions to other situations**	*- requires considerable support to make generalizations from results and conclusions*	*- generalizes from results and conclusions in a limited way with some support*	*- generalizes from results and conclusions to other situations in science with little or no support*	*- generalizes independently from results and conclusions to situations in other subjects and beyond the school*

Note: A student whose achievement is below level 1(50%) has not met the expectations for this assignment or activity.
Note: The process outlined above encompasses all elements of what is commonly called Scientific Method and places them in the broader context of inquiry

Partial Rubric for a Research Inquiry

Again, only one component within each criterion is expanded. The Achievement Chart has an expansion of the Communications criterion.

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Initiating and Planning formulates questions • *states research question** • identifies a variety of resources	*- requires assistance to formulate a research question*	*- research question lacks focus; has some relevance to student and is likely to yield sufficient information*	*- research question is focused, relevant to student; is likely to yield interesting information*	*- research question is original, creative, focused and relevant to student; likely to yield interesting information*
Performing and Recording • *uses resources to find information* • records information • records sources of information • uses appropriate vocabulary	*- a few relevant resources are used to find simple information*	*- an adequate number of relevant resources are used to find reliable, accurate information*	*- a variety of recent, relevant resources is used to find reliable, valid and accurate information*	*- a very wide variety of recent, relevant, authoritative resources is used to find reliable, valid, accurate and complex information*

Appendix 1 (Continued)

Analysing and Interpreting • *organizes and integrates information in an appropriate format* • makes conclusions based on information; provides reasons for conclusions	*- requires assistance to find and evaluate key information that relates to question; product lacks organization and flow*	*- finds and evaluates some key information that relates to question; product lacks order or logical sequence*	*- finds and evaluates key information that relates to question and develops concepts into a well connected product*	*- finds and evaluates key information that relates to the question and develops concepts into an insightful, original product*

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

Marking Scale (Rubric) for Written Report

Criteria	Level 1 (50-59%)	Level 2 (60-69%)	Level 3 (70-79%)	Level 4 (80-100%)
Content				
Clarity	- main idea is generally unclear	- main idea is recognizable	- main idea is reasonably clear	- main idea is very clear
Accuracy	- facts, ideas and details tend to be inaccurate	- facts, ideas and details exhibit some inaccuracies	- facts, ideas and details generally accurate	- facts, ideas and details are accurate
Integration of source material	- material from sources is poorly blended, pieces may be directly copied	- material from sources tends not to be well blended; many terms not explained	- material from sources is fairly well blended; some terms explained in own words	- material from sources is well blended. Difficult terms are explained in own words
Resource selection	- poor choice of resources; limited support of writing	- some resource material is well chosen and supports writing	- good choice of resource material to support writing	- excellent choice of resource material to support writing
Organization	- limited overall logical planning with ideas out of order	- some overall logical planning; some gaps in sequence of ideas	- adequate overall logical planning	- very good overall logical planning and forms well connected text
Use of Language	- weak command of appropriate vocabulary	- fair command of appropriate vocabulary	- good use of appropriate vocabulary including correct scientific terminology	- excellent use of appropriate vocabulary including correct scientific terminology
Conventions	- weak spelling, punctuation, and grammar	- fair spelling, punctuation and grammar	- good spelling, punctuation, and grammar	- excellent spelling, punctuation, and grammar

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