SECTION 4:
DOCUMENT ORGANIZATION

DOCUMENT ORGANIZATION

Document Organization and Format

The suggestions for instruction and assessment contained within *Grade 11 Chemistry: A Foundation for Implementation* provide teachers with strategies for assisting students in achieving the general and specific learning outcomes identified for this curriculum. The instructional and assessment suggestions offer teachers a range of strategies from which to select appropriate directions with students. Although they are not prescriptive, the strategies presented can be considered starting points from which teachers can include their own initiatives, style, and effective techniques to foster learning.

The topic-related and general appendices found at the end of this document provide additional information on student learning activities, teacher support materials related to instruction and assessment, and a variety of assessment rubrics. These complementary resources are closely linked to the learning outcomes and to the skills and attitudes, and are designed to support, facilitate, and enhance student learning.

At-a-glance listings of the general learning outcomes, skills and attitudes outcomes, and specific learning outcomes for Grade 11 Chemistry are provided at the end of this section of this document, as well as in Appendix 11.

Guide to Reading the Learning Outcomes and the Document Format

The specific learning outcomes identified for Grade 11 Chemistry are organized according to five "thematic" topics:

- Topic 1: Physical Properties of Matter
- Topic 2: Gases and the Atmosphere
- Topic 3: Chemical Reactions
- Topic 4: Solutions
- Topic 5: Organic Chemistry

The suggested strategies for implementing the curricular outcomes within each chemistry topic include the following components:

- **Specific Learning Outcomes (SLOs):** The SLOs identified in the headers outline the intended learning to be achieved by the student by the end of the course. They include the SLOs related to the particular chemistry topic, in addition to the learning outcomes related to Cluster 0: Skills and Attitudes, selected to correspond to the Suggestions for Instruction.
- **General Learning Outcome (GLO) Connections:** The GLOs, found in the footers, provide links across the entire scope of the Kindergarten to Grade 12 continuum of learning in science. These GLOs provide connections to the Five Foundations for Scientific Literacy that guide all Manitoba science curricula in all science discipline areas.

- **Suggestions for Instruction:** The instructional strategies relate directly to the achievement of the SLOs identified in the headers.
  - **Entry-Level Knowledge:** Students will have prior knowledge in relation to some learning outcomes. Identification of students' entry-level knowledge, where included, links instructors to key areas of the science curriculum from previous years, providing information about where students should be in relation to the present learning outcomes. Prior knowledge activities can then be used to provide students with a rationale about what is to come, or to provide a refreshment of conceptual or procedural knowledge that has lapsed over time.
  - **Student Activities:** Student learning activities are suggested for all learning outcomes. The examples of teacher-facilitated instructional strategies presented in this document are designed to be student-centred, engaging the learner directly in some contextual way.
- **Teacher Notes:** Incorporated throughout the document as needed, these notes provide teachers with definitions and content background (often beyond what students are required to know), planning hints, special-interest material, cautions and safety information, and depth of treatment on certain issues related to the identified learning outcomes.
- **Suggestions for Assessment:** These suggestions offer strategies for assessing students' achievement of the specific learning outcomes.
- **Learning Resources Links:** The links to additional chemistry resources are intended to guide and support instruction, the learning process, and student assessment. While only titles, authors, and page references are provided in the Learning Resources Links for the specific learning outcome(s), the complete bibliographic information is cited below (as well as in the Bibliography of this document). It is important to recognize that new editions of standard texts in the field of chemistry can be expected about every two years—often with minimal changes to content. The editions of learning resources identified in this document include those that were used directly in the preparation of *Grade 11 Chemistry: A Foundation for Implementation*. Teachers are encouraged to seek out newer versions of texts considered as "standards in the field."

  The following resources are cited most frequently in the **Learning Resources Links**.

  Brown, Theodore E., H. Eugene LeMay, and Bruce E. Bursten. *Chemistry: The Central Science.* 9th ed. Upper Saddle River, NJ: Pearson Education/Prentice Hall, 2003.

  Chang, Raymond. *Chemistry*. 4th ed. Boston, MA: McGraw-Hill Higher Education, 1991.

  CRC Handbook of Chemistry and Physics: A Ready-Reference Book of Chemical and Physical Data. Cleveland, OH: CRC Press, annual publication.

  Davies, Lucille, Maurice Di Giuseppe, Ted Gibb, Milan Sanader, and Angela Vavitsas. *Nelson Chemistry 12: College Preparation*. Ontario Edition. Toronto, ON: Thomson Nelson, 2003.

  Dingrando, Laurel, Kathleen (Gregg) Tallman, Nichols Hainen, and Cheryl Wistrom. *Glencoe Chemistry: Matter and Change.* Columbus, OH: Glencoe/McGraw-Hill, 2005.

Glencoe Chemistry: Matter and Change: CBL Laboratory Manual – Teacher Edition. Columbus, OH: Glencoe/McGraw-Hill, n.d.

Glencoe Chemistry: Matter and Change: Laboratory Manual – Teacher Edition. Columbus, OH: Glencoe/McGraw-Hill, 2005.

Glencoe Chemistry: Matter and Change: Small-Scale Laboratory Manual – Teacher Edition. Columbus OH: Glencoe/McGraw-Hill, 2005.

Holmquist, Dan, and Donald Volz. *Chemistry with Calculators.* Portland, OR: Vernier, n.d. Available online at <http://www.vernier.com/chemistry/>.

---. *Chemistry with Computers*. Portland, OR: Vernier, n.d. Available online at <http://www.vernier.com/chemistry/>.

Jenkins, Frank, Hans van Kessel, Lucille Davies, Oliver Lantz, Patricia Thomas, and Dick Tompkins. *Nelson Chemistry 11.* Ontario Edition. Toronto, ON: Nelson Thomson Learning, 2002.

LeMay, Eugene H., Herbert Beall, Karen M. Robblee, and Douglas C. Brouwer. *Prentice Hall Chemistry: Connections to Our Changing World.* Upper Saddle River, NJ: Pearson Education/Prentice Hall, 2002.

Manitoba Education and Training. *Senior Years Science Teachers' Handbook: A Teaching Resource.* Winnipeg, MB: Manitoba Education and Training, 1997.

Mustoe, Frank, Michael P. Jansen, Ted Doram, John Ivanco, Christina Clancy, and Anita Ghazariansteja. *McGraw-Hill Ryerson Chemistry.* Combined Atlantic Edition. Toronto, ON: McGraw-Hill Ryerson, 2004.

---. *McGraw-Hill Ryerson Chemistry 11.* Ontario Edition. Toronto, ON: McGraw-Hill Ryerson, 2001.

PASCO Scientific. Online Science Experiments: <http://www.pasco.com/experiments/chemistry/november_2001/home. html>

PASCO Scientific. *PASPort Explorations in Chemistry Lab Manual.* Roseville, CA: PASCO, n.d. Available online at <http://www.pasco.com/hsmanuals/ps2808.html>.

Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus, OH: Glencoe/McGraw-Hill, 2005.

Silberberg, Martin S. *Chemistry: The Molecular Nature of Matter and Change*. Boston, MA: McGraw-Hill Higher Education, 2003.

Slater, A., and G. Rayner-Canham. *Microscale Chemistry Laboratory Manual*. Reading, MA: Addison-Wesley, 1994.

van Kessel, Hans, Frank Jenkins, Lucille Davies, Donald Plumb, Maurice Di Giuseppe, Oliver Lanz, and Dick Tompkins. *Nelson Chemistry 12.* Ontario Edition. Toronto, ON: Thomson Nelson, 2003.

Vernier Software and Technology. Chemistry. <http://www.vernier.com/chemistry/>

Wilbraham, Antony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NJ: Pearson Prentice Hall, 2005.

Zumdahl, Steven S. *Introductory Chemistry: A Foundation.* 4th ed. Boston, MA: Houghton Mifflin, 2004.

Zumdahl, Steven S., and Susan A. Zumdahl. *Chemistry*. 6th ed. Boston, MA: Houghton Mifflin, 2003.

Note: For information on selecting learning resources for Grade 11 and Grade 12 Chemistry, see the Manitoba Education, Citizenship and Youth website at: <http://www.edu.gov.mb.ca/k12/learnres.bibliographies.html>.

Sample Two-Page Layout

The following clarification on reading the document format is based on a sample two-page layout from *Grade 11 Chemistry: A Foundation for Implementation*.

Icon indicates chemistry topic.

Specific learning outcome (SLO) statements define what students are expected to achieve by the end of Grade 11 Chemistry.

The first alpha-numeric code indicates course (Grade 11 Chemistry); second digit indicate topic number; and third digit(s) indicate(s) specific learning outcome number.

Suggestions for student learning experiences relate directly to the attainment of the specific learning outcome(s).

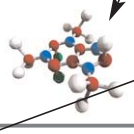
Include: Indicates a mandatory component of the specific learning outcome, or a defined set of limitations.

Examples: Provide ideas of what could be included (non-mandatory). No examples occur in this learning outcome.

General learning outcome (GLO) statements connect learning to the Manitoba Foundations for Scientific Literacy.

Suggested instructional time allotment for treatment of the specific learning outcome(s).

Notes provide teachers with background information, definitions, planning hints, special-interest material, and depth of treatment on certain issues. Safety information and cautions are often included.



SPECIFIC LEARNING OUTCOME

C11-5-07: Name, draw, and construct structural models of isomers for alkanes up to six-carbon atoms.

Include: condensed structural formulas

(0.5 hour)

SLO: C11-5-07

SUGGESTIONS FOR INSTRUCTION

Entry-Level Knowledge

Students are not expected to have any entry-level knowledge other than their current knowledge of organic IUPAC nomenclature.

TEACHER NOTES

Students should build these molecular models using techniques similar to those used for the previous learning outcome (C11-5-06).

Structural isomers are compounds having the same molecular formula, C_5H_{12}, but a different structural formula.

Example:

n–pentane $CH_3CH_2CH_2CH_2CH_3$

2–methylbutane

$$CH_3CHCH_2CH_3$$
$$\quad\;|$$
$$\quad CH_3$$

2,2–dimethylpropane

$$\quad\;\;CH_3$$
$$\quad\;\;|$$
$$CH_3CCH_3$$
$$\quad\;\;|$$
$$\quad CH_3$$

General Learning Outcome Connections

GLO B1: Describe scientific and technological developments—past and present—and appreciate their impact on individuals, societies, and the environment, both locally and globally.

GLO B2: Recognize that scientific and technological endeavours have been and continue to be influenced by human needs and the societal context of the time.

GLO D1: Understand essential life structures and processes pertaining to a wide variety of organisms, including humans.

GLO D3: Understand the properties and structures of matter, as well as various common manifestations and applications of the actions and interactions of matter.

GLO E1: Describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world.

Skills and attitudes learning outcomes define expectations across all topics in Grade 11 Chemistry.

SKILLS AND ATTITUDES OUTCOME

C11-0-U1: Use appropriate strategies and skills to develop an understanding of chemical concepts.

Examples: analogies, concept frames, concept maps, manipulatives, particulate representations, role-plays, simulations, sort-and-predict frames, word cycles…

Structural isomers will have the same molar mass but differing physical and chemical properties. The number of isomers that are possible for a given molecular formula increases rapidly with the number of carbon atoms.

Number of Carbon Atoms	Number of Isomers
4	2
5	3
6	5
10	75
40	62,491,178,805,831

Activity

Have students try to draw all the possible structures for heptane, C_7H_{16}. That should keep them busy for a while!

While other kinds of isomerism (beyond structural) could be addressed, they are not discussed in Grade 11 Chemistry (they are reserved for advanced-level study).

Suggested strategies relate directly to assessing student achievement of the specific learning outcome(s).

SUGGESTION FOR ASSESSMENT

Paper-and-Pencil Task

Students should be able to use an example to illustrate and explain isomers.

LEARNING RESOURCES LINKS

Links indicate the titles, authors, and page references (or URLs) where SLO-related content is treated within the various learning resources.

Chemistry (Chang 981)
Chemistry (Zumdahl and Zumdahl 1045)
Chemistry: The Central Science (Brown, *et al.* 988)
Chemistry: Concepts and Applications (Phillips, Strozak, and Wistrom 628)
Chemistry: The Molecular Nature of Matter and Change (Silberberg 623)
Glencoe Chemistry: Matter and Change (Dingrando, *et al.* 717)
Introductory Chemistry: A Foundation (Zumdahl 579)
McGraw-Hill Ryerson Chemistry, Combined Atlantic Edition (Mustoe, *et al.* 326)
McGraw-Hill Ryerson Chemistry 11, Ontario Edition (Mustoe, *et al.* 539)
Nelson Chemistry 11, Ontario Edition (Jenkins, *et al.* 529)
Nelson Chemistry 12, Ontario Edition (van Kessel, *et al.* 13, 814)
Prentice Hall Chemistry: Connections to Our Changing World (LeMay, *et al.* 820)

General Learning Outcomes

General learning outcomes (GLOs) provide connections to the Five Foundations for Scientific Literacy that guide all Manitoba science curricula in all science discipline areas.

Nature of Science and Technology

As a result of their Senior Years science education, students will:

A1 Recognize both the power and limitations of science as a way of answering questions about the world and explaining natural phenomena.

A2 Recognize that scientific knowledge is based on evidence, models, and explanations, and evolves as new evidence appears and new conceptualizations develop.

A3 Distinguish critically between science and technology in terms of their respective contexts, goals, methods, products, and values.

A4 Identify and appreciate contributions made by women and men from many societies and cultural backgrounds that have increased our understanding of the world and brought about technological innovations.

A5 Recognize that science and technology interact with and advance one another.

Science, Technology, Society, and the Environment (STSE)

As a result of their Senior Years science education, students will:

B1 Describe scientific and technological developments—past and present—and appreciate their impact on individuals, societies, and the environment, both locally and globally.

B2 Recognize that scientific and technological endeavours have been and continue to be influenced by human needs and the societal context of the time.

B3 Identify the factors that affect health, and explain the relationships among personal habits, lifestyle choices, and human health, both individual and social.

B4 Demonstrate knowledge of and personal consideration for a range of possible science- and technology-related interests, hobbies, and careers.

B5 Identify and demonstrate actions that promote a sustainable environment, society, and economy, both locally and globally.

Scientific and Technological Skills and Attitudes

As a result of their Senior Years science education, students will:

C1 Recognize safety symbols and practices related to scientific and technological activities and to their daily lives, and apply this knowledge in appropriate situations.

C2 Demonstrate appropriate scientific inquiry skills when seeking answers to questions.

C3 Demonstrate appropriate problem-solving skills when seeking solutions to technological challenges.

C4 Demonstrate appropriate critical thinking and decision-making skills when choosing a course of action based on scientific and technological information.

C5 Demonstrate curiosity, skepticism, creativity, open-mindedness, accuracy, precision, honesty, and persistence, and appreciate their importance as scientific and technological habits of mind.

C6 Employ effective communication skills and use information technology to gather and share scientific and technological ideas and data.

C7 Work cooperatively and value the ideas and contributions of others while carrying out scientific and technological activities.

C8 Evaluate, from a scientific perspective, information and ideas encountered during investigations and in daily life.

Essential Science Knowledge

As a result of their Senior Years science education, students will:

D1 Understand essential life structures and processes pertaining to a wide variety of organisms, including humans.

D2 Understand various biotic and abiotic components of ecosystems, as well as their interaction and interdependence within ecosystems and within the biosphere as a whole.

D3 Understand the properties and structures of matter, as well as various common manifestations and applications of the actions and interactions of matter.

D4 Understand how stability, motion, forces, and energy transfers and transformations play a role in a wide range of natural and constructed contexts.

D5 Understand the composition of the Earth's atmosphere, hydrosphere, and lithosphere, as well as the processes involved within and among them.

D6 Understand the composition of the universe, the interactions within it, and the implications of humankind's continued attempts to understand and explore it.

Unifying Concepts

As a result of their Senior Years science education, students will:

E1 Describe and appreciate the similarity and diversity of forms, functions, and patterns within the natural and constructed world.

E2 Describe and appreciate how the natural and constructed world is made up of systems and how interactions take place within and among these systems.

E3 Recognize that characteristics of materials and systems can remain constant or change over time, and describe the conditions and processes involved.

E4 Recognize that energy, whether transmitted or transformed, is the driving force of both movement and change, and is inherent within materials and in the interactions among them.

Cluster 0: Skills and Attitudes Outcomes

In Grade 11 Chemistry, Cluster 0 comprises four categories of specific learning outcomes that describe the skills and attitudes involved in scientific inquiry and the decision-making process for Science, Technology, Society, and the Environment (STSE) issues. From Grades 5 to 10, students develop scientific inquiry through the development of a hypothesis/prediction, the identification and treatment of variables, and the formation of conclusions. Students begin to make decisions based on scientific facts and refine their decision-making skills as they progress through the grades, gradually becoming more independent. Students also develop key attitudes, an initial awareness of the nature of science, and other skills related to research, communication, the use of information technology, and cooperative learning.

In Grade 11 Chemistry, students continue to use scientific inquiry as an important process in their science learning, but also recognize that STSE issues require a more sophisticated treatment through the decision-making process.

Teachers should select appropriate contexts to introduce and reinforce scientific inquiry, the decision-making process, and positive attitudes within the thematic topics (Topics 1 to 5) throughout the school year. To assist in planning and to facilitate curricular integration, many specific learning outcomes within the Skills and Attitudes cluster can link to specific learning outcomes in other subject areas.

Demonstrating Understanding

C11-0-U1 Use appropriate strategies and skills to develop an understanding of chemical concepts.

Examples: analogies, concept frames, concept maps, manipulatives, particulate representations, role-plays, simulations, sort-and-predict frames, word cycles…

C11-0-U2 Demonstrate an understanding of chemical concepts.

Examples: use accurate scientific vocabulary, explain concepts to others, compare and contrast concepts, apply knowledge to new situations and/or contexts, create analogies, use manipulatives…

Scientific Inquiry

C11-0-S1 Demonstrate work habits that ensure personal safety and the safety of others, as well as consideration for the environment.

Include: knowledge and use of relevant safety precautions, Workplace Hazardous Materials Information System (WHMIS), emergency equipment

C11-0-S2 State a testable hypothesis or prediction based on background data or on observed events.

C11-0-S3 Design and implement an investigation to answer a specific scientific question.

Include: materials, independent and dependent variables, controls, methods, safety considerations

C11-0-S4 Select and use scientific equipment appropriately and safely.

Examples: volumetric glassware, balance, thermometer…

C11-0-S5 Collect, record, organize, and display data using an appropriate format.

Examples: labelled diagrams, graphs, multimedia applications, software integration, probeware…

C11-0-S6 Estimate and measure accurately using Système International (SI) and other standard units.

Include: SI conversions, significant figures

C11-0-S7 Interpret patterns and trends in data, and infer and explain relationships.

C11-0-S8 Evaluate data and data-collection methods for accuracy and precision.

Include: discrepancies in data, sources of error, percent error

C11-0-S9 Draw a conclusion based on the analysis and interpretation of data.

Include: cause-and-effect relationships, alternative explanations, supporting or rejecting a hypothesis or prediction

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Research

C11-0-R1 Synthesize information obtained from a variety of sources.

Include: print and electronic sources, specialists, other resource people

C11-0-R2 Evaluate information obtained to determine its usefulness for information needs.

Examples: scientific accuracy, reliability, currency, relevance, balance of perspectives, bias…

C11-0-R3 Quote from or refer to sources as required and reference information sources according to an accepted practice.

C11-0-R4 Compare diverse perspectives and interpretations in the media and other information sources.

C11-0-R5 Communicate information in a variety of forms appropriate to the audience, purpose, and context.

Communication and Teamwork

C11-0-C1 Collaborate with others to achieve group goals and responsibilities.

C11-0-C2 Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions.

C11-0-C3 Evaluate individual and group processes.

Decision Making

C11-0-D1 Identify and explore a current STSE issue.

Examples: clarify what the issue is, identify different viewpoints and/or stakeholders, research existing data/information…

C11-0-D2 Evaluate implications of possible alternatives or positions related to an STSE issue.

Examples: positive and negative consequences of a decision, strengths and weaknesses of a position…

C11-0-D3 Recognize that decisions reflect values and consider their own values and those of others when making a decision.

Examples: being in balance with nature, generating wealth, respecting personal freedom…

C11-0-D4 Recommend an alternative or identify a position and provide justification.

C11-0-D5 Propose a course of action related to an STSE issue.

C11-0-D6 Reflect on the process used by self or others to arrive at an STSE decision.

Attitudes

C11-0-A1 Demonstrate confidence in their ability to carry out investigations in chemistry and to address STSE-related issues.

C11-0-A2 Value skepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.

C11-0-A3 Demonstrate a continuing, increasingly informed interest in chemistry and chemistry-related careers and issues.

C11-0-A4 Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.

Specific Learning Outcomes

The specific learning outcomes (SLOs) identified here constitute the intended learning to be achieved by the student by the end of Grade 11 Chemistry. These statements clearly define what students are expected to achieve and/or be able to perform at the end of course. These SLOs, combined with the Skills and Attitudes SLOs, constitute the source upon which assessment and instructional design are based.

Topic 1: Physical Properties of Matter

C11-1-01 Describe the properties of gases, liquids, solids, and plasma.
Include: density, compressibility, diffusion

C11-1-02 Use the Kinetic Molecular Theory to explain properties of gases.
Include: random motion, intermolecular forces, elastic collisions, average kinetic energy, temperature

C11-1-03 Explain the properties of liquids and solids using the Kinetic Molecular Theory.

C11-1-04 Explain the process of melting, solidification, sublimation, and deposition in terms of the Kinetic Molecular Theory.
Include: freezing point, exothermic, endothermic

C11-1-05 Use the Kinetic Molecular Theory to explain the processes of evaporation and condensation.
Include: intermolecular forces, random motion, volatility, dynamic equilibrium

C11-1-06 Operationally define vapour pressure in terms of observable and measurable properties.

C11-1-07 Operationally define normal boiling point temperature in terms of vapour pressure.

C11-1-08 Interpolate and extrapolate the vapour pressure and boiling temperature of various substances from pressure versus temperature graphs.

Topic 2: Gases and the Atmosphere

C11-2-01 Identify the abundances of the naturally occurring gases in the atmosphere and examine how these abundances have changed over geologic time.
Include: oxygenation of Earth's atmosphere, the role of biota in oxygenation, changes in carbon dioxide content over time

C11-2-02 Research Canadian and global initiatives to improve air quality.

C11-2-03 Examine the historical development of the measurement of pressure.
Examples: the contributions of Galileo Galilei, Evangelista Torricelli, Otto von Guericke, Blaise Pascal, Christiaan Huygens, John Dalton, Joseph Louis Gay-Lussac, Amadeo Avogadro…

C11-2-04 Describe the various units used to measure pressure.
Include: atmospheres (atm), kilopascals (kPa), millimetres of mercury (mmHg), millibars (mb)

C11-2-05 Experiment to develop the relationship between the pressure and volume of a gas using visual, numeric, and graphical representations.
Include: historical contributions of Robert Boyle

C11-2-06 Experiment to develop the relationship between the volume and temperature of a gas using visual, numeric, and graphical representations.
Include: historical contributions of Jacques Charles, the determination of absolute zero, the Kelvin temperature scale

C11-2-07 Experiment to develop the relationship between the pressure and temperature of a gas using visual, numeric, and graphical representations.
Include: historical contributions of Joseph Louis Gay-Lussac

C11-2-08 Solve quantitative problems involving the relationships among the pressure, temperature, and volume of a gas using dimensional analysis.
Include: symbolic relationships

C11-2-09 Identify various industrial, environmental, and recreational applications of gases.
Examples: self-contained underwater breathing apparatus (scuba), anaesthetics, air bags, acetylene welding, propane appliances, hyperbaric chambers…

Topic 3: Chemical Reactions

C11-3-01 Determine average atomic mass using isotopes and their relative abundance.
Include: atomic mass unit (amu)

C11-3-02 Research the importance and applications of isotopes.
Examples: nuclear medicine, stable isotopes in climatology, dating techniques…

C11-3-03 Write formulas and names for polyatomic compounds using International Union of Pure and Applied Chemistry (IUPAC) nomenclature.

C11-3-04 Calculate the mass of compounds in atomic mass units.

C11-3-05 Write and classify balanced chemical equations from written descriptions of reactions.
Include: polyatomic ions

C11-3-06 Predict the products of chemical reactions, given the reactants and type of reaction.
Include: polyatomic ions

C11-3-07 Describe the concept of the mole and its importance to measurement in chemistry.

C11-3-08 Calculate the molar mass of various substances.

C11-3-09 Calculate the volume of a given mass of a gaseous substance from its density at a given temperature and pressure.
Include: molar volume calculation

C11-3-10 Solve problems requiring interconversions between moles, mass, volume, and number of particles.

C11-3-11 Determine empirical and molecular formulas from percent composition or mass data.

C11-3-12 Interpret a balanced equation in terms of moles, mass, and volumes of gases.

C11-3-13 Solve stoichiometric problems involving moles, mass, and volume, given the reactants and products in a balanced chemical reaction.
Include: heat of reaction problems

C11-3-14 Identify the limiting reactant and calculate the mass of a product, given the reaction equation and reactant data.

C11-3-15 Perform a lab involving mass-mass or mass-volume relations, identifying the limiting reactant and calculating the mole ratio.
Include: theoretical yield, experimental yield

C11-3-16 Discuss the importance of stoichiometry in industry and describe specific applications.
Examples: analytical chemistry, chemical engineering, industrial chemistry…

Topic 4: Solutions

C11-4-01 Describe and give examples of various types of solutions.
Include: all nine possible types

C11-4-02 Describe the structure of water in terms of electronegativity and the polarity of its chemical bonds.

C11-4-03 Explain the solution process of simple ionic and covalent compounds, using visual, particulate representations and chemical equations.
Include: crystal structure, dissociation, hydration

C11-4-04 Explain heat of solution with reference to specific applications.
Examples: cold packs, hot packs…

C11-4-05 Perform a lab to illustrate the formation of solutions in terms of the polar and non-polar nature of substances.
Include: soluble, insoluble, miscible, immiscible

C11-4-06 Construct, from experimental data, a solubility curve of a pure substance in water.

C11-4-07 Differentiate among saturated, unsaturated, and supersaturated solutions.

C11-4-08 Use a graph of solubility data to solve problems.

C11-4-09 Explain how a change in temperature affects the solubility of gases.

C11-4-10 Explain how a change in pressure affects the solubility of gases.

C11-4-11 Perform a lab to demonstrate freezing-point depression and boiling-point elevation.

C11-4-12 Explain freezing-point depression and boiling-point elevation at the molecular level.

Examples: antifreeze, road salt…

C11-4-13 Differentiate among, and give examples of, the use of various representations of concentration.

Include: grams per litre (g/L), % weight-weight (% w/w), % weight-volume (% w/v), % volume/volume (% v/v), parts per million (ppm), parts per billion (ppb), moles per litre (mol/L) (molarity)

C11-4-14 Solve problems involving calculation for concentration, moles, mass, and volume.

C11-4-15 Prepare a solution, given the amount of solute (in grams) and the volume of solution (in millilitres), and determine the concentration in moles/litre.

C11-4-16 Solve problems involving the dilution of solutions.

Include: dilution of stock solutions, mixing common solutions with different volumes and concentrations

C11-4-17 Perform a dilution from a solution of known concentration.

C11-4-18 Describe examples of situations where solutions of known concentration are important.

Examples: pharmaceutical preparations, administration of drugs, aquaria, swimming-pool disinfectants, gas mixes for scuba, radiator antifreeze…

C11-4-19 Describe the process of treating a water supply, identifying the allowable concentrations of metallic and organic species in water suitable for consumption.

Topic 5: Organic Chemistry

C11-5-01 Compare and contrast inorganic and organic chemistry.
Include: the contributions of Friedrich Wöhler to the overturn of vitalism

C11-5-02 Identify the origins and major sources of hydrocarbons and other organic compounds.
Include: natural and synthetic sources

C11-5-03 Describe the structural characteristics of carbon.
Include: bonding characteristics of the carbon atom in hydrocarbons (single, double, triple bonds)

C11-5-04 Compare and contrast the molecular structures of alkanes, alkenes, and alkynes.
Include: trends in melting points and boiling points of alkanes only

C11-5-05 Name, draw, and construct structural models of the first 10 alkanes.
Include: IUPAC nomenclature, structural formulas, condensed structural formulas, molecular formulas, general formula $C_nH_{(2n+2)}$

C11-5-06 Name, draw, and construct structural models of branched alkanes.
Include: six-carbon parent chain, methyl and ethyl substituent groups, IUPAC nomenclature

C11-5-07 Name, draw, and construct structural models of isomers for alkanes up to six-carbon atoms.
Include: condensed structural formulas

C11-5-08 Outline the transformation of alkanes to alkenes and vice versa.
Include: dehydrogenation/hydrogenation, molecular models

C11-5-09 Name, draw, and construct molecular models of alkenes and branched alkenes.
Include: six-carbon parent chain, methyl and ethyl substituent groups, IUPAC nomenclature, structural formulas, condensed structural formulas, molecular formulas, general formula C_nH_{2n}

C11-5-10 Differentiate between saturated and unsaturated hydrocarbons.

C11-5-11 Outline the transformation of alkenes to alkynes and vice versa.
Include: dehydrogenation/hydrogenation, molecular models

C11-5-12 Name, draw, and construct structural models of alkynes and branched alkynes.
Include: six-carbon parent chain, methyl and ethyl substituent groups, IUPAC nomenclature, structural formulas, condensed structural formulas, molecular formulas, general formula C_nH_{2n-2}

C11-5-13 Compare and contrast the structure of aromatic and aliphatic hydrocarbons.
Include: molecular models, condensed structural formulas

C11-5-14 Describe uses of aromatic hydrocarbons.
Examples: polychlorinated biphenyls, caffeine, steroids, organic solvents (toluene, xylene)…

C11-5-15 Write condensed structural formulas for and name common alcohols.
Include: maximum of six-carbon parent chain, IUPAC nomenclature

C11-5-16 Describe uses of methyl, ethyl, and isopropyl alcohols.

C11-5-17 Write condensed structural formulas for and name organic acids.
Include: maximum of six-carbon parent chain, IUPAC nomenclature

C11-5-18 Describe uses or functions of common organic acids.
Examples: acetic, ascorbic, citric, formic, acetylsalicylic (ASA), lactic…

C11-5-19 Perform a lab involving the formation of esters, and examine the process of esterification.

C11-5-20 Write condensed structural formulas for and name esters.
Include: up to 6-C alcohols and 6-C organic acids, IUPAC nomenclature

C11-5-21 Describe uses of common esters.
Examples: pheromones, artificial flavourings…

C11-5-22 Describe the process of polymerization and identify important natural and synthetic polymers.
Examples: polyethylene, polypropylene, polystyrene, polytetrafluoroethylene (Teflon®)…

C11-5-23 Describe how the products of organic chemistry have influenced quality of life.
Examples: synthetic rubber, nylon, medicines, polytetrafluoroethylene (Teflon®)…

C11-5-24 Use the decision-making process to investigate an issue related to organic chemistry.
Examples: gasohol production, alternative energy sources, recycling of plastics…