

# Manitoba

Education, Citizenship and Youth

## Grade 12 CHEMISTRY 40S Student Specific Learning Outcomes

Spring 2007 Final Draft

For more information or to provide feedback, please contact:

**John Murray**

Science Consultant

Instruction, Curriculum and Assessment Branch

Manitoba Education, Citizenship and Youth

W240-1970 Ness Avenue

Telephone: 1-800-282-8069 ext. 7899 or 945-7899 (local)

E-Mail: [john.murray@gov.mb.ca](mailto:john.murray@gov.mb.ca)

## Cluster 0 : Chemistry Skills and Attitudes

### Demonstrating Understanding

C12-0-U1 Use appropriate strategies and skills to develop an understanding of chemical concepts.

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

C12-0-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

C12-0-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.

GLO: B3, B5, C1, C2

C12-0-S2 State a testable hypothesis or prediction based on background data or on observed events.

GLO: C2

C12-0-S3 Design and implement an investigation to answer a specific scientific question.

Include: materials, independent and dependant variables, controls, methods, safety considerations.

C12-0-S4 Select and use scientific equipment appropriately and safely.

*Examples: volumetric glassware, balance, thermometer...*

C12-0-S5 Collect, record, organize and display data using an appropriate format.

*Examples: labelled diagrams, graphs, multimedia applications, software integration, probeware...*

C12-0-S6 Estimate and measure accurately using Système International (SI) and other standard units.

Include: SI conversions, significant figures.

C12-0-S7 Interpret patterns and trends in data, and infer and explain relationships.

C12-0-S8 Evaluate data and data collection methods for accuracy and precision.

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

C12-0-S9 Draw a conclusion based on the analysis and interpretation of data.

## Grade 12 Chemistry (40S)

---

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

GLO: C2, C5, C8

### Research

C12-0-R1 Synthesize information obtained from a variety of sources.

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

C12-0-R2 Evaluate information obtained to determine its usefulness for information needs.

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

C12-0-R3 Quote from or refer to sources as required and reference information sources according to an accepted practice.

C12-0-R4 Compare diverse perspectives and interpretations in the media and other information sources.

C12-0-R5 Communicate information in a variety of forms appropriate to the audience, purpose, and context.

### Communication and Teamwork

C12-0-C1 Collaborate with other to achieve group goals and responsibilities.

C12-0-C2 Elicit, clarify, and respond to questions, ideas, and diverse points of view in discussions.

C12-0-C3 Evaluate individual and group processes.

### Nature of Science

C12-0-N1 Explain the roles of theory, evidence, and models in the development of scientific knowledge

C12-0-N2 Describe, from a historical perspective, how the observations and experimental work of many individuals led to modern understandings of matter.

C12-0-N3 Describe how scientific knowledge changes as new evidence emerges and/or new ideas and interpretations are advanced.

### STSE

C12-0-T1 Describe examples of the relationship between chemical principles and applications of chemistry.

C12-0-T2 Explain how scientific research and technology interact in the production and distribution of beneficial materials.

## **Grade 12 Chemistry (40S)**

---

C12-0-T3 Provide examples of how chemical principles are applied in products and processes, in scientific studies, and in daily life.

### Attitudes

C12-0-A1 Demonstrate confidence in their ability to carry out investigations in chemistry.

C12-0-A2 Value scepticism, honesty, accuracy, precision, perseverance, and open-mindedness as scientific and technological habits of mind.

C12-0-A3 Demonstrate a continuing, increasingly informed interest in chemistry and chemistry-related careers and issues.

C12-0-A4 Be sensitive and responsible in maintaining a balance between the needs of humans and a sustainable environment.

## Unit 1— Aqueous Reactions (18 hours)

C12-1-01 Explain examples of solubility and precipitation at the particulate and symbolic levels.

C12-1-02 Perform a lab to develop a set of solubility rules. (2 hours)

C12-1-03 Use a table of solubility rules to predict the formation of a precipitate. (2 hours)

C12-1-04 Write balanced neutralization reactions involving strong acids and bases. (1 hour)

C12-1-05 Perform a lab to demonstrate the stoichiometry of a neutralization reaction between a strong base and a strong acid. (3 hours)

C12-5-06 Calculate the concentration or volume of an acid or base from the concentration and volume of an acid or base required for neutralization. (1 hr)

C12-1-07 Design and implement a procedure to determine the identity of a number of unknown solutions. (2 hours)

C12-1-08 Outline the development of our understanding of oxidation and reduction reactions. (1/2 hour)

Include: gain or loss of oxygen, loss or gain of electrons

C12-1-09 Determine the oxidation numbers for atoms in compounds and ions. (1 hour)

C12-1-10 Identify reactions as redox or non redox.

Include: oxidizing agent, reducing agent, substance oxidized and substance reduced (1/2 hour)

C12-1-11 Balance oxidation-reduction reactions using redox methods. (3 hours)

C12-1-12 Research practical applications of redox reactions. (4 hours)

*Examples: rocket fuels, fireworks, household bleach, photography, metal recovery from ores, steel making, aluminum recycling, fuel cells, batteries, tarnish removal, fruit clocks, forensic blood detection using luminal, corrosion glass, chemiluminescence/bioluminescence, electrolytic cleaning, electrodeposition, photochemical etching, antioxidants/preservatives*

**Unit 2—Atomic Structure (10 hours)**

C12-2-01 Qualitatively describe the electromagnetic spectrum in terms of frequency, wavelength, and energy. (0.5 hours)

C12-2-02 Recognize, through direct observation, that elements have unique line spectra (1.5 hours)

Include: flame tests or gas discharge tubes, spectroscopes or diffraction gratings.

C12-2-03 Describe applications and/or natural occurrences of line spectra. (1 hour)

*Examples: astronomy, aurora borealis, fireworks, neon lights.*

C12-2-04 Outline the historical development of the Quantum Mechanical Model of the atom. (1.5 hours)

C12-2-05 Write electron configurations for elements of the periodic table. (1 hour)

Include: selected elements up to atomic number 36 (Krypton)

C12-2-06 Relate the electron configuration of an element to its valence electron(s) and its position on the periodic table. (0.5 hours)

C12-2-07 Identify and account for periodic trends among the properties of elements, and relate to electron configuration.

Include: atomic radii, ionic radii, ionization energy, electronegativity

### Unit 3 – Kinetics (10 hours)

C12-3-01 Formulate an operational definition of reaction rate.

Include: examples of chemical reactions that occur at different rates. (0.5 hr)

C12-3-02 Identify variables used to monitor reaction rates (i.e. change per unit time,  $\Delta x/\Delta t$ ).

*Examples: pressure, temperature, pH, conductivity, color.* (0.5 hr)

C12-3-03 Perform a lab to measure the average and instantaneous rate of a chemical reaction. (2 hr)

Include: initial rate

C12-3-04 Relate the rate of formation of a product to the rate of disappearance of a reactant given experimental rate data and reaction stoichiometry.

Include: Descriptive treatment at the particulate level (0.5 hr)

C12-3-05 Perform a lab to identify factors that affect the rate of a chemical reaction.

Include: nature of reactants, surface area, concentration, pressure, volume, temperature, and presence of a catalyst. (1.5 hr)

C12-3-06 Use the collision theory to explain the rate of chemical reactions.

Include: Activation energy

C12-3-07 Draw potential energy diagrams for endothermic and exothermic reactions.

Include: relative rates, effect of a catalyst, heat of reaction (enthalpy change) (1 hr)

C12-3-08 Describe qualitatively the relationship between factors which affect the rate of chemical reactions and the relative rate of a reaction using the Collision Theory. (1 hr)

C12-3-09 Explain the concept of a reaction mechanism.

Include: rate determining step (1 hr)

C12-3-10 Determine the rate law and order of a chemical reaction from experimental data.

Include: reactions that are zero, first or second order, rate versus concentration graphs. (2 hr)

## Unit 4 – Equilibrium (17 hours)

C12-4-01 Relate the concept of equilibrium to physical and chemical systems.

Include: conditions necessary to achieve equilibrium. (1 hr)

C12-4-02 Write equilibrium law expressions from balanced chemical equations for heterogeneous and homogeneous systems.

Include: mass action expression. (1 hr)

C12-4-03 Use the value of the equilibrium constant to explain how far a system at equilibrium has gone towards completion. (0.5 hr)

C12-4-04 Solve problems involving equilibrium constants. (2hrs)

C12-4-05 Perform a lab to determine the equilibrium constant of an equilibrium system. (1.5 hr)

C12-4-06 Use Le Chatelier's principle to predict and explain shifts in equilibrium.

Include: temperature changes, pressure/volume changes, changes in reactant/product concentration, the addition of a catalyst, the addition of an inert gas, the effects of various stresses on the equilibrium constant. (2 hr)

C12-4-07 Perform a lab to demonstrate Le Chatelier's principle. (1.5 hr)

C12-4-08 Interpret concentration versus time graphs.

Include: temperature changes, concentration changes, addition of a catalyst. (1 hr)

C12-4-09 Describe practical applications of Le Chatelier's principle.

*Examples: Haber Process, haemoglobin production at high altitude, carbonated beverages, eyes adjusting to light, blood pH, recharging of batteries, turbocharged/supercharged engines, ester synthesis, weather indicators, arrangement of produce, carbonated beverages in a hen's diet.*

(1 hr)

C12-4-10 Write solubility product ( $K_{sp}$ ) expressions from balanced chemical equations for salts with low solubility. (0.5 hr)

C12-4-11 Solve problems involving  $K_{sp}$ .

Include: common ion problems. (3 hr)

C12-4-12 Describe examples of salts with low solubilities.

*Examples: kidney stones, limestone caverns, osteoporosis, tooth decay.* (1.5 hr)

**C12-4-13** Perform a lab to determine the  $K_{sp}$  of a salt with low solubility. (1.5 hr)

**Unit 5 – Acids and Bases – 14.5 hours**

C12-5-01 Outline the historical development of acid base theories.

Include: Arrhenius, Bronsted-Lowry, Lewis. (1 hr)

C12-5-02 Write balanced acid/base chemical equations.

Include: conjugate acid/base pairs, amphoteric behavior. (1 hr)

C12-5-03 Describe the relationship between the hydronium and hydroxide ion concentrations in water

Include: the ion product of water,  $K_w$ . (0.5 hr)

C12-5-04 Perform an activity to formulate an operational definition of pH.

(1 hr)

C12-5-05 Describe how an acid-base indicator works in terms of colour shifts and Le Chatelier's Principle. (0.5 hr)

C12-5-06 Solve problems involving pH.

C12-5-07 Distinguish between strong and weak acids and bases.

Include: electrolytes and non-electrolytes, (0.25 hr)

C12-5-08 Write the equilibrium expression ( $K_a$  or  $K_b$ ) from a balanced chemical equation. (0.25 hr)

C12-5-09 Use  $K_a$  or  $K_b$  to solve problems for pH, percent dissociation and concentration. (4 hr)

C12-5-10 Using a standardized acid or base, determine the concentration of an unknown base or acid. (3 hr)

C12-5-11 Predict whether an aqueous solution of a given ionic compound will be acidic, basic or neutral given the formula. (1 hr)

## Unit 6 – Electrochemistry – 14.5 hours

C12-6-01 Develop an activity series experimentally. (2h)

C12-6-02 Predict the spontaneity of reactions using an activity series. (0.5h)

C12-6-03 Outline the historical development of voltaic (galvanic) cells. (1h)  
Include: contributions of Alessandro Volta, Luigi Galvani

C12-6-04 Explain the operation of a voltaic (galvanic) cell at the visual, particulate and symbolic levels. (1h)  
Include: writing half-cell reactions and overall reaction

C12-6-05 Construct a functioning voltaic (galvanic) cell and measure its potential. (1h)

C12-6-06 Define standard electrode potential. (0.5h)  
Include: hydrogen electrode as a reference

C12-6-07 Calculate standard cell potentials given standard electrode potentials. (1h).

C12-6-08 Predict the spontaneity of reactions using standard electrode potentials. (0.5h)

C12-6-09 Compare and contrast voltaic (galvanic) and electrolytic cells. (0.5 h)

C12-6-10 Explain the operation of an electrolytic cell at the visual, particulate and symbolic levels.  
Include: a molten ionic compound; an aqueous ionic compound; (1.5h)

C12-6-11 Describe practical uses of electrolytic cells.  
*Examples: electrolysis of water, electrolysis of brine, electroplating, production and purification of metals.* (1h)

C12-6-12 Using Faraday's law, solve problems related to electrolytic cells. (2h)