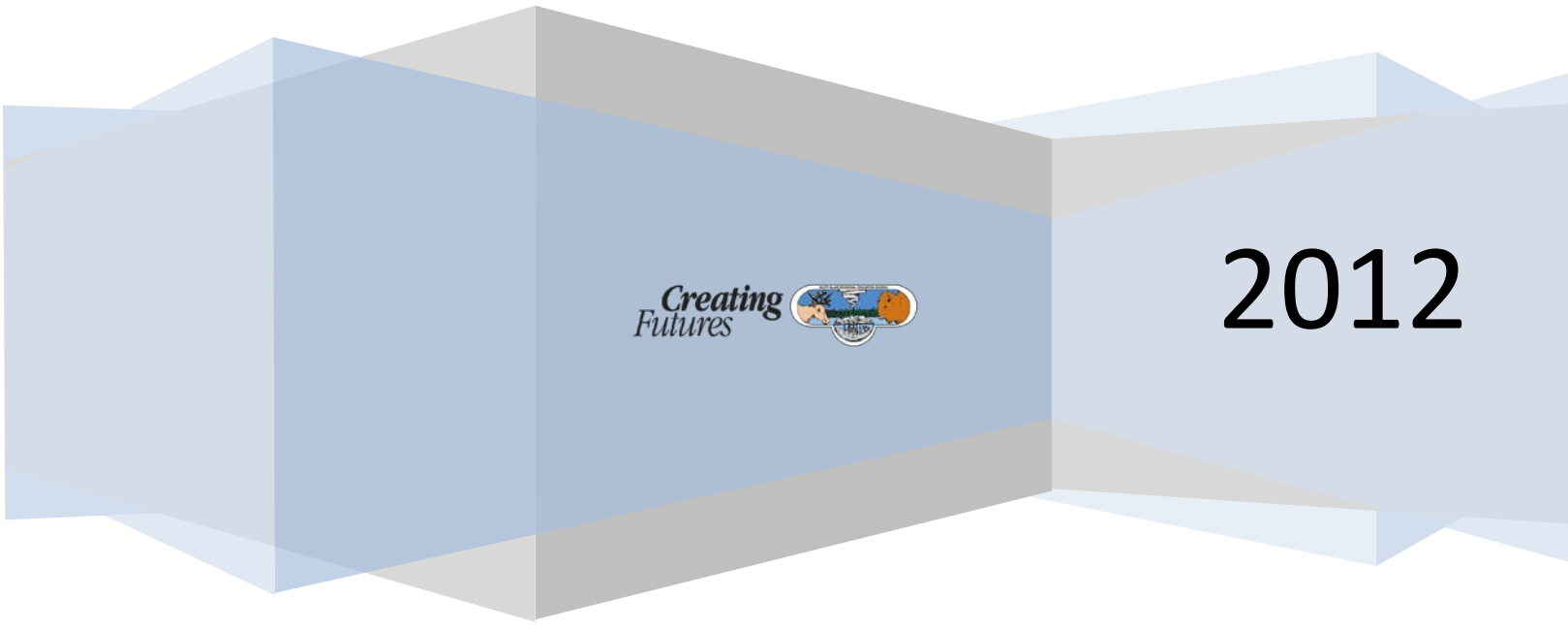
South Slave Divisional Education Council

Chemistry 30

Curriculum Package

February 2012



Unit A: Thermochemical Changes

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Focusing Questions: How does our society use the energy of chemical changes? What are the impacts of energy use on society and the environment? How do chemists determine how much energy will be produced or absorbed for a given chemical reaction?	
1 GENERAL OUTCOMES: STUDENTS WILL DETERMINE AND INTERPRET ENERGY CHANGES IN CHEMICAL REACTIONS	
Knowledge: Students will determine and interpret energy changes in chemical reactions	• Recall the application of $Q = mc\Delta t$ to the analysis of heat transfer • Explain, in a general way, how stored energy in the chemical bonds of hydrocarbons originated from the sun • Define enthalpy and molar enthalpy for chemical reactions • Write balanced equations for chemical reactions that include energy changes • Use and interpret ΔH notation to communicate and calculate energy changes in chemical reactions • Predict the enthalpy change for chemical equations using standard enthalpies of formation • Explain and use Hess' law to calculate energy changes for a net reaction from a series of reactions • Use calorimetry data to determine the enthalpy changes in chemical reactions • Identify that liquid water and carbon dioxide gas are reactants in photosynthesis and products of cellular respiration and that gaseous water and carbon dioxide gas are the products of hydrocarbon combustion in an open system • Classify chemical reactions as endothermic or exothermic, including those for the processes of photosynthesis, cellular respiration and hydrocarbon combustion.
Explain that the goal of technology is to provide solutions to practical problems **Science, Technology and Society (STS)** (Science and Technology Emphasis)	• Provide examples of personal reliance on the chemical potential energy of matter, such as the use of fossil fuels • Identify ways to use energy more efficiently • Identify and explain the selection of different fuels used by communities in urban, rural and remote areas, and compare that selection to the fuels used by the early inhabitants of a particular area of Alberta
Explain that technological problems often require multiple solutions that involve different designs, materials and processes and that have both intended and unintended consequences	• Explain the applications of fossil fuels, with examples from industries in Alberta • Evaluate the impact of the combustion of various energy sources, including fossil fuels and biomass, on personal health and the environment and describe the technologies used by early peoples to mitigate the harmful effects of combustion.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design a method to compare the molar enthalpy change when burning two or more fuels (e.g., octane, propane, ethanol and historic fuels such as seal or whale oil), identifying and controlling major variables • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information.

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Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform calorimetry experiments to determine the molar enthalpy change of chemical reactions • Use thermometers or temperature probes appropriately when measuring temperature changes • Use a computer-based laboratory to compile and organize data from an experiment to demonstrate molar enthalpy change • Select and integrate information from various print and electronic sources to create multiple-linked documents about the use of alternative fuels
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Compare energy changes associated with a variety of chemical reactions through the analysis of data and energy diagrams • Manipulate and present data through the selection of appropriate tools, such as scientific instrumentation, calculators, databases or spreadsheets
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use appropriate International System of Units (SI) notation, fundamental and derived units and significant digits • Use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results
2 GENERAL OUTCOMES: STUDENTS WILL EXPLAIN AND COMMUNICATE ENERGY CHANGES IN CHEMICAL REACTIONS.	
Knowledge: Students will explain and communicate energy changes in chemical reactions.	• Define activation energy as the energy barrier that must be overcome for a chemical reaction to occur • Explain the energy changes that occur during chemical reactions, referring to bonds breaking and forming and changes in potential and kinetic energy • Analyze and label energy diagrams of a chemical reaction, including reactants, products, enthalpy change and activation energy • Explain that catalysts increase reaction rates by providing alternate pathways for changes, without affecting the net amount of energy involved; e.g., enzymes in living systems.
Explain that the goal of technology is to provide solutions to practical problems **Science, Technology and Society (STS)** (Science and Technology Emphasis)	• Explain how catalysts, such as catalytic converters on automobiles, reduce air pollution resulting from the burning of fuels
• Explain that the appropriateness, risks and benefits of technologies need to be assessed for each potential application from a variety of perspectives, including sustainability	• Assess, qualitatively, the risks and benefits of relying on fossil fuels as energy sources
• Explain that the products of technology are devices, systems and processes that meet given needs; however, these products cannot solve all problems	• Evaluate the economic and environmental impacts of different fuels by relating carbon dioxide emissions and the heat content of a fuel.

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Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information • Design an experimental procedure to illustrate the effect of a catalyst on a chemical reaction
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Draw enthalpy diagrams, indicating changes in energy for chemical reactions • Use library and electronic research tools to compile information on the energy content of fuels used in Alberta power plants (PR–ST1) [ICT C1–4.1] • Design and build a heating device
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Draw and interpret enthalpy diagrams for chemical reactions • Explain the discrepancy between the theoretical and actual efficiency of a thermal energy conversion system • Determine the efficiency of thermal energy conversion systems (AI–NS3) • Assess whether coal or natural gas should be used to fuel thermal power plants in Alberta • Evaluate a personally designed and constructed heating device, including a calculation of its efficiency
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use appropriate SI notation, fundamental and derived units and significant digits to calculate and communicate enthalpy changes • Work cooperatively with others to develop a plan to build an energy conversion device and seek feedback, test and review the plan, make revisions and implement the plan • Use advanced menu features within word processing software to accomplish a task and to insert tables, graphs, text and graphics
Unit B: Electrochemical Changes	
Focusing Questions: What is an electrochemical change? How have scientific knowledge and technological innovation been integrated into the field of electrochemistry?	
1 GENERAL OUTCOMES: EXPLAIN THE NATURE OF OXIDATION-REDUCTION REACTIONS	
Students will explain the nature of oxidation-reduction reactions.	• Define oxidation and reduction operationally and theoretically • Define oxidizing agent, reducing agent, oxidation number, half-reaction, disproportionation • Differentiate between redox reactions and other reactions, using half-reactions and/or oxidation numbers • Identify electron transfer, oxidizing agents and reducing agents in redox reactions that occur in everyday life, in both living systems (e.g., cellular respiration, photosynthesis) and nonliving systems; i.e., corrosion • Compare the relative strengths of oxidizing and reducing agents, using empirical data • Predict the spontaneity of a redox reaction, based on standard reduction potentials, and compare their predictions to experimental results • Write and balance equations for redox reactions in acidic and neutral solutions by

Unit B: Electrochemical Changes

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Students will explain the nature of oxidation-reduction reactions.	○ Using half-reaction equations obtained from a standard reduction potential table ○ Developing simple half-reaction equations from information provided about redox changes ○ Assigning oxidation numbers, where appropriate, to the species undergoing chemical change • Perform calculations to determine quantities of substances involved in redox titrations.
Explain how the goal of technology is to provide solutions to practical problems **Science, Technology and Society (STS)** (Science and Technology Emphasis)	• Describe the methods and devices used to prevent corrosion; i.e., physical coatings and cathodic protection • Describe how the process of trial and error was used by early peoples to extract metals from ore
Explain that technological problems often require multiple solutions that involve different designs, materials and processes and that have both intended and unintended consequences	• Analyze redox reactions used in industry and commerce, such as pulp and paper, textiles, water treatment and food processing.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design an experiment to determine the reactivity of various metals • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Select and correctly use the appropriate equipment to perform a redox titration experiment • Use a standard reduction potential table as a tool when considering the spontaneity of redox reactions and their products • Create charts, tables or spreadsheets that present the results of redox experiments
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Evaluate data from an experiment to derive a simple reduction table • Interpret patterns and trends in data derived from redox reactions • Identify the limitations of data collected from redox experiments
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Select and use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate equations for redox reactions and answers to problems related to redox titrations
2 GENERAL OUTCOME STUDENTS WILL APPLY THE PRINCIPLES OF OXIDATION-REDUCTION TO ELECTROCHEMICAL CELLS.	
Students will apply the principles of oxidation-reduction to electrochemical cells.	• Define anode, cathode, anion, cation, salt bridge/porous cup, electrolyte, external circuit, power supply, voltaic cell and electrolytic cell • Identify the similarities and differences between the operation of a voltaic cell and that of an electrolytic cell • Predict and write the half-reaction equation that occurs at each electrode in an electrochemical cell • Recognize that predicted reactions do not always occur; e.g., the production of chlorine gas from the electrolysis of brine

Unit B: Electrochemical Changes

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Students will apply the principles of oxidation-reduction to electrochemical cells.	• Explain that the values of standard reduction potential are all relative to 0 volts, as set for the hydrogen electrode at standard conditions • Calculate the standard cell potential for electrochemical cells • Predict the spontaneity or nonspontaneity of redox reactions, based on standard cell potential, and the relative positions of half-reaction equations on a standard reduction potential table • Calculate mass, amounts, current and time in single voltaic and electrolytic cells by applying Faraday's law and stoichiometry.
Explain that scientific knowledge may lead to the development of new technologies, and new technologies may lead to or facilitate scientific discovery **Science, Technology and Society (STS)** (Science and Technology Emphasis)	• Analyze the relationship of scientific knowledge and technological development in the applications of voltaic and electrolytic cells in such applications as batteries, electroplating, refining metals from ores, electrowinning and sanitizing swimming pools with chlorine compounds
Describe science and technology applications that have developed in response to human and environmental needs	• investigate the use of technology, such as galvanism, metallurgy, magnesium coupling, painting, cathodic protection, to solve practical problems related to corrosion
Explain that science and technology have influenced, and been influenced by, historical development and societal needs	• Evaluate the economic importance to modern society of electrochemical cells, particularly fuel cells, and predict their future importance in transportation, the recycling of metals and the reduction of emissions from smokestacks.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design an experiment, including a labelled diagram, to test predictions regarding spontaneity, products and the standard cell potential for reactions occurring in electrochemical cells • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information • Develop a plan to build a battery and seek feedback, test and review the plan and make revisions to the plan.
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Construct and observe electrochemical cells • Investigate the issue of the disposal of used batteries and propose alternative solutions To this problem • Compile and display evidence and information about voltaic and electrolytic cells in a variety of formats, including diagrams, flowcharts, tables, graphs and scatterplots.
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Identify the products of electrochemical cells • Compare predictions with observations of electrochemical cells • Identify the limitations of data collected on an electrochemical cell • Explain the discrepancies between the theoretical and actual cell potential
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use appropriate SI notation, fundamental and derived units and significant digits to communicate answers to problems related to functioning electrochemical cells

Unit C: Chemical Changes of Organic Compounds

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Focusing Questions: What are the common organic compounds and what is the system for naming them? How does society rely on organic compounds? How can society ensure that the technical applications of organic chemistry are assessed to ensure future quality of life and a sustainable environment?	
1 GENERAL OUTCOMES: Students will explore organic compounds as a common form of matter	
Knowledge: Students will explore organic compounds as a common form of matter.	• Define organic compounds as compounds containing carbon, recognizing inorganic exceptions such as carbonates, cyanides, carbides and oxides of carbon • Identify and describe significant organic compounds in daily life, demonstrating generalized knowledge of their origins and applications; e.g., methane, methanol, ethane, ethanol, ethanoic acid, propane, benzene, octane, glucose, polyethylene • Name and draw structural, condensed structural and line diagrams and formulas, using international union of pure and applied chemistry (iupac) nomenclature guidelines, for saturated and unsaturated aliphatic (including cyclic) and aromatic carbon compounds • Containing up to 10 carbon atoms in the parent chain (e.g., pentane; 3-ethyl-2,4-dimethylpentane) or cyclic structure (e.g., cyclopentane) • Containing only one type of a functional group (with multiple bonds categorized as a functional group; e.g., pent-2-ene), including simple halogenated hydrocarbons (e.g., 2-chloropentane), alcohols (e.g., pentan-2-ol), carboxylic acids (e.g., pentanoic acid) and esters (e.g., methyl pentanoate), and with multiple occurrences of the functional group limited to halogens (e.g., 2-bromo-1-chloropentane) and alcohols (e.g., pentane-2,3-diol) • Identify types of compounds from the hydroxyl, carboxyl, ester linkage and halogen functional groups, given the structural formula • Define structural isomerism as compounds having the same empirical formulas, but with different structural formulas, and relate the structures to variations in the properties of the isomers • Compare, both within a homologous series and among compounds with different functional groups, the boiling points and solubility of examples of aliphatics, aromatics, alcohols and carboxylic acids • Describe, in general terms, the physical, chemical and technological processes (fractional distillation and solvent extraction) used to separate organic compounds from natural mixtures or solutions; e.g., petroleum refining, bitumen recovery.
Explain how science and technology are developed to meet societal needs and expand human capability **Science, Technology and Society (STS)** (Social and Environmental Contexts Emphasis)	• Describe where organic compounds are used in processes and common products, such as in hydrogenation to produce margarine and esters used as flavouring agents • Describe aboriginal use of organic substances for waterproofing, tanning, dyeing, medicines, salves and insect repellents
Explain that science and technology have influenced, and been influenced by, historical development and societal needs	• Explain how, as a result of chemistry and chemical technology, synthetic compounds of great benefit to society, such as plastics, medicines, hydrocarbon fuels and pesticides, have been produced.

Unit C: Chemical Changes of Organic Compounds

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design a procedure to identify types of organic compounds • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information • Design a procedure to separate a mixture of organic compounds, based on boiling point differences.
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Build molecular models depicting the structures of selected organic and inorganic compounds • Perform an experiment to compare the properties of organic compounds with inorganic compounds, considering properties such as solubility, viscosity, density, conductivity, reactivity
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Follow appropriate IUPAC guidelines when writing the names and formulas of organic compounds • Compile and organize data to compare the properties of structural isomers; e.g., pairs of hydrocarbon isomers and primary, secondary and tertiary alcohols • Interpret the results of a test to distinguish between a saturated and an unsaturated aliphatic, using aqueous bromine or potassium permanganate solutions
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use advanced menu features within word processing software to accomplish a task and to insert tables, graphs, text and graphics
2 GENERAL OUTCOME: STUDENTS WILL DESCRIBE CHEMICAL REACTIONS OF ORGANIC COMPOUNDS.	
Students will describe chemical reactions of organic compounds.	• Define, illustrate and provide examples of simple addition, substitution, elimination, esterification and combustion reactions • Predict products and write and interpret balanced equations for the above reactions • Define, illustrate and provide examples of monomers (e.g., ethylene), polymers (e.g., polyethylene) and polymerization in living systems (e.g., carbohydrates, proteins) and nonliving systems (e.g., nylon, polyester, plastics) • Relate the reactions described above to major reactions that produce thermal energy and economically important compounds from fossil fuels.
Explain how science and technology are developed to meet societal needs and expand human capability **Science, Technology and Society (STS)** (Social and Environmental Contexts Emphasis)	• Describe processes for obtaining economically important compounds from fossil fuels; e.g., o Compare hydrocracking and catalytic reforming o Describe bitumen upgrading • Describe major reactions used in the petrochemical industry in Alberta, such as in the production of methanol, ethylene glycol, polyethylene, polyvinyl chloride (PVC) and urea formaldehyde • Investigate the application of nanoscience and nanotechnology in the petrochemical industry and the medical sciences

Unit C: Chemical Changes of Organic Compounds

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Explain that science and technology have influenced, and been influenced by, historical development and societal needs	• Describe processes involved in producing fuels; e.g., o Adjusting octane/cetane rating o Reducing sulfur content o Adding compounds such as oxygenated additives (blending with ethanol)
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design a procedure to identify types of organic compounds • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information • Design a procedure to separate a mixture of organic compounds, based on boiling point differences.
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Build molecular models depicting the structures of selected organic and inorganic compounds • Perform an experiment to compare the properties of organic compounds with inorganic compounds, considering properties such as solubility, viscosity, density, conductivity, reactivity
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Follow appropriate IUPAC guidelines when writing the names and formulas of organic compounds • Compile and organize data to compare the properties of structural isomers; e.g., pairs of hydrocarbon isomers and primary, secondary and tertiary alcohols • Interpret the results of a test to distinguish between a saturated and an unsaturated aliphatic, using aqueous bromine or potassium permanganate solutions
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use advanced menu features within word processing software to insert tables, graphs, text and graphics when preparing a report on an issue related to society's use of organic chemistry

Unit D: Chemical Equilibrium Focusing on Acid-Base Systems

Focusing Questions: What is happening in a system at equilibrium? How do scientists predict shifts in the equilibrium of a system? How do Brønsted–Lowry acids and bases illustrate equilibrium?	
1 GENERAL OUTCOME: STUDENTS WILL EXPLAIN THAT THERE IS A BALANCE OF OPPOSING REACTIONS IN CHEMICAL EQUILIBRIUM SYSTEMS	
Knowledge: Students will explain that there is a balance of opposing reactions in chemical equilibrium systems	• Define equilibrium and state the criteria that apply to a chemical system in equilibrium; i.e., closed system, constancy of properties, equal rates of forward and reverse reactions • Identify, write and interpret chemical equations for systems at equilibrium • Predict, qualitatively, using Le Chatelier's principle, shifts in equilibrium caused by changes in temperature, pressure, volume, concentration or the addition of a catalyst and describe how these changes affect the equilibrium constant • Define K_c to predict the extent of the reaction and write equilibrium-law expressions for given chemical equations, using lowest whole-number coefficients • Describe Brønsted–Lowry acids as proton donors and bases as proton acceptors

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Unit D: Chemical Equilibrium Focusing on Acid-Base Systems

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Knowledge: Students will explain that there is a balance of opposing reactions in chemical equilibrium systems	• Write Brønsted–Lowry equations, including indicators, and predict whether reactants or products are favoured for acid-base equilibrium reactions for monoprotic and polyprotic acids and bases • Identify conjugate pairs and amphiprotic substances • Define a buffer as relatively large amounts of a weak acid or base and its conjugate in equilibrium that maintain a relatively constant pH when small amounts of acid or base are added.
Explain that the goal of science is knowledge about the natural world **Science, Technology and Society (STS)** (Nature of Science Emphasis)	• Apply equilibrium theories and principles to analyze a variety of phenomena; e.g., o Carbon dioxide escaping from an open bottle/can of carbonated beverage o Role of the oceans in the carbon cycle o Solubility of oxygen gas in lake water o Acid precipitation (deposition) o Blood gases in deep-sea diving o Buffers in living systems
Explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations	• Research how equilibrium theories and principles developed
Explain that the goal of technology is to provide solutions to practical problems	• Analyze how equilibrium principles have been applied in industrial processes; e.g., o Haber–Bosch process for producing ammonia o Solvay process for producing sodium carbonate o Production of methanol.
SKILLS OUTCOMES: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Predict variables that can cause a shift in equilibrium • Design an experiment to show equilibrium shifts; e.g., colour change, temperature change, precipitation • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information • Design a procedure to prepare a system capable of buffering .
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform an experiment to test, qualitatively, predictions of equilibrium shifts; e.g., colour change, temperature change, precipitation and gas production • Prepare a buffer and investigate its relative abilities, with a control (i.e., water), to resist a pH change when a small amount of strong acid or strong base is added
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Write the equilibrium law expression for a given equation • Analyze, qualitatively, the changes in concentrations of reactants and products after an equilibrium shift • Interpret data from a graph to determine when equilibrium is established and to determine the cause of a stress on the system • Interpret, qualitatively, titration curves of monoprotic and polyprotic acids and bases for strong acid–weak base and weak acid–strong base combinations, and identify buffering regions

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Unit D: Chemical Equilibrium Focusing on Acid-Base Systems

Specific Outcomes	Achievement Indicators – Measurable outcomes
It is expected that students will:	*The following set of indicators may be used to assess student achievement for each related specific learning outcome. Students who have fully met the specific learning outcomes are able to:*
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Work cooperatively to develop an illustration and explanation of reversible reactions • Use advanced menu features within word processing software to insert tables, graphs, text and graphics when developing a group report on equilibrium systems
2 GENERAL OUTCOMES: STUDENTS WILL DETERMINE QUANTITATIVE RELATIONSHIPS IN SIMPLE EQUILIBRIUM SYSTEMS	
Knowledge: Students will determine quantitative relationships in simple equilibrium systems	• Recall the concepts of pH and hydronium ion concentration and pOH and hydroxide ion concentration, in relation to acids and bases • Define K_w , K_a , K_b and use these to determine pH, pOH, $[H_3O^+]$ and $[OH^-]$ of acidic and basic solutions • Calculate equilibrium constants and concentrations for homogeneous systems and • Brønsted–Lowry acids and bases (excluding buffers) when o Concentrations at equilibrium are known o Initial concentrations and one equilibrium concentration are known o The equilibrium constant and one equilibrium concentration are known.
Explain that technological development may involve the creation of prototypes, the testing of prototypes and the application of knowledge from related scientific and interdisciplinary fields **Science, Technology and Society (STS)** (Nature of Science Emphasis)	• Analyze, on the basis of chemical principles, the application of equilibrium o Industrial processes or medical sciences o Buffering in living systems o Acid precipitation.
• **SKILLS OUTCOMES**: (embed throughout the unit)	
Initiating and Planning: Formulate questions about observed relationships; plan investigations of questions, ideas, problems and issues	• Design an experiment to show qualitative equilibrium shifts in concentration under a given set of conditions • Describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information
Performing and Recording: Conduct investigations into relationships between and among observable variables and use a broad range of tools and techniques to gather and record data and information	• Perform an experiment to show equilibrium shifts in concentration
Analyzing and Interpreting: Analyze data and apply mathematical and conceptual models to develop and assess possible solutions	• Use experimental data to calculate equilibrium constants
Communication and Teamwork: Work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results	• Use advanced menu features within word processing software to insert tables, graphs, text and graphics when developing a group report on equilibrium applications in Alberta industries