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Correlation with the

Alberta Chemistry 20–30 Program of Studies

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CHEMISTRY 20

Unit A: The Diversity of Matter and Chemical Bonding

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

• chemical bond
• ionic bond
• covalent bond
• electronegativity
• polarity
• valence electron
• intramolecular and intermolecular forces
• hydrogen bond
• electron dot diagrams
• Lewis structures
• valence-shell electron-pair repulsion (VSEPR) theory

General Outcome 1
Students will describe the role of modelling, evidence and theory in explaining and understanding the structure, chemical bonding and properties of ionic compounds.

Specific Outcomes for Knowledge
Students will:
20–A1.1k recall principles for assigning names to ionic compounds
20–A1.2k explain why formulas for ionic compounds refer to the simplest whole-number ratio of ions that result in a net charge of zero

⟶ **Miscellaneous** *Chemical Matter* "The Types of Compounds"

20–A1.3k define valence electron, electronegativity, ionic bond and intramolecular force
20–A1.4k use the periodic table and electron dot diagrams to support and explain ionic bonding theory
20–A1.5k explain how an ionic bond results from the simultaneous attraction of oppositely charged ions

⟶ **Lab** *Chemical Bonding* "Exploring Ionic Interactions"

20–A1.6k explain that ionic compounds form lattices and that these structures relate to the compounds' properties; *e.g., melting point, solubility, reactivity*.

⟶ **LAB** *Liquids & Solids* "Basic Structure Types of Ionic Solids"

Specific Outcomes for Skills (Nature of Science Emphasis)
Initiating and Planning
Students will:
20–A1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• design an investigation to determine the properties of ionic compounds (solubility, conductivity and melting point) **(IP–NS2)**
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information **(IP–NS4)**
• *research the question, "Should all scientific research have a practical application?"* **(IP–NS1) [ICT C2–4.1]**
• *design an experiment to explore the formation of ionic compounds* **(IP–NS2)**.

Performing and Recording
Students will:
20–A1.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• draw electron dot diagrams **(CT–NS2)**
• *build models of ionic solids* **(CT–NS2)**
• *perform an investigation to illustrate properties of ionic compounds* **(PR–NS3, PR–NS5)**
• *use the periodic table to make predictions about bonding and nomenclature* **(PR–NS1, AI–NS1)**
• *use model-building software to collect and integrate information on the structure of ionic crystals* **(PR–NS4) [ICT C6–4.4]**.

⟶ *Builder,* "Solid" Panel

⟶ **LAB** *Liquids & Solids* "Basic Structure Types of Ionic Solids"

Analyzing and Interpreting
Students will:
20–A1.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• analyze experimental data to determine the properties of ionic compounds **(AI–NS6) [ICT C7–4.2]**
• *use data from various sources to predict the strength of bonds between ions* **(PR–NS1, AI–NS2) [ICT C6–4.1]**.

Communication and Teamwork
Students will:
20–A1.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
• use appropriate *Système international* (SI) units, fundamental and derived units and significant digits **(CT–NS2)**_
• use appropriate numeric, symbolic, graphical and linguistic modes of representation to communicate ideas, plans and results **(CT–NS2)**_
• *analyze, critically, models of ionic compounds built by others* **(CT–NS3)**.

General Outcome 2

Students will describe the role of modelling, evidence and theory in explaining and understanding the structure, chemical bonding and properties of molecular substances.

Specific Outcomes for Knowledge
Students will:
20–A2.1k recall principles for assigning names to molecular substances

⟶ **LAB** *Chemical Matter* "Naming Molecular Compounds"

20–A2.2k explain why formulas for molecular substances refer to the number of atoms of each constituent element

⟶ **MISCELLANEOUS** *Chemical Matter* "The Types of Compounds"

20–A2.3k relate electron pairing to multiple and covalent bonds

⟶ **LAB** *Chemical Bonding* "Multiple Bonds and Resonance"

20–A2.4k draw electron dot diagrams of atoms and molecules, writing structural formulas for molecular substances and using Lewis structures to predict bonding in simple molecules
20–A2.5k apply VSEPR theory to predict molecular shapes for linear, angular (V-shaped, bent), tetrahedral, trigonal pyramidal and trigonal planar molecules

⟶ **LAB** *Chemical Bonding* "VSEPR Theory"

⟶ **LAB** *Chemical Bonding* "Comparing Conceivable Shapes for a Molecule"

20–A2.6k illustrate, by drawing or by building models, the structure of simple molecular substances

⟶ *Builder,* "Entry-Level" and "Simulation Cell" Panels

20–A2.7k explain intermolecular forces, London (dispersion) forces, dipole-dipole forces and hydrogen bonding

⟶ **LAB** *Liquids & Solids* "Intermolecular Forces"

⟶ **LAB** *Liquids & Solids* "Dipole-Dipole Forces"

⟶ **MISCELLANEOUS** *Liquids & Solids* "Elements with HydrogenBonding"

20–A2.8k relate properties of substances (*e.g., melting and boiling points, enthalpies of fusion and vaporization*) to the predicted intermolecular bonding in the substances

⟶ **LAB** *Liquids & Solids* "Bonding in Crystalline Solids"

20–A2.9k determine the polarity of a molecule based on simple structural shapes and unequal charge distribution

⟶ **LAB** *Chemical Bonding* "Polar Bonds and Molecules"

20–A2.10k describe bonding as a continuum ranging from complete electron transfer to equal sharing of electrons.

⟶ **LAB** *Chemical Bonding* "Classifying by Bond Polarity"

Specific Outcomes for Science, Technology and Society (STS) (Nature of Science Emphasis)
Students will:
20–A2.1sts explain that the goal of science is knowledge about the natural world **(NS1)**
• *identify everyday processes and products in which molecular substances are significant, such as in the composition of household products and foods and in life processes*

⟶ **LAB** *Chemical Matter* "Introduction to the Molecular Level"

• *identify examples of processes and products in which molecular substances are significant, such as in the use of adhesives and rubber by Aboriginal peoples*

⟶ **MISCELLANEOUS** Multiple Examples

20–A2.2sts explain that scientific knowledge and theories develop through hypotheses, the collection of evidence, investigation and the ability to provide explanations **(NS2)**
• *relate chemical properties to predicted intermolecular bonding by investigating melting and boiling points*

20–A2.3sts explain that scientific knowledge is subject to change as new evidence becomes apparent and as laws and theories are tested and subsequently revised, reinforced or rejected **(NS4)**
• *explain how scientific research and technology interact in the production and distribution of beneficial materials, such as polymers, household products and solvents*
• *investigate how basic knowledge about the structure of matter is advanced through nanotechnology research and development.*

Specific Outcomes for Skills (Nature of Science Emphasis)
Initiating and Planning
Students will:
20–A2.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• state a hypothesis and make a prediction about the properties of molecular substances based on attractive forces; *e.g., melting or boiling point, enthalpies of fusion and vaporization* **(IP–NS3)**
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information **(IP–NS4)**.

Performing and Recording
Students will:
20–A2.2s conduct investigations into relationships among observable variables and use a broad range of tools and techniques to gather and record data and information
• build models depicting the structure of simple covalent molecules, including selected organic compounds **(CT–NS2)**
• carry out an investigation to determine the melting or boiling point of a molecular substance **(PR–NS3, PR–NS5)**
• *use a thermometer and a conductivity apparatus to collect data* **(PR–NS2)**
• *carry out an investigation to compare the physical properties of molecular substances* **(PR–NS3) [ICT F1–4.2]**.

⟶ *Builder,* "Entry-Level" Panel
⟶ **Lab** *Chemical Matter* "Chemical and Physical Properties"

Analyzing and Interpreting
Students will:
20–A2.3s analyze data and apply mathematical and conceptual models to develop and assess possible solutions
• graph and analyze data, for trends and patterns, on the melting and boiling points of a related series of molecular substances **(AI–NS2) [ICT C7–4.2]**.

Communication and Teamwork
Students will:
20–A2.4s work collaboratively in addressing problems and apply the skills and conventions of science in communicating information and ideas and in assessing results
• analyze and evaluate, objectively, models and graphs constructed by others **(CT–NS3)**
• *research the ways that scientists develop and analyze new materials* **(PR–NS1) [ICT C2–4.1]**.

Unit B: Forms of Matter: Gases

Key Concepts
The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

• Celsius and Kelvin temperature scales
• absolute zero
• real and ideal gases
• law of combining volumes
• Charles's law
• Boyle's law
• ideal gas law
• standard temperature and pressure (STP)
• standard ambient temperature and pressure (SATP)

General Outcome 1
Students will explain molecular behaviour, using models of the gaseous state of matter.

Specific Outcomes for Knowledge
Students will:
20–B1.1k describe and compare the behaviour of real and ideal gases in terms of kinetic molecular theory

⟶ **Miscellaneous** *Gases* "The Universality of the Ideal Gas Law"

⟶ **Lab** *Gases* "Gases at High Pressure"

20–B1.2k convert between the Celsius and Kelvin temperature scales

⟶ **Lab** *Gases* "Temperature Scales in Chemistry"

20–B1.3k explain the law of combining volumes

⟶ **Demonstration** *Gases* "What is Avogadro's Law?"

20–B1.4k illustrate how Boyle's and Charles's laws, individually and combined, are related to the ideal gas law ($PV = nRT$)

⟶ **Lab** *Gases* "The Pressure-Volume Relationship"

⟶ **Demonstration** *Gases* "What is Boyle's Law?"

⟶ **Lab** *Gases* "The Pressure-Temperature Relationship"

• express pressure in a variety of ways, including units of kilopascals, atmospheres and millimetres of mercury

⟶ **Lab** *Gases* "Gas Pressure"

• perform calculations, based on the gas laws, under STP, SATP and other defined conditions.

⟶ **Lab** *Gases* "Standard Temperature and Pressure"

Unit C: Matter as Solutions, Acids and Bases

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

• homogeneous mixtures
• solubility
• electrolyte/nonelectrolyte
• concentration
• dilution
• strong acids and bases
• weak acids and bases
• monoprotic/polyprotic acid
• monoprotic/polyprotic base
• Arrhenius (modified) theory of acids and bases
• indicators
• hydronium ion/pH
• hydroxide ion/pOH
• neutralization

General Outcome 1
Students will investigate solutions, describing their physical and chemical properties.

Specific Outcomes for Knowledge
Students will:
20–C1.1k recall the categories of pure substances and mixtures and explain the nature of homogeneous mixtures

⟶ **MISCELLANEOUS** *Chemical Matter* "The Types of Compounds"

⟶ **MISCELLANEOUS** *Chemical Matter* "The Types of Mixtures"

20–C1.2k provide examples from living and nonliving systems that illustrate how dissolving substances in water is often a prerequisite for chemical change

⟶ **DEMONSTRATION** *Solutions* "How do salts dissolve in water?"

20–C1.3k explain dissolving as an endothermic or exothermic process with respect to the breaking and forming of bonds

⟶ **MISCELLANEOUS** *Solutions* "Energetics of Solutions"

20–C1.4k differentiate between electrolytes and nonelectrolytes

⟶ **STOCKROOM** "Strong, Weak and Non-Electrolytes"

20–C1.5k express concentration in various ways; i.e., moles per litre of solution, percent by mass and parts per million

⟶ **LAB** *Solutions* "Specifying the Molarity"

20–C1.6k calculate, from empirical data, the concentration of solutions in moles per litre of solution and determine mass or volume from such concentrations

⟶ **LAB** *Solutions* "Concentration of a Dissolved Pesticide"

20–C1.7k calculate the concentrations and/or volumes of diluted solutions and the quantities of a solution and water to use when diluting
20–C1.8k use data and ionization/dissociation equations to calculate the concentration of ions in a solution

⟶ **STOCKROOM** "Aqueous Solutions" (Many Models)

20–C1.9k define solubility and identify related factors; i.e., temperature, pressure and miscibility

⟶ **MISCELLANEOUS** *Solutions* "Miscible and Nonmiscible Liquids"

20–C1.10k explain a saturated solution in terms of equilibrium; i.e., equal rates of dissolving and crystallization
20–C1.11k describe the procedures and calculations required for preparing and diluting solutions.

General Outcome 2
Students will describe acidic and basic solutions qualitatively and quantitatively.

Specific Outcomes for Knowledge
Students will:
20–C2.1k recall International Union of Pure and Applied Chemistry (IUPAC) nomenclature of acids and bases
20–C2.2k recall the empirical definitions of acidic, basic and neutral solutions determined by using indicators, pH and electrical conductivity
20–C2.3k calculate H_3O^+(aq) and OH^-(aq) concentrations and the pH and pOH of acidic and basic solutions based on logarithmic expressions; i.e., $pH = -\log[H_3O^+]$ and $pOH = -\log[OH^-]$
20–C2.4k use appropriate Système international (SI) units to communicate the concentration of solutions and express pH and concentration answers to the correct number of significant digits; i.e., use the number of decimal places in the pH to determine the number of significant digits of the concentration
20–C2.5k compare magnitude changes in pH and pOH with changes in concentration for acids and bases
20–C2.6k explain how the use of indicators, pH paper or pH meters can be used to measure H_3O^+(aq)
20–C2.7k define Arrhenius (modified) acids as substances that produce H_3O^+(aq) in aqueous solutions and recognize that the definition is limited

20–C2.8k define Arrhenius (modified) bases as substances that produce $OH^-(aq)$ in aqueous solutions and recognize that the definition is limited
20–C2.9k define neutralization as a reaction between hydronium and hydroxide ions
20–C2.10k differentiate, qualitatively, between strong and weak acids and between strong and weak bases on the basis of ionization and dissociation; i.e., pH, reaction rate and electrical conductivity

⟶ **LAB** *Acids & Bases* "Strong Acids"

⟶ **MISCELLANEOUS** *Acids & Bases* "Oxoacids"

20–C2.11k identify monoprotic and polyprotic acids and bases and compare their ionization/dissociation.

⟶ **STOCKROOM** "Nitric Acid", "Sulfuric Acid", "Phosphoric Acid", etc.

Unit D: Quantitative Relationships in Chemical Changes

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- chemical reaction equations
- net ionic equations
- spectator ions
- reaction stoichiometry
- precipitation
- limiting and excess reagents
- actual, theoretical and percent yield
- titration
- end point
- equivalence point
- titration curves for strong acids and bases

General Outcome 1
Students will explain how balanced chemical equations indicate the quantitative relationships between reactants and products involved in chemical changes.

Specific Outcomes for Knowledge
Students will:
20–D1.1k predict the product(s) of a chemical reaction based upon the reaction type

⟶ **LAB** *Kinetics* "Reactive Collisions Between Molecules"

20–D1.2k recall the balancing of chemical equations in terms of atoms, molecules and moles

⟶ **DEMONSTRATION** *Kinetics* "What does a chemical reaction look like at the molecular level?"

20–D1.3k contrast quantitative and qualitative analysis
20–D1.4k write balanced ionic and net ionic equations, including identification of spectator ions, for reactions taking place in aqueous solutions
20–D1.5k calculate the quantities of reactants and/or products involved in chemical reactions, using gravimetric, solution or gas stoichiometry.

General Outcome 2

Students will use stoichiometry in quantitative analysis.

Specific Outcomes for Knowledge

Students will:

20–D2.1k explain chemical principles (i.e., conservation of mass in a chemical change), using quantitative analysis

⟶ **DEMONSTRATION** *Kinetics* "What does a chemical reaction look like at the molecular level?"

20–D2.2k identify limiting and excess reagents in chemical reactions
20–D2.3k define theoretical yields and actual yields
20–D2.4k explain the discrepancy between theoretical and actual yields
20–D2.5k draw and interpret titration curves, using data from titration experiments involving strong monoprotic acids and strong monoprotic bases
20–D2.6k describe the function and choice of indicators in titrations
20–D2.7k identify equivalence points on strong monoprotic acid–strong monoprotic base titration curves and differentiate between the indicator end point and the equivalence point.

CHEMISTRY 30

Unit A: Thermochemical Changes

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

- enthalpy of formation
- enthalpy of reaction
- ΔH notation
- Hess' law
- molar enthalpy
- energy diagrams
- activation energy
- catalysts
- calorimetry
- fuels and energy efficiency

General Outcome 1
Students will determine and interpret energy changes in chemical reactions.

Specific Outcomes for Knowledge

Students will:

30–A1.1k recall the application of $Q = mc\Delta t$ to the analysis of heat transfer

⟶ **LAB** *Thermochemistry* "Specific Heat"

30–A1.2k explain, in a general way, how stored energy in the chemical bonds of hydrocarbons originated from the sun
30–A1.3k define enthalpy and molar enthalpy for chemical reactions
30–A1.4k write balanced equations for chemical reactions that include energy changes

→ **LAB** *Thermochemistry* "Energetics of a Chemical Reaction"

30–A1.5k use and interpret ΔH notation to communicate and calculate energy changes in chemical reactions
30–A1.6k predict the enthalpy change for chemical equations using standard enthalpies of formation
30–A1.7k explain and use Hess' law to calculate energy changes for a net reaction from a series of reactions
30–A1.8k use calorimetry data to determine the enthalpy changes in chemical reactions
30–A1.9k 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
30–A1.10k classify chemical reactions as endothermic or exothermic, including those for the processes of photosynthesis, cellular respiration and hydrocarbon combustion.

→ **LAB** *Kinetics* "Examining a Reaction Mechanism"

General Outcome 2
Students will explain and communicate energy changes in chemical reactions.

Specific Outcomes for Knowledge
Students will:
30–A2.1k define activation energy as the energy barrier that must be overcome for a chemical reaction to occur

→ **LAB** *Kinetics* "Examining a Reaction Mechanism"

30–A2.2k explain the energy changes that occur during chemical reactions, referring to bonds breaking and forming and changes in potential and kinetic energy

→ **LAB** *Thermochemistry* "Energetics of a Chemical Reaction"

30–A2.3k analyze and label energy diagrams of a chemical reaction, including reactants, products, enthalpy change and activation energy
30–A2.4k 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.*

Unit B: Electrochemical Changes

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in the courses. The intended level and scope of treatment is defined by the outcomes.

- oxidation
- reduction
- oxidizing agent
- reducing agent
- oxidation-reduction (redox) reaction
- oxidation number
- half-reaction
- disproportionation
- spontaneity
- standard reduction potential
- voltaic cell
- electrolytic cell
- electrolysis
- standard cell potential
- Faraday's law

• corrosion

General Outcome 1
Students will explain the nature of oxidation-reduction reactions.

Specific Outcomes for Knowledge
Students will:
30–B1.1k define oxidation and reduction operationally and theoretically
30–B1.2k define oxidizing agent, reducing agent, oxidation number, half-reaction, disproportionation
30–B1.3k differentiate between redox reactions and other reactions, using half-reactions and/or oxidation numbers
30–B1.4k 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
30–B1.5k compare the relative strengths of oxidizing and reducing agents, using empirical data
30–B1.6k predict the spontaneity of a redox reaction, based on standard reduction potentials, and compare their predictions to experimental results
30–B1.7k write and balance equations for redox reactions in acidic and neutral solutions by
• 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

30–B1.8k perform calculations to determine quantities of substances involved in redox titrations.

General Outcome 2
Students will apply the principles of oxidation-reduction to electrochemical cells.

Specific Outcomes for Knowledge
Students will:
30–B2.1k define anode, cathode, anion, cation, salt bridge/porous cup, electrolyte, external circuit, power supply, voltaic cell and electrolytic cell
30–B2.2k identify the similarities and differences between the operation of a voltaic cell and that of an electrolytic cell
30–B2.3k predict and write the half-reaction equation that occurs at each electrode in an electrochemical cell
30–B2.4k recognize that predicted reactions do not always occur; *e.g., the production of chlorine gas from the electrolysis of brine*
30–B2.5k explain that the values of standard reduction potential are all relative to 0 volts, as set for the hydrogen electrode at standard conditions
30–B2.6k calculate the standard cell potential for electrochemical cells
30–B2.7k 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
30–B2.8k calculate mass, amounts, current and time in single voltaic and electrolytic cells by applying Faraday's law and stoichiometry.

Unit C: Chemical Changes of Organic Compounds

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the learning outcomes.

• organic compounds
• naming organic compounds
• structural formulas
• structural isomers

- monomers
- polymers
- aliphatic and aromatic compounds
- saturated/unsaturated hydrocarbons
- functional groups identifying alcohols, carboxylic acids, esters and halogenated hydrocarbons
- esterification
- combustion reactions
- polymerization
- addition, substitution
- elimination

General Outcome 1
Students will explore organic compounds as a common form of matter.

Specific Outcomes for Knowledge

Students will:

30–C1.1k define organic compounds as compounds containing carbon, recognizing inorganic exceptions such as carbonates, cyanides, carbides and oxides of carbon

⟶ **Lab** *Organic Chem.* "Bonding Characteristics of Carbon"

30–C1.2k 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*

⟶ **Lab** *Organic Chemistry* "Functional Groups"

30–C1.3k 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*)

⟶ **Lab** *Organic Chemistry* "Straight-Chain Alkanes"

⟶ **Lab** *Organic Chemistry* "Cyclic Hydrocarbons"

⟶ **Lab** *Organic Chemistry* "Isomers of Alkenes and Alkynes"

30–C1.4k identify types of compounds from the hydroxyl, carboxyl, ester linkage and halogen functional groups, given the structural formula

⟶ **Lab** *Organic Chemistry* "Alcohols"

⟶ **Lab** *Organic Chemistry* "Carboxylic Acids"

⟶ **Lab** *Organic Chemistry* "Esters"

30–C1.5k define structural isomerism as compounds having the same molecular formulas, but with different structural formulas, and relate the structures to variations in the properties of the isomers

⟶ **Lab** *Organic Chemistry* "Isomers of the Alkanes"

30–C1.6k 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

⟶ **Lab** *Organic Chemistry* "Straight-Chain Alkanes"

30–C1.7k 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*.

Specific Outcomes for Skills (Social and Environmental Contexts Emphasis)
Initiating and Planning
Students will:
30–C1.1s formulate questions about observed relationships and plan investigations of questions, ideas, problems and issues
• design a procedure to identify types of organic compounds **(IP–NS1, IP–NS2, IP–NS3)**
• describe procedures for the safe handling, storage and disposal of materials used in the laboratory, with reference to WHMIS and consumer product labelling information **(IP–SEC3)**
• design a procedure to separate a mixture of organic compounds, based on boiling point differences **(IP–ST2, IP–ST3)**.

Performing and Recording
Students will:
30–C1.2s conduct investigations into relationships 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 **(PR–NS4) [ICT C6–4.4]**
• perform an experiment to compare the properties of organic compounds with inorganic compounds, considering properties such as solubility, viscosity, density, conductivity, reactivity **(PR–NS2, PR–NS3, PR–NS5)**.

⟶ *Builder,* "Entry-Level" and "Advanced" Panels

Analyzing and Interpreting
Students will:
30–C1.3s 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 **(AI–NS1)**
• compile and organize data to compare the properties of structural isomers; *e.g., pairs of hydrocarbon isomers and primary, secondary and tertiary alcohols* **(AI–NS1) [ICT C6–4.2]**
• interpret the results of a test to distinguish between a saturated and an unsaturated aliphatic, using aqueous bromine or potassium permanganate solutions **(AI–NS2)**
• *analyze the contributions and limitations of scientific and technological knowledge in societal decision making, in relation to the costs and benefits of societal use of petrochemicals, pharmaceuticals and pesticides* **(AI–SEC2) [ICT F3–4.1]**
• *explore aspects of present-day reliance on extracted or synthesized nutrients, with consideration of the synergy of compounds (reliance on vitamin supplements, meal replacements and nutraceuticals versus traditional methods of consuming natural foods)* **(AI–SEC2)**.

⟶ **Stockroom**, Many Examples of Organic Compounds

⟶ **Lab** *Organic Chemistry* "Isomers of the Alkanes"

⟶ **Lab** *Organic Chemistry* "Alcohols"

Communication and Teamwork
Students will:
30–C1.4s 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* **(CT–SEC2) [ICT P4–4.3]**.

General Outcome 2
Students will describe chemical reactions of organic compounds.

Specific Outcomes for Knowledge

Students will:
30–C2.1k define, illustrate and provide examples of simple addition, substitution, elimination, esterification and combustion reactions

⟶ **Lab** *Organic Chemistry* "Esters"

⟶ **Lab** *Organic Chemistry* "Example of a Nucleophilic Substitution"

30–C2.2k predict products and write and interpret balanced equations for the above reactions
30–C2.3k 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)*

⟶ **Miscellaneous** "Polymers" Section

30–C2.4k relate the reactions described above to major reactions that produce thermal energy and economically important compounds from fossil fuels.

Unit D: Chemical Equilibrium Focusing on Acid-Base Systems

Key Concepts

The following concepts are developed in this unit and may also be addressed in other units or in other courses. The intended level and scope of treatment is defined by the outcomes.

• chemical equilibrium systems
• reversibility of reactions
• Le Chatelier's principle
• equilibrium law expression
• equilibrium constants Kc , Kw , Ka , Kb
• acid-base equilibrium
• Brønsted–Lowry acids and bases
• titration curves
• conjugate pairs of acids and bases
• amphiprotic substances
• buffers
• indicators

General Outcome 1
Students will explain that there is a balance of opposing reactions in chemical equilibrium systems.

Specific Outcomes for Knowledge
Students will:
30–D1.1k 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

⟶ **Miscellaneous** *Equilibria* "The Dynamic Nature of Equilibria"

30–D1.2k identify, write and interpret chemical equations for systems at equilibrium
30–D1.3k 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

⟶ **Lab** *Equilibria* "Equilibrium and Temperature"

⟶ **Lab** *Equilibria* "Equilibrium and Pressure"

30–D1.4k define K_c to predict the extent of the reaction and write equilibrium-law expressions for given chemical equations, using lowest whole-number coefficients

30–D1.5k describe Brønsted–Lowry acids as proton donors and bases as proton acceptors
30–D1.6k 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
30–D1.7k identify conjugate pairs and amphiprotic substances
30–D1.8k 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.

General Outcome 2
Students will determine quantitative relationships in simple equilibrium systems.

Specific Outcomes for Knowledge
Students will:
30–D2.1k recall the concepts of pH and hydronium ion concentration and pOH and hydroxide ion concentration, in relation to acids and bases
30–D2.2k define K_w , K_a , K_b and use these to determine pH, pOH, $[H_3O^+]$ and $[OH^-]$ of acidic and basic solutions
30–D2.3k calculate equilibrium constants and concentrations for homogeneous systems and Brønsted–Lowry acids and bases (excluding buffers) when
- concentrations at equilibrium are known
- initial concentrations and one equilibrium concentration are known
- the equilibrium constant and one equilibrium concentration are known.