Chemistry, Grade 12

University Preparation SCH4U

This course enables students to deepen their understanding of chemistry through the study of organic chemistry, the structure and properties of matter, energy changes and rates of reaction, equilibrium in chemical systems, and electrochemistry. Students will further develop their problem-solving and investigation skills as they investigate chemical processes, and will refine their ability to communicate scientific information. Emphasis will be placed on the importance of chemistry in everyday life and on evaluating the impact of chemical technology on the environment.

Prerequisite: Chemistry, Grade 11, University Preparation

Big Ideas

Organic Chemistry
- Organic compounds have predictable chemical and physical properties determined by their respective structures.
- Organic chemical reactions and their applications have significant implications for society, human health, and the environment.

Structure and Properties of Matter
- The nature of the attractive forces that exist between particles in a substance determines the properties and limits the uses of that substance.
- Technological devices that are based on the principles of atomic and molecular structures can have societal benefits and costs.

Energy Changes and Rates of Reaction
- Energy changes and rates of chemical reactions can be described quantitatively.
- Efficiency of chemical reactions can be improved by applying optimal conditions.
- Technologies that transform energy can have societal and environmental costs and benefits.

Chemical Systems and Equilibrium
- Chemical systems are dynamic and respond to changing conditions in predictable ways.
- Applications of chemical systems at equilibrium have significant implications for nature and industry.

Electrochemistry
- Oxidation and reduction are paired chemical reactions in which electrons are transferred from one substance to another in a predictable way.
- The control and applications of oxidation and reduction reactions have significant implications for industry, health and safety, and the environment.

Fundamental Concepts Covered in This Course (see also page 5)

Fundamental Concepts	Organic Chemistry	Structure and Properties of Matter	Energy Changes and Rates of Reaction	Chemical Systems and Equilibrium	Electrochemistry
Matter					
Energy					
Systems and Interactions					
Structure and Function					
Sustainability and Stewardship					
Change and Continuity					

A. SCIENTIFIC INVESTIGATION SKILLS AND CAREER EXPLORATION

OVERALL EXPECTATIONS

Throughout this course, students will:

A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating);

A2. identify and describe careers related to the fields of science under study, and describe the contributions of scientists, including Canadians, to those fields.

SPECIFIC EXPECTATIONS

A1. Scientific Investigation Skills

Throughout this course, students will:

Initiating and Planning [IP]*

A1.1 formulate relevant scientific questions about observed relationships, ideas, problems, or issues, make informed predictions, and/or formulate educated hypotheses to focus inquiries or research

A1.2 select appropriate instruments (e.g., glassware, calorimeter, thermometer) and materials (e.g., chemical compounds and solutions), and identify appropriate methods, techniques, and procedures, for each inquiry

A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately

A1.4 apply knowledge and understanding of safe laboratory practices and procedures when planning investigations by correctly interpreting Workplace Hazardous Materials Information System (WHMIS) symbols; by using appropriate techniques for handling and storing laboratory equipment and materials and disposing of laboratory materials; and by using appropriate personal protection (e.g., wearing safety goggles)

Performing and Recording [PR]*

A1.5 conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data

A1.6 compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams

A1.7 select, organize, and record relevant information on research topics from a variety of appropriate sources, including electronic, print, and human sources, using suitable formats and an accepted form of academic documentation

Analysing and Interpreting [AI]*

A1.8 synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems involving quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and error; and suggest improvements to the inquiry to reduce the likelihood of error

A1.9 analyse the information gathered from research sources for logic, accuracy, reliability, adequacy, and bias

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions with reference to scientific knowledge

* The abbreviation(s) for the broad area(s) of investigation skills – IP, PR, AI, and/or C – are provided in square brackets at the end of the expectations in strands B–F to which the particular area(s) relate (see pp. 20–22 for information on scientific investigation skills).

Communicating [C]*

A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

A1.12 use appropriate numeric, symbolic, and graphic modes of representation, and appropriate units of measurement (e.g., SI units, imperial units)

A1.13 express the results of any calculations involving data accurately and precisely, to the appropriate number of decimal places and significant figures

A2. Career Exploration

Throughout this course, students will:

A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., food and drug analyst, chemical safety officer, nurse practitioner, consumer protection specialist, metallurgy technologist, environmental and waste management technician, geochemist) and the education and training necessary for these careers

A2.2 describe the contributions of scientists, including Canadians (e.g., Robert G. Ackman, Alice Wilson, Carol Ann Budd, Norman L. Bowen, Brian Evans Conway), to the fields under study

B. ORGANIC CHEMISTRY

OVERALL EXPECTATIONS

By the end of this course, students will:

B1. assess the social and environmental impact of organic compounds used in everyday life, and propose a course of action to reduce the use of compounds that are harmful to human health and the environment;

B2. investigate organic compounds and organic chemical reactions, and use various methods to represent the compounds;

B3. demonstrate an understanding of the structure, properties, and chemical behaviour of compounds within each class of organic compounds.

SPECIFIC EXPECTATIONS

B1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

B1.1 assess the impact on human health, society, and the environment of organic compounds used in everyday life (e.g., polymers, nutritional supplements, food additives, pharmaceuticals, pesticides) [AI, C]

Sample issue: Organic solvents can dissolve many substances such as paint, oil, and grease. They are used to produce plastics, dyes, detergents, textiles, and pharmaceuticals. However, workers exposed to organic solvents may experience long-term effects on their health. Also, solvents from industrial spills and leaks can leach into soil and groundwater, posing serious health and environmental risks.

Sample questions: What methods should be used to safely dispose of volatile organic compounds? What WHMIS symbols or Household Hazardous Waste Symbols (HHWS) should appear on containers of pesticides? Why are organic compounds added to food products? What impact can these additives have on human health?

B1.2 propose a personal course of action to reduce the use of compounds that are harmful to human health and the environment (e.g., weed lawns by hand rather than using herbicides, use cloth bags for shopping to reduce the number of plastic bags in landfill sites, choose fuel-efficient or hybrid vehicles to reduce fossil fuel emissions) [AI, C]

Sample issue: Many Ontario communities have banned the use of pesticides. As a consequence of these by-laws, many homeowners are seeking alternative ways of controlling weeds in their lawns.

Sample questions: How long does it take for plastic garbage bags to decompose in a landfill site? What biodegradable materials can be used to replace polystyrene as a packaging material? What are some technologies and features that are making new cars more fuel-efficient?

B2. Developing Skills of Investigation and Communication

By the end of this course, students will:

B2.1 use appropriate terminology related to organic chemistry, including, but not limited to: *organic compound, functional group, saturated hydrocarbon, unsaturated hydrocarbon, structural isomer, stereoisomer,* and *polymer* [C]

B2.2 use International Union of Pure and Applied Chemistry (IUPAC) nomenclature conventions to identify names, write chemical formulae, and create structural formulae for the different classes of organic compounds, including hydrocarbons, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, amines, amides, and simple aromatic compounds [AI, C]

B2.3 build molecular models for a variety of simple organic compounds [PR, AI, C]

B2.4 analyse, on the basis of inquiry, various organic chemical reactions (e.g., production of esters, polymerization, oxidation of alcohols, multiple bonds in an organic compound, combustion reactions, addition reactions) [PR, AI]

B3. Understanding Basic Concepts

By the end of this course, students will:

B3.1 compare the different classes of organic compounds, including hydrocarbons, alcohols, aldehydes, ketones, carboxylic acids, esters, ethers, amines, and amides, by describing the similarities and differences in names and structural formulae of the compounds within each class

B3.2 describe the similarities and differences in physical properties (e.g., solubility in different solvents, odour, melting point, boiling point) within each class of organic compounds

B3.3 explain the chemical changes that occur during various types of organic chemical reactions, including substitution, addition, elimination, oxidation, esterification, and hydrolysis

B3.4 explain the difference between an addition reaction and a condensation polymerization reaction

B3.5 explain the concept of isomerism in organic compounds, and how variations in the properties of isomers relate to their structural and molecular formulae

C. STRUCTURE AND PROPERTIES OF MATTER

OVERALL EXPECTATIONS

By the end of this course, students will:

C1. assess the benefits to society and evaluate the environmental impact of products and technologies that apply principles related to the structure and properties of matter;

C2. investigate the molecular shapes and physical properties of various types of matter;

C3. demonstrate an understanding of atomic structure and chemical bonding, and how they relate to the physical properties of ionic, molecular, covalent network, and metallic substances.

SPECIFIC EXPECTATIONS

C1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

C1.1 assess the benefits to society of technologies that are based on the principles of atomic and molecular structures (e.g., magnetic resonance imaging [MRI], infrared spectroscopy, X-ray crystallography, nuclear energy, medical applications of spectroscopy and mass spectrometry) [AI, C]

Sample issue: In medicine, radioisotopes are bonded with chemical compounds to form radioactive tracers, which are then injected into the patient's bloodstream. The radiation emitted by the tracers allows doctors to obtain images of organ systems, facilitating the early and accurate diagnosis of disease. However, to avoid radioactive contamination, care must be taken in the storage, use, and disposal of this material.

Sample questions: How does infrared spectroscopy aid in criminal investigations? How has the use of X-ray crystallography and mass spectrometry advanced our understanding of atomic and molecular structure? What social benefits are associated with such advances?

C1.2 evaluate the benefits to society, and the impact on the environment, of specialized materials that have been created on the basis of scientific research into the structure of matter and chemical bonding (e.g., bulletproof fabric, nanotechnologies, superconductors, instant adhesives) [AI, C]

Sample issue: Nanoparticles have many potential applications in medicine, including the improvement of drug delivery systems, the enhancement of diagnostic images, and use in surgical robotics, all of which could improve the effectiveness of our health care system. However, nanoparticle contamination can have a negative effect on the environment.

Sample questions: What precautions are taken to protect the health and safety of people working with nanoparticles? What properties of disposable diapers enable them to hold so much liquid? What impact has the widespread use of such diapers had on the environment? What impact has the development of synthetic fibres, such as nylon, had on society? What would your life be like if there were no plastics? In what ways has the invention of the silicon chip changed society?

C2. Developing Skills of Investigation and Communication

By the end of this course, students will:

C2.1 use appropriate terminology related to structure and properties of matter, including, but not limited to: *orbital*, *emission spectrum*, *energy level*, *photon*, and *dipole* [C]

C2.2 use the Pauli exclusion principle, Hund's rule, and the aufbau principle to write electron configurations for a variety of elements in the periodic table [AI, C]

C2.3 predict the shapes of simple molecules and ions (e.g., CH_4, SO_3, O_2, H_2O, NH_4^+), using the valence shell electron pair repulsion (VSEPR) model, and draw diagrams to represent their molecular shapes [AI, C]

C2.4 predict the polarity of various chemical compounds, based on their molecular shapes and the difference in the electronegativity values of the atoms [AI]

C2.5 predict the type of solid (ionic, molecular, covalent network, metallic) formed by a given substance in a chemical reaction, and describe the properties of that solid [AI]

C2.6 conduct an inquiry to observe and analyse the physical properties of various substances (e.g., salts, metals) and to determine the type of chemical bonding present in each substance [PR, AI]

C3. Understanding Basic Concepts

By the end of this course, students will:

C3.1 explain how experimental observations and inferences made by Ernest Rutherford and Niels Bohr contributed to the development of the planetary model of the hydrogen atom

C3.2 describe the electron configurations of a variety of elements in the periodic table, using the concept of energy levels in shells and subshells, as well as the Pauli exclusion principle, Hund's rule, and the aufbau principle

C3.3 identify the characteristic properties of elements in each of the *s*, *p*, and *d* blocks of the periodic table, and explain the relationship between the position of an element in the periodic table, its properties, and its electron configuration

C3.4 explain how the physical properties of a solid or liquid (e.g., solubility, boiling point, melting point, melting point suppression, hardness, electrical conductivity, surface tension) depend on the particles present and the types of intermolecular and intramolecular forces (e.g., covalent bonding, ionic bonding, Van der Waals forces, hydrogen bonding, metallic bonding)

C3.5 describe a Canadian contribution to the field of atomic and molecular theory (e.g., the work of Richard F.W. Bader of McMaster University on electronic density in small molecules; the work of Robert J. LeRoy of the University of Waterloo on the mathematical technique to determine the atomic radius of molecules known as the LeRoy Radius; the work of Ronald J. Gillespie of McMaster University on the VSEPR model)

D. ENERGY CHANGES AND RATES OF REACTION

OVERALL EXPECTATIONS

By the end of this course, students will:

D1. analyse technologies and chemical processes that are based on energy changes, and evaluate them in terms of their efficiency and their effects on the environment;

D2. investigate and analyse energy changes and rates of reaction in physical and chemical processes, and solve related problems;

D3. demonstrate an understanding of energy changes and rates of reaction.

SPECIFIC EXPECTATIONSP

D1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

D1.1 analyse some conventional and alternative energy technologies (e.g., fossil fuel–burning power plants, hydro-powered generators, solar panels, wind turbines, fuel cells), and evaluate them in terms of their efficiency and impact on the environment [AI, C]

Sample issue: The cooling of homes and commercial buildings in summer requires more energy than heating in the winter at peak times. Brownouts are more likely in summer than in winter. However, new technologies use deep lake water cooling as an alternative to conventional air conditioning systems in office towers. This significantly reduces energy use and its environmental impact.

Sample questions: What proportion of Ontario's energy needs is served by solar and wind technologies? What are the pros and cons of expanding the availability of these technologies? What types of chemical reactions occur in different types of fuel cells? What are the advantages and disadvantages, in terms of efficiency and environmental impact, of using corn to produce ethanol fuel?

D1.2 analyse the conditions (e.g., temperature, pressure, presence of a catalyst) required to maximize the efficiency of some common natural or industrial chemical reactions (e.g., decomposition, combustion, neutralization), and explain how the improved efficiency of the reaction contributes to environmental sustainability [AI, C]

Sample issue: Bleaches such as hydrogen peroxide and chlorine are used when fibres are processed into paper or textiles. Concentrations of these substances can harm the environment, but if enzymes are added to these processes as biocatalysts, fewer chemicals are needed, less energy is consumed, and there is less environmental impact.

Sample questions: How can you increase the rate of decomposition in a home composter? What can be done to improve the efficiency of an automobile that runs entirely on fossil fuels? Why is just a very small quantity of catalyst required in industrial processes? Why is the ozone layer still deteriorating despite the banning of chlorofluorocarbons (CFCs)?

D2. Developing Skills of Investigation and Communication

By the end of this course, students will:

D2.1 use appropriate terminology related to energy changes and rates of reaction, including, but not limited to: *enthalpy*, *activation energy*, *endothermic*, *exothermic*, *potential energy*, and *specific heat capacity* [C]

D2.2 write thermochemical equations, expressing the energy change as a ΔH value or as a heat term in the equation [AI, C]

D2.3 solve problems involving analysis of heat transfer in a chemical reaction, using the equation $Q = mc\Delta T$ (e.g., calculate the energy released in the combustion of an organic compound, and express the results in energy per mole of fuel [J/mol]) [AI, C]

D2.4 plan and conduct an inquiry to calculate, using a calorimeter, the heat of reaction of a substance (e.g., the heat of solution of ammonium nitrate, or of combustion of a hydrocarbon), compare the actual heat of reaction to the theoretical value, and suggest sources of experimental error [IP, PR, AI, C]

D2.5 solve problems related to energy changes in a chemical reaction, using Hess's law [AI]

D2.6 conduct an inquiry to test Hess's law (e.g., measure heats of reaction from the combustion of magnesium, and combine them to yield the ΔH value of the reaction) [PR, AI]

D2.7 calculate the heat of reaction for a formation reaction, using a table of standard enthalpies of formation and applying Hess's law [AI]

D2.8 plan and conduct an inquiry to determine how various factors (e.g., change in temperature, addition of a catalyst, increase in surface area of a solid reactant) affect the rate of a chemical reaction [IP, PR, AI]

D3. Understanding Basic Concepts

By the end of this course, students will:

D3.1 compare the energy changes resulting from physical change (e.g., boiling water), chemical reactions (e.g., bleaching a stain), and nuclear reactions (e.g., fission, fusion), in terms of whether energy is released or absorbed

D3.2 compare the energy change from a reaction in which bonds are formed to one in which bonds are broken, and explain these changes in terms of endothermic and exothermic reactions

D3.3 explain how mass, heat capacity, and change in temperature of a substance determine the amount of heat gained or lost by the substance

D3.4 state Hess's law, and explain, using examples, how it is applied to find the enthalpy changes of a reaction

D3.5 explain, using collision theory and potential energy diagrams, how factors such as temperature, the surface area of the reactants, the nature of the reactants, the addition of catalysts, and the concentration of the solution control the rate of a chemical reaction

D3.6 describe simple potential energy diagrams of chemical reactions (e.g., the relationships between the relative energies of reactants and products and the activation energy of the reaction)

D3.7 explain, with reference to a simple chemical reaction (e.g., combustion), how the rate of a reaction is determined by the series of elementary steps that make up the overall reaction mechanism

E. CHEMICAL SYSTEMS AND EQUILIBRIUM

OVERALL EXPECTATIONS

By the end of this course, students will:

E1. analyse chemical equilibrium processes, and assess their impact on biological, biochemical, and technological systems;

E2. investigate the qualitative and quantitative nature of chemical systems at equilibrium, and solve related problems;

E3. demonstrate an understanding of the concept of dynamic equilibrium and the variables that cause shifts in the equilibrium of chemical systems.

SPECIFIC EXPECTATIONS

E1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

E1.1 analyse the optimal conditions for a specific chemical process related to the principles of equilibrium that takes place in nature or is used in industry (e.g., the production of sulfuric acid, electrolyte balance in the human body, sedimentation in water systems) [AI, C]

Sample issue: The principle of dynamic equilibrium is used in industrial processes to maximize the concentration of products and minimize leftover reactants. Industrial chemists determine ideal pressure and temperature conditions, and proper catalysts, so that fewer materials and less energy are used.

Sample questions: Why are low temperature conditions not used with exothermic reactions? How do chemicals dissolved in human blood help maintain a blood pH level between 7.2 and 7.4?

E1.2 assess the impact of chemical equilibrium processes on various biological, biochemical, and technological systems (e.g., remediation in areas of heavy metal contamination, development of gallstones, use of buffering in medications, use of barium sulfate in medical diagnosis) [AI, C]

Sample issue: Heavy metals such as copper, lead, and zinc can accumulate to toxic levels in the human body. A process called chelation, which causes a chemical reaction involving an equilibrium shift, removes the metals from the body before permanent organ damage occurs.

Sample questions: Why are headache tablets buffered? Why is barium sulfate safe to use for X-rays of the digestive system even though barium ions are poisonous? How do kidney stones form?

E2. Developing Skills of Investigation and Communication

By the end of this course, students will:

E2.1 use appropriate terminology related to chemical systems and equilibrium, including, but not limited to: *homogeneous, closed system, reversible reaction, equilibrium constant, equilibrium concentration, molar solubility,* and *buffer* [C]

E2.2 predict, applying Le Châtelier's principle or the reaction quotient for a given reaction, how various factors (e.g., changes in volume, temperature, or concentration of reactants or products in a solution) would affect a chemical system at equilibrium, and conduct an inquiry to test those predictions [PR, AI]

E2.3 conduct an inquiry to determine the value of an equilibrium constant for a chemical reaction (e.g., K_{eq} for iron(III) thiocyanate, K_{sp} for calcium hydroxide, K_a for acetic acid) [PR, AI]

E2.4 solve problems related to equilibrium by performing calculations involving concentrations of reactants and products (e.g., K_{eq}, K_{sp}, K_a, pH, pOH, K_p, K_b) [AI]

E2.5 solve problems related to acid–base equilibrium, using acid–base titration data and the pH at the equivalence point [AI]

E3. Understanding Basic Concepts

By the end of this course, students will:

E3.1 explain the concept of dynamic equilibrium, using examples of physical and chemical equilibrium systems (e.g., liquid–vapour equilibrium, weak electrolytes in solution, reversible chemical reactions)

E3.2 explain the concept of chemical equilibrium and how it applies to the concentration of reactants and products in a chemical reaction at equilibrium

E3.3 explain Le Châtelier's principle and how it applies to changes to a chemical reaction at equilibrium

E3.4 identify common equilibrium constants, including K_{eq}, K_{sp}, K_w, K_a, K_b, and K_p, and write the expressions for each

E3.5 use the ionization constant of water (K_w) to calculate pH, pOH, $[H_3O^+]$, and $[OH^-]$ for chemical reactions

E3.6 explain the Brønsted-Lowry theory of acids and bases

E3.7 compare the properties of strong and weak acids, and strong and weak bases, using the concept of dynamic equilibrium

E3.8 describe the chemical characteristics of buffer solutions

F. ELECTROCHEMISTRY

OVERALL EXPECTATIONS

By the end of this course, students will:

F1. analyse technologies and processes relating to electrochemistry, and their implications for society, health and safety, and the environment;

F2. investigate oxidation-reduction reactions using a galvanic cell, and analyse electrochemical reactions in qualitative and quantitative terms;

F3. demonstrate an understanding of the principles of oxidation-reduction reactions and the many practical applications of electrochemistry.

SPECIFIC EXPECTATIONS

F1. Relating Science to Technology, Society, and the Environment

By the end of this course, students will:

F1.1 assess, on the basis of research, the viability of using electrochemical technologies as alternative sources of energy (e.g., fuel cells for emergency power generation or as power sources in remote locations), and explain their potential impact on society and the environment [IP, PR, AI, C]

Sample issue: Hydrogen fuel cells use hydrogen as the fuel and oxygen as the oxidant, and produce water, rather than environmentally harmful greenhouse gases, as waste. Although some cars run on such cells, practical problems must be resolved before this source of energy is commonly used in the transportation sector.

Sample questions: What is the capacity of a standard rechargeable battery before it has to be recharged? What methods should be used to dispose of depleted batteries? What impact has the use of rechargeable batteries in portable electronic devices had on society?

F1.2 analyse health and safety issues involving electrochemistry (e.g., corrosion of metal pipes in drinking water systems) [AI, C]

Sample issue: Corrosion is a leading cause of structural degradation of bridges and roadways. Not only does rust weaken metal structures, but as it builds up it forces apart connecting parts of the structure, causing the structure to fail and risking public safety. Yet, methods used to prevent corrosion may also have negative effects on human health.

Sample questions: What health and safety hazards are associated with waste generated by electroplating companies? Why do metal orthodontic braces not corrode? What are some of the toxic substances that can escape from electronic waste into the environment? What are the potential effects of these poisons on our health?

F2. Developing Skills of Investigation and Communication

By the end of this course, students will:

F2.1 use appropriate terminology related to electrochemistry, including, but not limited to: *half-reaction*, *electrochemical cell*, *reducing agent*, *oxidizing agent*, *redox reaction*, and *oxidation number* [C]

F2.2 conduct an inquiry to analyse, in qualitative terms, an oxidation-reduction (redox) reaction [PR, AI, C]

F2.3 write balanced chemical equations for oxidation-reduction reactions, using various methods including oxidation numbers of atoms and the half-reaction method of balancing [AI, C]

F2.4 build a galvanic cell and measure its cell potential [PR, AI]

F2.5 analyse the processes in galvanic cells, and draw labelled diagrams of these cells to show the oxidation or reduction reaction that occurs in each of the half-cells, the direction of electron flow, the electrode polarity (anode and cathode), the cell potential, and the direction of ion movement [AI, C]

F2.6 predict the spontaneity of redox reactions, based on overall cell potential as determined using a table of standard reduction potentials for redox half-reactions [AI]

F3. Understanding Basic Concepts

By the end of this course, students will:

F3.1 explain redox reactions in terms of the loss and gain of electrons and the associated change in oxidation number

F3.2 identify the components of a galvanic cell, and explain how each component functions in a redox reaction

F3.3 describe galvanic cells in terms of oxidation and reduction half-cells whose voltages can be used to determine overall cell potential

F3.4 explain how the hydrogen half-cell is used as a standard reference to determine the voltages of another half-cell

F3.5 explain some applications of electrochemistry in common industrial processes (e.g., in refining metals such as aluminum and zinc; in the production of hydrogen)

F3.6 explain the corrosion of metals in terms of an electrochemical process, and describe some common corrosion-inhibiting techniques (e.g., painting, galvanizing, cathodic protection)