Curriculum Development
In the Fairfield Public Schools

FAIRFIELD PUBLIC SCHOOLS

FAIRFIELD, CONNECTICUT

CHEMISTRY 31

Board of Education Approved 00/00/0000

CHEMISTRY 31

Statement Of Purpose

The study of Chemistry gives students an opportunity to use skills and processes of science to explore and explain the composition and interaction of matter. Students will investigate the nature of science and scientific knowledge, science as a human endeavor, historical perspectives, science as inquiry, and the link between science and technology. Students will have opportunities to move from concrete to abstract levels of thinking. Students examine the relationships between the structure of matter, its properties, and its interactions.

Audience

Academically motivated, high achieving grade 10 or 11 students who have successfully completed Biology 21 and are in the advanced sequence in math.

Prerequisites

Biology 21; Algebra 31 (may be taken concurrently)

Design and Description

Chemistry is the science dealing with the composition of materials and the qualitative and quantitative changes that these materials undergo. This advanced sequence course will provide students with a detailed and intricate knowledge of chemistry and will prepare students for entry into the advanced placement program. Major topics of study include: Atomic and molecular structure; chemical reactions; the periodic table; the separation of substances; energy in chemical change; and solutions.

Students will investigate these topics through a variety of classroom activities which include: pre-written and open-ended laboratory experiments; small group discussions; lectures and note taking; viewing videos; learning and applying problem-solving techniques; and relating chemical principles to daily experience. Students become aware of the role of chemistry in explaining natural phenomena and seeking solutions to human problems and needs.

Course Objectives

Students will be able to:

- Use dimensional analysis to convert and calculate chemical quantities.
- Correctly use significant digits in measurements and calculations.
- Differentiate between chemical and physical changes.
- Classify a substance as an element, compound, or mixture based on observable physical and chemical properties.
- Trace the development of the atomic theory.
- Relate atomic number, mass number, and location on the periodic table to subatomic particles.
- Write electron configurations for atoms of any element, and use these configurations to predict chemical behavior.
- Use the periodic table to predict the physical and chemical properties of elements.
- Describe and explain the processes of nuclear fission and fusion.
- Write and interpret a nuclear equation.

- Write the correct chemical formula for a given ionic or molecular compound.
- Calculate formula mass, molar mass and percent composition of a compound.
- Analyze and predict the shapes, bond angles, and polarities of molecules and polyatomic ions.
- Write, balance and classify a chemical equation.
- Predict the products of simple reactions, given the reactants.
- Analyze the mole concept and Avogadro's number as they relate to chemical formulas.
- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Calculate specific heats of substances, heats of reaction, heats of formation, and heats of combustion.
- Use the kinetic-molecular theory to describe changes of state and the relationships among pressure, temperature, volume and number of moles.
- Describe the solution process and the factors affecting solubility.
- Calculate the concentration of solutions and determine the effect of concentration on colligative properties.
- Use the concept of equilibrium to describe and explain physical and chemical changes.
- Write and calculate the value of the equilibrium constant for a given reaction.
- Use LeChâtelier's principle to predict and explain the shift in direction of a reversible reaction.
- Describe a precipitation reaction and use solubility product to predict precipitate formation.
- Use collision theory to describe and explain the factors that affect the rate of reaction.
- Use potential energy diagrams to illustrate and explain exothermic and endothermic changes, activation energy, and the effect of catalysts.
- Use the driving forces of enthalpy and entropy to determine the spontaneity of a physical or chemical change.
- Calculate the Gibbs free energy change of a chemical reaction and relate its value to spontaneity.
- Define, describe and classify acids, bases, and salts, and recognize their presence in common substances.
- Calculate ion concentrations and pH for a given solution.
- Describe the titration process and use it to determine the concentration of an unknown solution.
- Identify oxidation-reduction reactions in practical, everyday examples.
- Use conservation of electrons to identify oxidation numbers and balance redox equations.
- Describe electrochemical cells using oxidation-reduction reactions.

Standards

Atomic and Molecular Structure

The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure

The nucleus of the atom is much smaller than the atom yet contains most of its mass.

The quantum model of the atom is based on experiments and analyses by many scientists, including Dalton, Thomson, Bohr, Rutherford, Millikan, and Einstein.

The position of an element in the periodic table is related to its atomic number.

The periodic table can be used to identify metals, semimetals, non-metals, and halogens.

The periodic table can be used to identify trends in ionization energy, electronegativity, the relative sizes of ions and atoms and the number of electrons available for bonding.

The electronic configuration of elements and their reactivity can be identified based on their position in the periodic table.

Chemical Bonds

Biological, chemical, and physical properties of matter result from the ability of atoms to form bonds from electrostatic forces between electrons and protons and between atoms and molecules

Atoms combine to form molecules by sharing electrons to form covalent or metallic bonds or by exchanging electrons to form ionic bonds.

Chemical bonds between atoms in molecules such as H2, CH4, NH3, H2CCH2, N2, Cl2, and many large biological molecules are covalent.

Salt crystals, such as NaCl, are repeating patterns of positive and negative ions held together by electrostatic attraction.

The atoms and molecules in liquids move in a random pattern relative to one another because the intermolecular forces are too weak to hold the atoms or molecules in a solid form.

Lewis dot structures can provide models of atoms and molecules.

The shape of simple molecules and their polarity can be predicted from Lewis dot structures.

Electronegativity and ionization energy are related to bond formation.

Solids and liquids held together by van der Waals forces or hydrogen bonds that affect their volatility and boiling/melting point temperatures.

Conservation of Matter and Stoichiometry

The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants.

Chemical reactions can be described by writing balanced equations.

The quantity one mole is set by defining one mole of carbon-12 atoms to have a mass of exactly 12 grams.

One mole equals 6.02.x 1023 particles (atoms or molecules).

The molar mass of a molecule can be determined from its chemical formula and a table of atomic masses

The mass of a molecular substance can be converted to moles, number of particles, or volume of gas at standard temperature and pressure.

Hess's Law is used to calculate enthalpy change in a reaction.

Reaction Rates
Chemical reaction rates depend on factors that influence the frequency of collision of reactant molecules.

The rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.

Reaction rates depend on such factors as concentration, temperature and pressure.

Equilibrium is established when forward and reverse reaction rates are equal.

Catalyst plays a role in increasing the reaction rate by changing the activation energy in a chemical reaction.

Organic Chemistry and Biochemistry
The bonding characteristics of carbon allow the formation of many different organic molecules of varied sizes, shapes, and chemical properties and provide the biochemical basis of life.

Large molecules (polymers), such as proteins, nucleic acids, and starch, are formed by repetitive combinations of organic monomers.

The bonding characteristics of carbon result in the formation of a large variety of structures, ranging from simple hydrocarbons to complex biological molecules and synthetic polymers.

Amino acids are the building blocks of proteins.

UNITS of STUDY

Chemistry: An Introduction

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?

Focus Questions

Unit Objectives

Students will be able to:

- Differentiate between chemical and physical changes.
- Classify a substance as an element, compound, or mixture based on observable physical and chemical properties. Define the field of Chemistry and explain the importance of studying it.
- Describe several ways in which Chemistry affects daily life.
- List and describe the steps of the scientific method.
- Explain how a hypothesis may become a natural law.
- List and follow basic safety rules that must be followed when working in the laboratory.
- Explain the reason for each laboratory safety rule.
- Identify common laboratory equipment.
- Classify a substance as an element, compound, or mixture.
- Classify changes of matter as physical or chemical.
- State and apply the Law of Conservation of Matter/Energy.
- Separate a mixture of substances based on their physical and chemical properties.
- Distinguish between kinetic and potential energy.

Skill Objectives

Sample Assessment

Pacing

Measuring and Calculating

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?

Focus Questions

Unit Objectives:

Students will be able to:

- Use dimensional analysis to convert and calculate chemical quantities.
- Correctly use significant digits in measurements and calculations.
- Choose the correct SI unit for a given measurement and perform SI unit conversions.
- Distinguish among a quantity, a unit, and a measurement standard.
- Name SI units for length, mass, time, volume, temperature, energy, and density.
- Distinguish between mass and weight.
- Perform density calculations.
- Transform a statement of equality to a conversion factor.
- Solve problems using dimensional analysis.
- Write and perform calculations with numbers in scientific notation.
- Relate significant digits to uncertainty in measurement.
- Evaluate data using the concepts of accuracy and precision.
- Determine the number of significant digits in measurements and calculated results.
- Distinguish between inversely and directly proportional relationships.
- Draw, use, and interpret graphs of scientific data.
- Translate a calculated ratio into a meaningful written statement.
- Use correct problems solving techniques.

Skill Objective

Sample Assessment

Pacing

Formula Writing and Nomenclature

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?

- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Focus Questions

Unit Objectives:
Students will be able to:

1. Write the correct chemical formula for a given ionic or molecular compound.
2. Calculate formula mass, molar mass and percent composition of a compound.
3. Distinguish between ionic and molecular compounds.
4. Compare and contrast a chemical formula for a molecular compound with one for an ionic compound.
5. Explain the significance of a chemical formula.
6. Determine the formula of an ionic compound formed between two given ions.
7. Name an ionic compound given its formula.
8. Using prefixes, name a binary molecular compound from its formula.
9. Name binary molecular compounds using oxidation numbers and the Stock system.
10. Write the formula of a binary molecular compound given its name.
11. List the rules for assigning oxidation numbers.
12. Give the oxidation number for each element in the formula of a chemical compound.
13. Name and write formulas for acids, bases, polyatomic ions, and hydrates.
14. Name and write formulas for simple organic compounds.

Skill Objective

Sample Assessment

Pacing

Atoms: The Building Blocks of Matter

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?

Focus Questions

Unit Objectives
Students will be able to:

- Trace the development of the atomic theory.
- Relate atomic number, mass number, and location on the periodic table to subatomic particles.
- Write and interpret a nuclear equation.
- Describe and explain the processes of nuclear fission and fusion.
- Trace the historical development of atomic theory from early Greek models to present knowledge.
- State the postulates of Dalton's atomic model and use them to explain the Law of Conservation of Mass, and the Law of Definite Composition.
- Describe Thompson's cathode ray tube experiment and perform calculations using the charge to mass ratio.
- Describe Millikan's oil drop experiment and use the result to calculate the mass of an electron.
- Characterize the three types of radioactive decay and explain how knowledge of radioactivity was used in determining atomic structure.
- Describe Rutherford's gold foil experiment and interpret his observations.
- Name and describe the three major subatomic particles.
- Given the identity of a nuclide determine the number of protons, neutrons, and electrons in an atom.
- Diagram and explain ion formation.
- Define atomic number and mass number, and describe how they apply to isotopes.
- Calculate average atomic mass of an element, and calculate percentage abundance of an isotope given its average atomic mass.
- Explain how average atomic masses in the periodic table are based on the carbon-12 standard.
- Describe the changes that may occur in the nucleus a radioactive atom.
- Write and balance a nuclear equation.
- Define half-life, explain its significance, and calculate the amount of substance that remains after a given period of time.
- Define and describe the processes of nuclear fission and fusion.
- Describe how the events of the early 20^{th} century led to the development of nuclear weapons and nuclear energy.

Skill Objectives

Sample Assessment

Pacing

Electron Configuration

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?

Focus Questions

Unit Objectives:

Students will be able to:

- Write electron configurations for atoms of any element, and use these configurations to predict chemical behavior.
- Describe a wave in terms of its frequency, wavelength, speed, and amplitude.
- Explain the relationship between wavelength and frequency, and calculate one given the other.
- Diagram the electromagnetic spectrum showing trends in frequency, wavelength and energy.
- Calculate the energy of a photon.
- Explain how Bohr's model of the atom incorporated Planck's idea of quantization.
- Perform calculations using the Bohr model of the hydrogen atom.
- Explain how the quantum model of the atom exposes the limitations of the Bohr model.
- Explain what is meant by a quantum of energy.
- Explain how the Heisenberg uncertainty principle and the Schrödinger wave equation led to the idea of atomic orbitals.
- Discuss the dual nature of radiant energy.
- Observe, describe, and explain the difference between a line spectrum and a continuous spectrum.
- Draw and interpret the energy level diagram for electron order of filling.
- List the four quantum numbers, give their possible values, and explain their significance.
- Determine the four quantum number values for any electron in a given atom.
- Compare s, p, d, and f orbitals and sublevels in terms of size, shape, and energy.
- Relate the number of sublevels corresponding to each of an atom's main energy levels, the number of orbitals per sublevel, and the number of orbitals per main energy level.
- Write the electron configuration for any element using the Aufbau principle, the Pauli exclusion principle and Hund's rule.
- Describe and identify valence electrons.
- Draw the Lewis dot structure for any atom or ion.
- Relate the electron configuration of an atom to its reactivity and to its location in the periodic table.
- Explain the significance of the octet rule in reactivity and ion formation.

Skill Objectives

Sample Assessment

Pacing

Periodic Law

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Focus Questions

Unit Objectives

Students will be able to:

- Use the periodic table to predict the physical and chemical properties of elements.
- Describe the early attempts at classifying the elements and how they evolved into the modern periodic table.
- State and explain the periodic law.
- Explain the arrangement of the periodic table using periods, groups, blocks, and metallic character.
- Describe the relationship between electrons and sublevels and the length of each period of the periodic table.
- Relate group configurations to their group numbers.
- Describe the general properties of the main group elements.
- Describe and explain the trends in atomic mass, atomic number, atomic radius, electronegativity, ionic size, ionization energy, and electron affinity.

Skill Objectives

Sample Assessment

Pacing

Chemical Reactions and Equations

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?

- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Unit Objectives:
Students will be able to:
- Write, balance and classify a chemical equation.
- Predict the products of simple reactions, given the reactants.
- List and describe possible forms of evidence that a chemical reaction has occurred.
- Differentiate between reactants and products in a given chemical reaction.
- Use the Law of Conservation of Matter/Energy and coefficients to balance a chemical equation.
- Write the word equation, formula equation, and balanced chemical equation for a given chemical reaction.
- Interpret a balanced equation in terms of atoms, molecules, and ions.
- Classify a reaction as synthesis, decomposition, single replacement, double replacement, and combustion.
- Identify different types of single and double replacement reactions.
- Predict the products of simple reactions, given the reactants.
- Use the activity series of metals to predict whether a reaction will occur.
- Describe energy (ΔH) in a chemical reaction as a reactant or product.

Skill Objectives

Sample Assessment

Pacing

The Mole

Standards

Core Topics

Essential Questions
- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Unit Objectives:
Students will be able to:
- Calculate formula mass, molar mass and percent composition of a compound.

- Analyze the mole concept and Avogadro's number as they relate to chemical formulas.
- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Use Avogadro's number to define the mole and to calculate molecular and molar mass.
- Use dimensional analysis to convert among grams, moles, particles, and volume.
- Calculate the mass of a single atom or molecule.
- Calculate the molar mass of elements, compounds and hydrates.
- Define and describe molar volume of a substance, and list and describe factors that affect its value.
- Calculate percent composition for a given chemical compound.
- Determine empirical and molecular formula from percent composition data.
- Determine empirical and molecular formula from actual mass data.
- Determine empirical and molecular formula from analysis of experimental results.

Skill Objectives

Sample Assessment

Pacing

Mathematics of Chemical Equations

Standards

Core Topics

Essential Questions

- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Focus Questions

Unit Objectives:

Students will be able to:

- Calculate formula mass, molar mass and percent composition of a compound.
- Write, balance and classify a chemical equation.
- Predict the products of simple reactions, given the reactants.
- Analyze the mole concept and Avogadro's number as they relate to chemical formulas.
- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Calculate the molar mass of elements, compounds, and hydrates, and use molar mass in solving stoichiometry problems.

- Determine mole ratio from a balanced equation, and use mole ratio in solving stoichiometry problems.
- Calculate the amount in moles of a reactant or product from the amount in moles of a different reactant or product.
- Calculate the mass of a reactant or product from the amount in moles of a different reactant or product.
- Calculate the amount in moles of a reactant or product from the mass of a different reactant or product.
- Calculate the mass of a reactant or product from the mass of a different reactant or product.
- Describe a method for determining which or two reactants is a limiting reactant.
- Calculate the amount in moles or mass in grams of a product, given the amounts in moles or masses in grams of two reactants, one of which is in excess.
- Distinguish among theoretical yield, actual yield and percent yield.
- Calculate percent yield, given the actual yield, and quantity of a reactant.
- Calculate number of atoms, numbers of molecules, and volume occupied of a reactant or product in a stoichiometry problem.

Skill Objectives

Sample Assessment

Pacing

Thermochemistry

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Focus Questions

Unit Objectives

Students will be able to:

- Calculate formula mass, molar mass and percent composition of a compound.
- Write, balance and classify a chemical equation.
- Analyze the mole concept and Avogadro's number as they relate to chemical formulas.

- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Calculate specific heats of substances, heats of reaction, heats of formation, and heats of combustion.
- Use potential energy diagrams to illustrate and explain exothermic and endothermic changes, activation energy, and the effect of catalysts.
- Compare and contrast heat and temperature and state the units in which each is measured.
- Convert among the units of heat and temperature.
- Measure and recognize energy changes in chemical reactions.
- Use potential energy diagrams to illustrate and explain exothermic and endothermic changes, activation energy, and the effect of catalysts.
- Design and perform experiments that involve thermochemistry.
- Explain how a calorimeter is used to determine the quantity of heat transferred in a chemical reaction.
- Use calorimetry to experimentally determine the quantity of heat transferred in a chemical reaction.
- Calculate specific heats of substances, heats of reaction, heats of formation, and heats of combustion.
- State, use, and diagram Hess' law to determine enthalpy change for a chemical reaction.
- Determine the amount of energy stored in various foods and fuels.

Skill Objectives

Sample Assessment

Pacing

Behavior of Gases

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How do the interactions among particles determine and affect states of matter?

Focus Questions

Unit Objectives:

Students will be able to:

- Calculate formula mass, molar mass and percent composition of a compound.

- Write, balance and classify a chemical equation.
- Predict the products of simple reactions, given the reactants.
- Analyze the mole concept and Avogadro's number as they relate to chemical formulas.
- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Use the kinetic-molecular theory to describe changes of state and the relationships among pressure, temperature, volume and number of moles.
- Describe the kinetic-molecular theory and explain how it accounts for observed gas behaviors.
- List the postulates of the kinetic-molecular theory.
- List and describe the physical properties of gases.
- Explain and diagram how a barometer and a manometer work.
- Identify the four gas variables and convert among their measurement units.
- Give the values and explain the significance of standard temperature and pressure (STP).
- List and explain the contributions of Boyle, Charles, Avogadro, Gay-Lussac, Dalton, and Graham to knowledge of gas behavior.
- Perform calculations using Boyle's Law, Charles' Law, Avogadro's Hypothesis and Gay-Lussac's Law.
- Solve problems involving the combined gas law.
- Compare and contrast real and ideal gases.
- Use the ideal gas law to solve for P, V, T or n.
- Use kinetic-molecular theory to explain the combined and ideal gas laws.
- Solve problems using Dalton's Law and Graham's Law.
- Use volume ratios and the gas laws to calculate volumes, masses, particles, and molar amounts of gaseous reactants or products.
- Collect data to determine the molar volume of a gas.
- Identify and explain real world applications of the gas laws.

Skill Objectives

Sample Assessment

Pacing

Liquids and Solids: Condensed States

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How do the interactions between matter and energy produce changes in a system?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How do the interactions among particles determine and affect states of matter?

Focus Questions

Unit Objectives
Students will be able to:

- Use the kinetic-molecular theory to describe changes of state and the relationships among pressure, temperature, volume and number of moles.
- Describe the solution process and the factors affecting solubility.
- Describe the motion of particles in liquids and solids, and their properties, according to the kinetic-molecular theory.
- List and describe the different types of intermolecular forces.
- Describe how solids are classified, and list and describe the four categories of solids.
- Describe, on the molecular level, the processes of vaporization/condensation, freezing/melting, and sublimation/deposition.
- Draw and interpret a heating curve (Temperature/Heat Energy)
- Relate changes of state to the vapor pressure of a substance.
- Draw and interpret a phase diagram (P/T).
- Describe some of the unusual properties of water and relate those properties to hydrogen bonding.

Skill Objectives

Sample Assessment

Pacing

Chemical Bonding

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?

Focus Questions

Unit Objectives
Students will be able to:

- Relate atomic number, mass number, and location on the periodic table to subatomic particles.
- Write electron configurations for atoms of any element, and use these configurations to predict chemical behavior.
- Analyze and predict the shapes, bond angles, and polarities of molecules and polyatomic ions.
- Define a chemical bond and explain why most atoms form chemical bonds.
- Trace the formation of a chemical bond in terms of change in potential energy.
- Describe the distinguishing characteristics of an ionic bond.
- Compare and contrast covalent and ionic bonds.
- Compare and contrast the properties of ionic, covalent, metallic and network substances.
- Use orbital notation and Lewis dots to illustrate ionic and covalent bonding.
- Use the octet rule to illustrate and explain bonding.
- Describe the distinguishing characteristics of a covalent bond.
- Differentiate between a molecule and a formula unit.
- Illustrate and explain the meaning of single, double and triple bonds, and classify them as sigma and or pi bonds.
- Relate bond length to bond energy for single, double, and triple bonds, in covalent compounds.

Skill Objectives

Sample Assessment

Pacing

Solution Chemistry

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How do the interactions among particles determine and affect states of matter?
- How does the behavior of particles determine the properties of solutions?

Focus Questions

Unit Objectives

Students will be able to:

- Analyze and predict the shapes, bond angles, and polarities of molecules and polyatomic ions.
- Write, balance and classify a chemical equation.
- Describe the solution process and the factors affecting solubility.
- Calculate the concentration of solutions and determine the effect of concentration on colligative properties.
- Use the concept of equilibrium to describe and explain physical and chemical changes.
- Describe a precipitation reaction and use solubility product to predict precipitate formation.
- Use potential energy diagrams to illustrate and explain exothermic and endothermic changes, activation energy, and the effect of catalysts.
- Identify and characterize different types of solutions.
- Calculate the concentration of solutions in terms of molarity, molality and mole fraction.
- Given the concentration of a solution determine the amount of solute or solvent.
- Explain the formation of a solution in terms of particle behavior.
- Describe the factors that affect the rate of dissolving a solute and solubility.
- List and describe the four colligative properties of a solution.
- Calculate changes in freezing point and boiling point of electrolytic and non-electrolytic solutions.
- Compare and contrast dissolution and precipitation.
- Predict the formation of a precipitate given the reactants.
- Write the net ionic equation of a precipitation reaction.
- Predict the formation of a precipitate using the solubility product constant (Ksp).
- Relate precipitation to solubility.
- Explain the common-ion effect and how it shifts solubility equilibria.

Skill Objectives

Sample Assessment

Pacing

Chemical Kinetics

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?

- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How do physical and chemical factors influence the rate of chemical reactions?

Focus Questions

Unit Objectives

Students will be able to:

- Write, balance and classify a chemical equation.
- Calculate the concentration of solutions and determine the effect of concentration on colligative properties.
- Write and calculate the value of the equilibrium constant for a given reaction.
- Use collision theory to describe and explain the factors that affect the rate of reaction.
- Define the rate of a chemical reaction.
- Identify the intermediate products in a rate equation.
- Use the collision theory to interpret chemical reactions.
- Describe the role of energy in chemical reactions.
- Graph the reaction pathways of a reaction including the activation energy and complex.
- Describe the conditions necessary for a reaction to take place.
- List the factors that influence the rate of reactions using the collision theory.
- Calculate and interpret equations using the rate law.
- Describe the role of a catalyst and list the different types.

Skill Objectives

Sample Assessment

Pacing

Chemical Equilibrium

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How are equilibrium principles used to study reversible reactions?

Focus Question

Unit Objectives

Students will be able to:

- Write, balance and classify a chemical equation.
- Calculate the concentration of solutions and determine the effect of concentration on colligative properties.
- Use the concept of equilibrium to describe and explain physical and chemical changes.
- Write and calculate the value of the equilibrium constant for a given reaction.
- Use LeChâtelier's principle to predict and explain the shift in direction of a reversible reaction.
- Describe a precipitation reaction and use solubility product to predict precipitate formation.
- Use collision theory to describe and explain the factors that affect the rate of reaction.
- Describe reversible reactions.
- Calculate and explain the nature of the equilibrium constant.
- Write and calculate equilibrium expressions for reactions.
- Determine the extent of a reaction from its equilibrium constant.
- List the factors that cause a reaction to shift in equilibrium.
- Explain le Chatelier's Principle.
- Relate the Haber process to shifts in the equilibrium of a reaction.

Skill Objectives

Sample Assessment

Pacing

Thermodynamics

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How are equilibrium principles used to study reversible reactions?

Focus Questions

Unit Objectives

Students will be able to:

- Write, balance and classify a chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Calculate specific heats of substances, heats of reaction, heats of formation, and heats of combustion.
- Use the driving forces of enthalpy and entropy to determine the spontaneity of a physical or chemical change.
- Calculate the Gibbs free energy change of a chemical reaction and relate its value to spontaneity.
- Explain the relationship between enthalpy and entropy change and the tendency of a reaction to occur.
- Calculate, interpret and explain the concept of free energy.
- Use the change in free energy change to predict the likelihood of a reaction.
- State the criteria for reaction spontanaeity.

Skill Objectives

Sample Assessment

Pacing

Acids, Bases, and Salts

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How is mathematics used as a tool to investigate chemical concepts?
- What is the structure of matter, and how does it determine the physical and chemical properties of substances?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How are equilibrium principles used to study reversible reactions?
- How does the behavior of particles determine the properties of solutions?

Focus Questions

Unit Objectives

Students will be able to:

- Write, balance and classify a chemical equation.
- Calculate the quantity of a reactant or product in a balanced chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Describe the solution process and the factors affecting solubility.

- Calculate the concentration of solutions and determine the effect of concentration on colligative properties.
- Use the concept of equilibrium to describe and explain physical and chemical changes.
- Write and calculate the value of the equilibrium constant for a given reaction.
- Define, describe and classify acids, bases, and salts, and recognize their presence in common substances.
- Calculate ion concentrations and pH for a given solution.
- Describe the titration process and use it to determine the concentration of an unknown solution.
- Identify the common physical and chemical properties of acids and bases.
- Compare and contrite Arrhenius, and Bronsted-Lowry acids and bases.
- Describe and calculate the dissociation constant of an acid and a base.
- Categorize acids and bases based on strength.
- Use laboratory data to determine the strength of an acid or base.
- Explain the role of a conjugate acid or base.
- Calculate the ion concentrations in aqueous acids and bases.
- Calculate and describe the pH scale.
- Write an acid base neutralization reaction.
- Identify and describe a buffer and how it works.
- Perform an acid-base titration.
- Explain how indicators are used in a titration.
- Describe the equivalence point in a titration.

Skill Objectives

Sample Assessment

Pacing

Oxidation, Reduction and Electrochemistry

Standards

Core Topics

Essential Questions

- How are the nature and processes of science used to explain properties of matter?
- How does the Law of Conservation of Matter/Energy govern chemical concepts?
- How is mathematics used as a tool to investigate chemical concepts?
- How do the interactions between matter and energy produce changes in a system?
- How are the interactions of matter described in chemical reactions and equations, and how are those interactions related to their bonding and molecular shape?
- How are equilibrium principles used to study reversible reactions?
- How does the behavior of particles determine the properties of solutions?

Focus Questions

Unit Objectives

Students will be able to:

- Relate atomic number, mass number, and location on the periodic table to subatomic particles.
- Write, balance and classify a chemical equation.
- Measure and recognize energy changes in chemical reactions.
- Use the concept of equilibrium to describe and explain physical and chemical changes.
- Identify oxidation-reduction reactions in practical, everyday examples.
- Use conservation of electrons to identify oxidation numbers and balance redox equations.
- Describe electrochemical cells using oxidation-reduction reactions.
- Assign oxidation numbers to reactants and products and explain their significance.
- Write and balance an oxidation-reduction equation.
- Explain the Activity series of elements and if a reaction will proceed.
- List the applications of redox reactions.
- Explain the conservation of electrons in redox equations.
- Write half-reactions.
- Identify the oxidizing and reducing agents.
- Describe the components of an electrochemical cell.
- Experimentally test the electrical potential of a solution.
- Describe the nature of a voltaic cell.
- Relate standard electrode potentials to standard cell potentials.
- Explain the process of electroplating.
- Describe the chemistry of a disposable and rechargeable battery.
- Calculate the cell potentials from the table of standard electrode potentials.
- List some practical applications of electrolytic cells.

Skill Objectives

Sample Assessment

Pacing