Unit	Lesson	Lesson Objectives
Scientific Inquiry: The Scientific Process		
	Formulating Scientific Questions	
		Demonstrate how scientific questions are developed.
		Identify questions that can be answered through scientific investigations.
		Science Practice: Describe how scientific investigations lead to new scientific questions.
	Hypotheses, Laws, and Theories	
		Differentiate scientific hypotheses, theories, and laws.
		Give examples of how hypotheses lead to new experimentation.
		Identify the role of consensus and retesting in the development of theories.
		Science Practice: Create a chart comparing hypotheses, theories,and laws.
	Designing Scientific Investigations	
		Demonstrate how scientific questions are turned into investigations.
		Science Practice: Design and conduct a laboratory experiment to answer a specific question.
	Scientific Methods	
		Describe how scientists perform experiments and gather data.
		Describe the function of models in science, and recognize the usefulness and limitations of models as representations.
		Explain the importance of controlled tests in scientific investigations.
		Science Practice: Write a procedure for a controlled investigation to answer a question.
		Show how scientists communicate, share information, and support the importance of peer review.
	Safety in Science	
		Demonstrate safe practices while conducting investigations.
		Outline the correct protocol for reporting safety violations and accidents in the lab.
		Science Practice: Write a safety contract, revising as necessary.
		Use a material safety data sheet (MSDS) to learn about specific chemical hazards and proper chemical disposal.
	Tools, Technology, and Measurement	
		Science Practice: Use technology to display data in tables and graphs, and use the graphical representations to interpret the data.
		Select and use appropriate technology such as computers and graphing calculators to gather, analyze, interpret, and display data.
		Select and use appropriate tools to perform tests and collect data.
		Use the SI system of measurement to convert between standard and metric, and metric and metric, and to recognize approximate representations of measurement.
	Lab: Measurement	
		Demonstrate how scientific tools can be used to gather accurate measurements.
		Determine how to measure volume, mass, and density of regular and irregular objects.
		Science Practice: Develop a relationship between SI units and standard units.

Unit	Lesson	Lesson Objectives
	Using Math to Analyze Data	
		Create graphs and compare data points graphically.
		Explain the difference and relationship between accuracy and precision.
		Science Practice: Make measurements with accuracy and precision.
		Use mathematical error analysis to analyze data points.
	Scientific Notation and Significant Figures	
		Science Practice: Solve science-related math problems using scientific notation with the correct number of significant figures.
		Use appropriate numbers of significant figures for calculated data.
		Write measurements in scientific notation.
	Dimensional Analysis	
		Explain how dimensional analysis works.
		Science Practice: Convert between units using dimensional analysis.
		Solve scientific problems using dimensional analysis.
Scientific Inquiry: Analyzing and Communicating Scientific Information		
	Assessing Claims and Evidence	
		Assess the reliability of a variety of sources of scientific information.
		Evaluate the merit and accuracy of scientific claims based on supporting evidence.
		Identify the claims made within a scientific text.
		Science Practice: Critique scientific writing.
	Analyzing Evidence	
		Identify possible reasons for inconsistencies in scientific evidence.
		Predict trends by analyzing and evaluating data.
		Science Practice: Analyze how new technologies and experiments affect previous scientific explanations.
		Use evidence to critique scientific arguments.
	Science-Based Communication	
		Communicate results of a scientific investigation.
		Identify sources of error and justify valid conclusions.
		Science Practice: Justify the need for peer review in science.
	Science and Society	
		Investigate a scientific problem that affects society.
		Science Practice: Show how scientific evidence can affect societal decisions.

Unit	Lesson	Lesson Objectives
	The Progress of Scientific Knowledge	
		Analyze how new technologies and experiments affect previous scientific explanations.
		Describe the cumulative nature of science and give examples of how a diverse group of scientists have contributed to science.
		Explain why curiosity, creativity, openness, and skepticism are important in the progress of science.
		Science Practice: Summarize the history of a scientific discovery.
Structure of Atoms		
	The Historical Development of Atomic Theory	
		Describe early atomic models including Dalton's postulates.
		Describe how Rutherford's gold foil experiment led to Rutherford's nuclear model of the atom.
		Describe how Thomson's and Millikan's research led to the understanding of the electron in the early atomic model.
		Science Practice: Describe, in writing, how a scientist's creativity resulted in changes in atomic theory.
	The Modern Atomic Theory	
		Describe the experimental basis for Einstein's explanation of the photoelectric effect.
		Describe the modern (electron cloud) model of the atom.
		Explain Bohr's model of the atom and how it accounts for the existence of spectral lines.
		Science Practice: Compare Dalton's atomic model with the current quantum model of the atom.
	The Structure of the Atom	
		Describe the structure of atoms, and discriminate between the relative sizes and electrical charges of protons, neutrons, and electrons.
		Explain that protons and neutrons have substructures and consist of particles called quarks.
		Explain the relationship between the number of neutrons in an atom of an element, its mass number, and its isotopes.
		Identify an element based on the number of protons in an atom.
		Science Practice: Use math to calculate the average atomic mass of an element from its isotopic composition.
	Elements, Compounds, and Mixtures	
		Describe compounds as pure substances.
		Describe elements as pure substances.
		Describe mixtures.
		Science Practice: Classify matter as pure substances or mixtures by studying their properties.
	The History and Arrangement of the Periodic Table	
		Describe the arrangement of the periodic table and relate the properties of atoms to their position in the periodic table.
		Outline the historical development of the periodic table.
		Science Practice: Predict the properties of elements based on their position on the periodic table.
		Use the periodic table to classify elements.

Unit	Lesson	Lesson Objectives
	Atomic Numbers and Electron Configurations	
		Express the arrangement of electrons of atoms using electron configurations.
		Identify electron configurations as a scientific model, and explain its usefulness and limitations.
		Science Practice: Use specific symbols to represent the arrangement of electrons in atoms.
		Use atomic orbitals to write quantum numbers for electrons.
	Electrons and the Periodic Table	
		Relate the position of an element in the periodic table to its electron configuration.
		Science Practice: Analyze the relationship between electron configurations and the structure of the periodic table.
		Use the periodic table to determine the number of valence electrons available for bonding.
	Periodic Trends	
		Science Practice: Given two elements, make predictions that compare their radii, ionization energy, electronegativity, and/or electron affinity.
		Use the periodic table to identify and explain periodic trends in ionization energy.
		Use the periodic table to identify trends in electronegativity and electron affinity.
		Use the periodic table to predict trends in atomic radii and ionic radii.
Structure and Properties of Matter: Chemical Bonding		
	Types of Chemical Bonds	
		Compare and contrast ionic, metallic, and covalent bonds.
		Relate electronegativity and ionization energy to bond formation.
		Science Practice: Create a chart to compare and contrast ionic, metallic, and covalent bonds.
	Ionic Bonding	
		Describe how polyatomic ions form ionic bonds with other ions.
		Explain how ionic bonds affect the properties of ionic compounds.
		Explain how ionic bonds form.
		Explain that ionic compounds form crystal lattices.
		Science Practice: Explain the process by which ionic bonds form.
	Covalent Bonding	
		Construct electron-dot structures (i.e., Lewis structures) to illustrate the arrangement of electrons in covalent structures.
		Explain how covalent bonds affect the properties of covalent compounds.
		Science Practice: Develop and use electron-dot models, and explain their usefulness and limitations.
		Use the octet rule to predict covalent compounds.
		Use the periodic table to determine the number of electrons available for bonding.

Unit	Lesson	Lesson Objectives
	Lab: Ionic and Covalent Bonds	
		Design and conduct an experiment to test the properties of substances.
		Draw conclusions about the type of bond in a substance based on the tested properties of that substance.
		Science Practice: Compare your conclusions about the identity of the bonds in substances to published information about those substances.
	Metallic Bonding	
		Describe how metallic bonds form.
		Describe the properties of metals including thermal conductivity, electrical conductivity, malleability, and ductility.
		Science Practice: Apply the theory of metallic bonding to explain metallic properties.
	Intermolecular Forces	
		Describe how hydrogen bonding and van der Waals forces affect the volatility, boiling points, and melting points of liquids and solids.
		Describe hydrogen bonding.
		Describe van der Waals forces, including dipole-dipole forces and London dispersion forces.
		Science Practice: Give examples of intermolecular forces occurring in nature.
	Molecular Geometry	
		Predict molecular structure using the Valence Shell Electron Pair Repulsion (VSEPR) theory.
		Science Practice: Predict the shape of simple molecules using the VSEPR theory and Lewis structures.
		Use the hybridization model to predict molecular geometry.
Structure and Properties of Matter: States and Changes of Matter		
	Gases	
		Describe how kinetic-molecular theory explains the properties of gases, including temperature, pressure, compressibility, and volume.
		Describe the postulates of kinetic-molecular theory.
		Interpret the behavior of ideal gases in terms of kinetic-molecular theory, including diffusion and effusion.
		Science Practice: Identify the limitations of kinetic-molecular theory.
	Liquids	
		Describe how kinetic-molecular theory explains the properties of liquids, including compressibility and shape.
		Describe how the postulates of kinetic-molecular theory apply to liquids.
		Science Practice: Use the kinetic-molecular theory model to explain the behavior of liquids.
	Solids and Plasmas	
		Describe how kinetic-molecular theory explains the properties of plasmas.
		Describe how kinetic-molecular theory explains the properties of solids, including compressibility, shape, and volume.
		Science Practice: Give examples of plasmas in nature and technology.
		Use kinetic-molecular theory to compare and contrast atomic or molecular motion in solids and plasmas.

Unit	Lesson	Lesson Objectives
	Phase Changes	
		Describe phase changes in terms of kinetic-molecular theory.
		Describe the energy changes that happen during changes of state.
		Science Practice: Make and interpret graphs of temperature vs. time for changes of state.
	Changes in Matter	
		Differentiate between extensive and intensive properties of matter, and give examples of each.
		Differentiate between physical changes and chemical changes of matter.
		Differentiate between physical properties and chemical properties of matter.
		Science Practice: Identify substances based on their chemical and physical properties.
	Lab: Physical and Chemical Changes	
		Conduct systematic observations during an experiment.
		Describe indicators of chemical change.
		Distinguish between chemical changes and physical changes.
		Science Practice: Write a clear, coherent laboratory report that describes methods used and conclusions made.
Structure and Properties of Matter: The Gas Laws		
	Pressure	
		Explain how the motion of molecules relates to pressure.
		List units of pressure and give values for standard temperature and pressure (STP).
		Science Practice: Convert between units of pressure using dimensional analysis.
	Gas Laws	
		Apply Dalton's law of partial pressures to describe the composition of gases.
		Define partial pressure.
		Derive the combined gas law from Boyle's law, Charles's law, and Gay-Lussac's law.
		Science Practice: Make a table to compare the various gas laws.
		State Boyle's law, Charles's law, and Gay-Lussac's law, and apply these laws to calculate the relationships among volume, temperature, and pressure.
	Lab: Charles's Law	
		Calculate relationships between volume and temperature according to Charles's law.
		Perform an investigation that demonstrates the relationship between the volume and temperature of a gas.
		Science Practice: Analyze and interpret data gathered in an investigation about Charles's law.
	Lab: Boyle's Law	
		Calculate relationships between volume and pressure according to Boyle's law.
		Science Practice: Obtain, evaluate, and communicate information gathered in an investigation about Boyle's law.

Unit	Lesson	Lesson Objectives
	The Ideal Gas Law	
		Explain how Avogadro's law, or principle, can be combined with other gas laws to describe the relationships among pressure, temperature, volume, and number of moles of a gas.
		Science Practice: Use math to solve ideal gas law problems.
		Solve problems using the ideal gas law.
		State the ideal gas law, which relates pressure, temperature, and volume of an ideal gas.
Structure and Properties of Matter: Organic Chemistry and Compounds		
	Organic Compounds	
		Describe carbon's unique bonding characteristics that make the diversity of carbon compounds possible.
		Explain the difference between structural isomers and geometric isomers.
		Read and draw structural formulas of organic compounds.
		Science Practice: Use different models to represent the same idea (ball-and-stick models, space-filling models, and structural formulas) and explain the usefulness and limitations of each kind of model.
	Properties and Uses of Saturated Hydrocarbons	
		Describe the properties of straight-chain alkanes, branched-chain alkanes, and cycloalkanes.
		Identify uses of saturated hydrocarbons.
		Science Practice: Build vocabulary knowledge by learning how to name hydrocarbons.
		Use the system for naming the ten simplest linear hydrocarbons and isomers that contain single bonds.
	Properties and Uses of Unsaturated Hydrocarbons	
		Describe the properties of alkenes, alkynes, and aromatic hydrocarbons.
		Identify uses of unsaturated hydrocarbons including uses in pharmaceuticals, petrochemicals, plastics, and food.
		Science Practice: Describe different alkenes and alkynes that can be found in nature.
		Use the system for naming the ten simplest linear hydrocarbons and isomers that contain double bonds, triple bonds, and benzene rings.
	Functional Groups	
		Describe uses and natural occurrences of compounds containing functional groups.
		Identify the functional groups that form the basis of alcohols, ketones, ethers, amines, esters, aldehydes, and organic acids.
		Science Practice: Translate technical information expressed in words in a text about functional groups into a visual form, such as a chart.
	Carbohydrates and Lipids	
		Compare monosaccharides, disaccharides, and polysaccharides.
		Differentiate between saturated and unsaturated fats.
		Identify carbohydrates and where they are found in nature.
		Identify lipids and where they are found in nature.
		Science Practice: Describe the functions of carbohydrates and lipids in nature.

Unit	Lesson	Lesson Objectives
	Amino Acids and Proteins	
		Describe amino acids as the building blocks of proteins.
		Describe the biological functions of proteins.
		Describe the R-group structure of amino acids, and explain how amino acids combine to form the polypeptide backbone structure of proteins.
		Science Practice: Determine the meaning and analyze the relationships among the following terms: amino acids, proteins, and polymerization.
	Nucleic Acids	
		Describe RNA and explain how it is related to protein synthesis.
		Describe the structure and replication of DNA.
		Describe uses of genetic engineering.
		Science Practice: Evaluate the impact of genetic engineering on society.
	Organic Reactions	
		Compare addition polymerization and condensation polymerization.
		Explain that large molecules (polymers) are formed by repetitive combinations of simple subunits.
		Identify substitution, addition, condensation, and elimination reactions.
		Science Practice: Construct explanations on how polymers form.
Chemical Reactions: Types of Reactions		
	Evidence of Chemical Reactions	
		Explain what happens during a chemical reaction.
		Identify indicators of a chemical reaction.
		Science Practice: Compare scenarios to determine whether a chemical reaction has occurred.
	Writing and Balancing Chemical Equations	
		Describe chemical reactions by writing word equations and formula equations.
		Science Practice: Identify and use special symbols properly in chemical equations.
		Use the law of conservation of mass to balance chemical equations.
	Types of Reactions	
		Classify a reaction as synthesis, decomposition, single replacement, double replacement, or combustion.
		Identify and characterize the types of reactions, including synthesis, decomposition, combustion, single replacement, and double replacement.
		Science Practice: Predict the products of a reaction using the activity series.
		Use the activity series to determine whether a single replacement reaction will occur.

Unit	Lesson	Lesson Objectives
	Lab: Types of Reactions	
		Identify the reactants and products of a reaction performed in alaboratory setting.
		Science Practice: Use experimental data to classify a reaction.
		Write balanced equations for a reaction performed in a laboratory setting.
Chemical Reactions: Stoichiometry		
	Percent Composition and Molecular Formula	
		Determine the empirical formula and the molecular formula of a substance through calculations.
		Explain the relationship between the empirical formula and the molecular formula of a compound.
		Science Practice: Use math to solve percent composition problems and to determine empirical and molecular formulas.
		Solve problems to calculate percent composition.
	Molar Masses	
		Define a mole and explain its role in the measurement of matter.
		Determine the molar mass of a molecule from its chemical formula.
		Explain the relationship between the mole and Avogadro's number.
		Science Practice: Perform math calculations to determine the number of particles in a given sample of a substance.
	Introduction to Stoichiometry	
		Perform stoichiometric calculations to determine the mole-to-mole relationships between reactants and products of a reaction.
		Science Practice: Use mathematical procedures, including dimensional analysis and significant figures, when solving mole-to-mole stoichiometry problems.
		Use a balanced equation to write mole ratios correctly to use in stoichiometry problems.
	Stoichiometric Calculations	
		Identify and solve stoichiometric problems that relate mass to moles and mass to mass.
		Perform stoichiometric calculations to determine mass relationships between reactants and products of a reaction.
		Science Practice: Use mathematical procedures, including dimensional analysis and significant figures, when solving mole-to-mass, mass-to-mole, and mass-to-mass stoichiometric problems.
		Use molar mass to write conversion factors that convert between mass and moles.
	Gas Stoichiometry	
		Identify the molar volume of a gas at standard temperature and pressure.
		Perform stoichiometric calculations to determine mass and volume relationships between reactants and products for reactions involving gases.
		Science Practice: Calculate answers to the correct number of significant figures when solving gas stoichiometry problems.

Unit	Lesson	Lesson Objectives
	Limiting Reactant and Percent Yield	
		Calculate the percent yield of a reaction.
		Identify the limiting and excess reactants for a given reaction.
		Science Practice: Use mathematical procedures, including dimensional analysis and significant figures, when solving limiting reactant and percent yield stoichiometry problems.
		Use the limiting reactant to predict the theoretical yield of a reaction.
Chemical Reactions: Oxidation-Reduction Reactions		
	Oxidation-Reduction	
		Define oxidation and reduction, and identify oxidized and reduced species.
		Follow rules to assign oxidation numbers to atoms in compounds.
		Identify oxidation-reduction (redox) reactions.
		Science Practice: Establish context by describing oxidation-reduction reactions in living and nonliving systems.
	Oxidizing and Reducing Agents	
		Explain disproportionation.
		Identify oxidizing agents and reducing agents.
		Science Practice: Analyze the structure of the relationships among oxidation, reduction, oxidizing agents, and reducing agents.
		Use the relative strengths of oxidizing and reducing agents to predict an oxidation/reduction reaction.
	Balancing Oxidation-Reduction Equations	
		Science Practice: Develop the half-reaction procedure to solve scientific problems as an alternate method of balancing equations.
		Use the half-reaction method to balance oxidation-reduction equations.
		Write half-reactions for oxidation-reduction reactions.
	Electrolysis	
		Describe electrolysis.
		Explain why electrolysis is important in industry.
		Science Practice: Establish context by exploring industrial processes related to electrolysis.
	Fuel Cells	
		Describe drawbacks and limitations of fuel-cell cars.
		Describe fuel cells.
		Explain the benefits of fuel-cell cars.
		Science Practice: Investigate a science-based societal issue (i.e., the possible use of fuel-cell cars) by researching the literature and analyzing the data. Then, construct a defense for one side of the issue.
	Metabolism	
		Describe how cells use ATP.
		Explain how metabolism releases energy.
		Science Practice: Analyze a sequence (i.e., the ATP cycle) that is characteristic of natural phenomena.

Unit	Lesson	Lesson Objectives
Chemical Reactions: Understanding Solutions		
	Properties of Water	
		Describe how the structure of water accounts for its polarity.
		Describe the unique role of water in chemical and biological systems.
		Explain why water has unique properties including high surface tension and a high boiling point.
		Science Practice: Explain how the chemistry of water is important to biological systems.
	Mixtures and Solutions	
		Describe heterogeneous mixtures, including suspensions and colloids.
		Describe homogeneous mixtures, such as solutions.
		Identify nonaqueous solutions.
		Identify the components of a solution.
		Science Practice: Build vocabulary by properly using the terms *mixture, solution, solute,* and solvent.
	Solutions and Solubility	
		Define solubility and differentiate between saturated, supersaturated, and unsaturated solutions.
		Describe the dissolving process on the molecular level.
		Identify factors affecting the rate at which a substance dissolves.
		Investigate factors that influence solubility.
		Science Practice: Interpret, analyze, and make inferences from solubility graphs.
	Lab: Solubility	
		Accurately read the temperature in °C to know how temperature affects saturation.
		Formulate an investigative question to scientifically investigate how temperature affects solubility.
		Investigate how the temperature of a solvent affects the solubility of a solid.
		Science Practice: Plan and carry out an investigation to test factors affecting solubility.
	Measures of Concentration: Molarity	
		Calculate the concentration of solutions in units of molarity.
		Define concentration.
		Science Practice: Use mathematics and computational thinking to solve problems involving molarity.
		Solve stoichiometry problems involving molarity.
		Use molarity to calculate dilutions of solutions.
	Measures of Concentration: Molality and Other Calculations	
		Calculate the concentration of a solution in grams per liter, parts per million, and percent concentration.
		Calculate the concentration of a solution in terms of molality.
		Science Practice: Use different units to express concentrations and understand the relationships between the different measures of concentration.

Unit	Lesson	Lesson Objectives
	Colligative Properties	
		Describe the colligative properties of osmotic pressure and vapor pressure.
		Describe the relationship between the molality of a solute in solution and the solution's depressed freezing point or elevated boiling point.
		Explain why electrolytes and nonelectrolytes cause different changes in colligative properties.
		Science Practice: Establish context by exploring real-life experiences of colligative properties.
		Use molality to calculate the amount of freezing point depression and boiling point elevation.
	Reactions in Aqueous Solutions	
		Describe dissociation and ionization.
		Describe reactions in aqueous solutions, including the formation of a precipitate and the production of a gas.
		Distinguish between strong electrolytes, weak electrolytes, and nonelectrolytes.
		Science Practice: Analyze and interpret information to classify electrolytes (into strong, weak, and nonelectrolytes).
Chemical Reactions: Acids and Bases		
	Properties of Acids and Bases	
		Describe applications of acids and bases.
		Describe the observable properties of acids.
		Describe the observable properties of bases.
		Science Practice: Determine the meaning of the key terms *acid* and base as they are used in chemistry.
	Arrhenius, Bronsted-Lowry, and Lewis Acids and Bases	
		Describe the Arrhenius definitions of acids and bases.
		Describe the Bronsted-Lowry definitions of acids and bases.
		Describe the Lewis definitions of acids and bases.
		Identify conjugate acids and conjugate bases in a Bronsted-Lowry acid-base reaction.
		Science Practice: Describe how Arrhenius's, Bronsted's, Lowry's, and Lewis's competing interpretations of the same evidence are useful in different ways.
	pH	
		Convert between pH and hydrogen ion concentration, and between pOH and hydroxide ion concentration.
		Convert between pH and pOH, and between hydrogen ion concentration and hydroxide ion concentration.
		Define pH and pOH.
		Describe the self-ionization of water.
		Science Practice: Solve scientific problems involving pH using logarithmic functions.
		Use the pH scale to characterize the acidity and basicity of solutions.

Unit	Lesson	Lesson Objectives
	Lab: Measuring pH	
		Create a universal pH indicator using an everyday material.
		Measure the pH of various substances using a universal indicator and its key.
		Science Practice: Calibrate the scale for a pH indicator by comparing it to data measured using a known scale.
	Neutralization Reactions	
		Define salt and describe the observable properties of salts and salt solutions.
		Predict the products of acid-base neutralization reactions.
		Science Practice: Use domain-specific symbols to correctly write net ionic equations.
		Write equations and net ionic equations for neutralization reactions.
	Titration Reactions	
		Describe how to measure pH with indicators and meters.
		Describe the steps of the titration process.
		Explain the use of titration in chemistry.
		Science Practice: Construct an explanation of what happens during the titration process, and describe why each step of a titration is performed.
	Buffers	
		Describe buffers as substances that stabilize pH in acid-base reactions.
		Describe how buffers work, and identify the components of a buffer system.
		Science Practice: Apply concepts from chemistry and biology in order to analyze the role of buffers in blood.
Interactions of Energy and Matter: Reaction Rates and Equilibrium		
	Reaction Rate	
		Describe collision theory and how it is related to reactions.
		Explain how various factors, including concentration, temperature, and pressure, affect the rate of a chemical reaction.
		Explain the concept of reaction rate.
		Science Practice: Use the collision theory model to explain how reactions happen.
	Lab: Reaction Rate	
		Demonstrate the effects of changing temperature and particle size on the rate of a chemical reaction.
		Develop reasonable conclusions in an investigation about reaction rate and generate explanations for the observed results.
		Science Practice: Plan and perform controlled tests of multiple variables using repeated trials during an investigation about reaction rate.
	Reaction Pathways	
		Define and explain the role of the activation energy in a chemical reaction.
		Interpret reaction pathways.
		Science Practice: Interpret and make inferences from reaction pathway graphs.
		Use reaction pathway graphs to identify exothermic and endothermic reactions.

Unit	Lesson	Lesson Objectives
	Catalysts	
		Compare homogeneous and heterogeneous catalysts.
		Explain the role that a catalyst plays in increasing reaction rate.
		Science Practice: Apply the effects of a catalyst to everyday examples.
	Rate Laws	
		Explain the purpose of rate laws.
		Formulate a rate law by using exponential functions.
		Identify the order of a reaction and the order of individual reactants.
		Interpret a rate law in terms of reactant concentration changes.
		Science Practice: Solve scientific rate law problems using exponential functions.
	Reaction Mechanism and Rate-Determining Step	
		Define rate-determining step, and identify the rate-determining step in a reaction pathway.
		Explain what a reaction mechanism is and what intermediates are in a reaction mechanism.
		Science Practice: Use logic to formulate conclusions about the rate-determining step in a reaction given evidence or data about the reaction.
		Write the rate law for a reaction pathway.
	Reversible Reactions and Equilibrium	
		Explain dynamic equilibrium.
		Science Practice: Use scientific notation when solving problems to find the equilibrium constant for a reaction.
		Write equilibrium expressions, and use them to calculate the equilibrium constant for reactions.
	Shifts in Equilibrium	
		Science Practice: Translate technical information expressed in words about Le Chatelier's principle into a chart.
		Use Le Chatelier's principle to predict shifts in equilibrium caused by changes in pressure, concentration, and temperature.
		Use Le Chatelier's principle to predict shifts in equilibrium caused by the addition of a common ion to the system.
Interactions of Energy and Matter: Energy in Chemical Reactions		
	Energy	
		Describe the law of conservation of energy.
		Differentiate among the various forms of energy, including kinetic energy, potential energy, chemical energy, and thermal energy.
		Explain that energy can be transformed from one form to another.
		Science Practice: Integrate concepts from both chemistry and physics to analyze energy transformations and the conservation of energy.
	Temperature and Thermal Energy	
		Describe how temperature is measured.
		Convert temperature readings between different temperature scales.
		Descibe how thermal energy relates to temperature.
		Explain how temperature relates to kinetic energy.

Unit	Lesson	Lesson Objectives
	Heat	
		Describe heat flow in terms of the motion of atoms or molecules.
		Distinguish between exothermic chemical processes and endothermic chemical processes.
		Relate temperature to the average molecular kinetic energy.
		Science Practice: Analyze and interpret information about a reaction to classify the reaction as either an exothermic process or an endothermic process.
	Calorimetry	
		Define calorimetry and explain how calorimeters work.
		Differentiate between heat capacity and specific heat.
		Science Practice: Perform mathematical calculations involving heat, mass, temperature change, and specific heat.
		Solve problems involving heat flow and temperature changes to calculate the specific heat of a substance.
		Use calorimetry to calculate the heat of a chemical process.
	Lab: Calorimetry and Specific Heat	
		Demonstrate safe laboratory practices while using a calorimeter.
		Determine the specific heat of a metal using a calorimeter.
		Identify possible sources of procedural and mathematical errors in an experiment.
		Science Practice: Precisely follow a multistep procedure to build and use a calorimeter.
		Systematically collect, organize, record, and analyze data.
	Thermochemical Equations	
		Science Practice: Examine books and other sources of information to find standard enthalpies of formation to solve thermochemical problems.
		Understand the use of enthalpy in thermochemistry.
		Use thermochemical equations to calculate energy changes (i.e., enthalpy changes) that occur in a chemical reaction.
		Use thermochemical equations to calculate energy changes (i.e., enthalpy changes) that occur in a combustion reaction.
	Enthalpy of Reaction	
		Apply Hess's law to calculate enthalpy change in a reaction.
		Demonstrate how to produce an overall chemical equation from equations for intermediate reaction steps.
		Science Practice: Translate quantitative information expressed in words in a text into a visual form by drawing enthalpy diagrams.
	Enthalpy and Phase Changes	
		Analyze conceptually the flow of energy during changes of state (phase).
		Analyze quantitatively the flow of energy during changes of state (phase) using the molar enthalpies (heats) of fusion, solidification, vaporization, and condensation.
		Science Practice: Use appropriate scientific tools and techniques to gather and analyze data.

Unit	Lesson	Lesson Objectives
	Lab: Enthalpy	
		Collect data with accuracy and precision, and organize the data while doing repeated trials in an experiment about enthalpy and entropy.
		Determine the enthalpy change in a reaction by applying Hess's law.
		Know specific hazards of chemical substances used in an experiment about enthalpy and entropy as summarized on the MSDS.
		Science Practice: Develop reasonable conclusions about changes in enthalpy based on data collected.
		Select and use appropriate tools to gather and analyze data during an experiment about enthalpy and entropy.
	Enthalpy, Entropy, and Free Energy	
		Compare spontaneous and nonspontaneous reactions.
		Define free energy and use the Gibbs free energy equation to determine whether a reaction is spontaneous.
		Describe and give examples of entropy.
		Differentiate "enthalpy" and "entropy" and describe how enthalpy and entropy affect a reaction's spontaneity.
		Science Practice: Use mathematics to solve problems involving the Gibbs free energy equation.
Interactions of Energy and Matter: Nuclear Chemistry		
	The Nucleus	
		Differentiate chemical and nuclear reactions in terms of energy released.
		Explain how protons and neutrons in the nucleus are held together by nuclear forces.
		Explain why Einstein's equation $E = mc2$ is used to determine the nuclear binding energy.
		Identify some naturally occurring isotopes of elements that are radioactive.
		Science Practice: Analyze a sequence (i.e., radioactive decay) that is characteristic of natural phenomena.
	Types of Radioactive Decay	
		Differentiate between chemical reactions and nuclear reactions.
		Identify types of radioactive decay.
		Science Practice: Translate technical information expressed in words in a text about nuclear radiation into a visual form, such as a table, to compare the different types of radiation.
	Half-Life	
		Calculate the amount of a radioactive substance remaining after an integral number of half-lives have passed.
		Calculate the number of half-lives that have passed given mass data for the radioactive substance.
		Describe what a half-life is.
		Science Practice: Solve scientific problems by substituting quantitative values.
	Decay Series and Artificial Transmutation	
		Describe artificial transmutation.
		Explain why some elements decay via a decay series.
		Identify artificial radioactive elements on the periodic table.
		Science Practice: Analyze sequences and time frames of a decay series.

Unit	Lesson	Lesson Objectives
	Nuclear Fission and Nuclear Fusion	
		Explain and compare fission and fusion reactions.
		Relate the role of nuclear fusion to the production of essentially all elements heavier than helium.
		Science Practice: Justify the need for peer review in science.
	Nuclear Energy	
		Describe how nuclear power plants work.
		Describe the issues surrounding nuclear waste.
		Science Practice: Weigh the merits of using nuclear energy to solve society's need for electrical energy by comparing a number of human, economic, and environmental costs and benefits.
	Nuclear Radiation	
		Describe applications of radiation.
		Describe how radiation is measured and detected.
		Explain that alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and describe the effects of each kind of radiation on living things.
		Science Practice: Describe careers that involve working with radioactive substances.