



CHEMISTRY PACING GUIDE

FIRST QUARTER (46 days)				
UNIT (Storylines)	PACING	TOPICS (Investigations)	STANDARDS	LEARNING OBJECTIVES (Experiences)
44 days for standard based curriculum. 1-2 days should be taken for Lab Safety before the start of the 1 st lab procedure. REQUIRED: Each student must have a signed safety contract on file to perform analyses in the laboratory.				
Storyline 1: Atoms, Elements, and Molecules	7 Weeks	1. Atomic Structure	<ul style="list-style-type: none"> Chem1.PS1.1 Chem1.PS1.3 	<ul style="list-style-type: none"> The Particle Nature of Matter: Explore and explain the properties of matter. Students build upon what they already know about atoms, elements, molecules, and the three states of matter. Students investigate the flow of energy in a system. Modeling Atoms: Explore and explain the makeup and properties of atoms and isotopes. Students use mathematics to identify the mass number and atomic number of atoms. Students sketch atomic models with differing protons and use models to compare isotopes. Atomic Emission Spectra and the Bohr Model: Explore and explain the Bohr model of the atom and the atomic emission spectra of elements. Students identify an element that produces an unknown emission spectrum and reference Bohr's atomic model. Modern Atomic Theory: Explore and explain the modern model of the atom. Students relate the quantum mechanical model to the Bohr model. Students explore the atomic orbitals and the relative energies of the subshells. Electrons in Atoms: Explore and explain electron configurations of atoms. Students practice writing electron configurations and identify the patterns in the electron configurations. Students explore electron dot structures.
		2. The Periodic Table	<ul style="list-style-type: none"> Chem1.PS1.2 Chem1.PS1.5 	<ul style="list-style-type: none"> The Periodic Table: An Overview - Explain the periodic table and how it was developed according to the periodic law. Students construct explanations of the periodicity of the periodic table, note patterns in the table and make connections between the characteristics of atoms in the columns and rows of the table. The Periodic Table and Atomic Structure: Explore and explain how the periodic table is used to identify the atomic structure of elements. Students construct explanations of the pattern of electron configuration and effective nuclear charge across a period of main group elements of the periodic table. Students use Coulomb's law to explain effective nuclear charge of atomic particles. Periodic Trends: Explain various trends that appear in the periodic table and how they are related. Students use periodic trends to explain some chemical properties of elements. Students use the concepts of ionization energy, net effective charge, and atomic radius to explain reactivity patterns in the periodic table.
		3. Chemical Bonding	<ul style="list-style-type: none"> Chem1.PS1.3 Chem1.PS1.4 Chem1.PS1.5 	<ul style="list-style-type: none"> Ionic Bonds: Explore and explain the formation of ionic bonds and the properties of ionic compounds. Students explore the octet rule and how the electrostatic attractions between cations and anions form ionic bonds. Students describe how the structure of ionic compounds affect their properties.

				<ul style="list-style-type: none"> • Metallic Bonds: Explore and explain the properties of metals and to compare them to the properties of ionic compounds. Students explain how the bonding in metals and alloys affects their properties. Students describe the sea of electrons model, and they compare ionic and metallic bonds. • Covalent Bonds: Explore and explain covalent bonding and to analyze bond polarity. Students investigate molecular geometry and polarity. Students estimate the difference in electronegativities between two elements to determine polarity. • Intermolecular Attractions: Explain the differences in the properties of molecular substances as a result of intermolecular forces. Students explore hydrogen bonds. Students explain how intermolecular attractions between molecules affect the properties of a material. • Names and Formulas of Compounds: Explain the names and chemical formulas for ionic and molecular compounds. Students explain the rules for naming compounds and acids, including how to name a compound when given its formula. Students predict bond types in a compound based on its name or formula.
Storyline 2: Understanding Chemical Reactions	2 Weeks	TN 1	<ul style="list-style-type: none"> • Chem1.PS1.14 • Chem1.PS1.15 	<ul style="list-style-type: none"> • Solutions and Mixtures: Students learn how to calculate concentrations using units of parts per million (ppm) as an alternative to molarity. Students should recognize the similarity to calculating a percentage and should understand that ppm is useful for expressing extremely small concentrations. Students will learn about filtration and distillation as examples of separation methods.
		TN 2	<ul style="list-style-type: none"> • Chem1.PS3.3 	<ul style="list-style-type: none"> • Specific Heat and Calorimetry: Students learn about the physical property of specific heat by observing that the same amount of heat produces different changes in temperature for different materials. Students use the equation, $Q = mc\Delta T$, to perform calculations based on the relationship between heat lost or gained, temperature change, and the mass of a substance. Students will also learn how to apply this equation to measure the heat released or absorbed during a chemical or physical change. By applying the principle of conservation of energy, students can equate the energy change to the change in temperature of the water in a simple calorimeter.
		4. Physical Properties of Materials	<ul style="list-style-type: none"> • Chem1.PS1.2 • Chem1.PS1.4 • Chem1.PS1.11 • Chem1.PS1.13 • Chem1.PS3.1 • Chem1.PS3.2 	<ul style="list-style-type: none"> • States of Matter: Explore and explain the properties of different states of matter. Students describe three states of matter. Students explain behaviors of gases with changes in temperature, pressure, and volume, and relate intermolecular forces and the states of matter. • Modeling phase changes: Explore and explain the changes in energy during phase changes. Students investigate the behavior of particles in the different states of matter. They relate variations in kinetic energy among particles to constant evaporation and condensation, and interpret phase diagrams. • Comparing Ionic and Molecular Compounds: Explain the properties of ionic and molecular compounds. Students differentiate between the representative units of ionic and molecular compounds. Students relate the properties of compounds to the intermolecular forces and bonds between the particles. • Comparing metals and non metals: Explore and explain the properties of metals and non metals. Students explore delocalized electrons and their relationship to metallic properties. Students identify the defining properties of metals and compare metals and nonmetals and explain their differences. • Water and aqueous systems: Explore and explain the properties of water and aqueous systems. Students investigate polarity in hydrogen bonding between water molecules and how this bonding affects the surface tension, boiling point, and the formation of ice. Students model solvation within an aqueous solution.

SECOND QUARTER (39 days)

UNIT (Storyline)	PACING	TOPICS (Investigations)	STANDARDS	LEARNING OBJECTIVES (Experiences)
Storyline 2: Understanding Chemical Reactions	8 Weeks	4. Physical Properties of Materials	<ul style="list-style-type: none"> Chem1.PS1.13 	<ul style="list-style-type: none"> Properties of solutions: Explore and explain the properties of solutions. Students investigate the role of temperature and surface area in the formation of solutions. Students interpret solubility curves and factors that affect the solubility of a substance
		5. Chemical Quantities	<ul style="list-style-type: none"> Chem1.PS1.7 Chem1.PS1.13 Chem1.PS1.14 	<ul style="list-style-type: none"> The Mole Concept: Explore and explain moles and atomic mass. Students measure matter and count with moles. Students use mathematics to convert atoms to moles and find the molar mass of a compound. Molar Relationships: Explore and explain how the mole relates to mass, volume, and the number of particles. Students explore the mole-mass relationship. They use mathematics to convert moles to mass and mass to moles. Students interpret data on molar mass and density. Percent Composition and Empirical Formulas: Explore and explain percent composition and molecular formulas. Students use mathematics to calculate percent composition of a compound. Students determine empirical, molecular, and chemical formulas. Concentrations of Solutions: Explore and explain concentration and molarity. Students carry out an investigation of concentrations of solutions. Students use mathematics to calculate molarity and moles of solute in a solution. Students design a process for diluting an aqueous solution
		6. Chemical Reactions	<ul style="list-style-type: none"> Chem1.PS1.6 Chem1.PS1.9 Chem1.PS3.4 Chem1.PS3.5 	<ul style="list-style-type: none"> Modeling Chemical Reactions: Explore and explain how to model chemical reactions. Students balance word and chemical equations. Students investigate the law of conservation of energy. Students analyze data on what causes reactions. Predicting outcomes of chemical reactions: Explore and explain how to predict outcomes of chemical reactions. Students interpret data on different types of reactions. Students develop models of the different reactions. Students use models to predict the products of reactions. Reactions in aqueous solution: Explore and explain the nature of chemical reactions that occur in aqueous solution. Students balance net ionic equations. Students construct an explanation on solubility and intermolecular forces of a solution. Students predict the formation of a precipitate.
		7. Stoichiometry	<ul style="list-style-type: none"> Chem1.PS1.6 Chem1.PS1.7 Chem1.PS1.8 	<ul style="list-style-type: none"> Quantifying Reactants and Products: Explore and explain how the amounts of reactants and products are related to each other. Students explore equations as a recipe. Students construct an argument using evidence of how to quantify reactants and products. Students investigate what is conserved according to the law of conservation of mass. Chemical Calculations: Explore and explain stoichiometric calculations. Students use mathematical thinking to complete mole-mole, mass-mass, and volume-volume calculations. Students investigate a road map model for solving

				<p>stoichiometric problems. Students calculate molecules of a product.</p> <ul style="list-style-type: none"> • Limiting reagent and Percent Yield: Explore and explain limiting reagents and reaction yields. Students compare limiting reagents to limiting ingredients in a recipe. Students analyze and interpret data on mass of products and reactants. Students define and construct explanations on percent yield and then calculate percent yield.
		8. Thermochemistry	<ul style="list-style-type: none"> • Chem1.PS3.2 • Chem1.PS3.4 • Chem1.PS3.5 	<ul style="list-style-type: none"> • Energy in Chemical Bonds: Students construct explanations of collisions in reactions. Students develop a model of the flow of energy between a system and its surroundings. Students use data on bond enthalpies and estimate change in enthalpy. Students model enthalpy diagrams. • Enthalpies of Formation and Reaction: Explore and explain the enthalpy changes involved in various chemical processes. Students investigate Hess's law. Students sketch enthalpy diagrams and find the standard enthalpy of formation. Students design a solution for formulating a new compound to be used in a heat pack. Students use mathematics to calculate the standard enthalpy of reaction. • Enthalpy in Changes of State: Explore and explain the enthalpy changes involved in changes of state. Students explore heat during phase changes. Students construct an explanation related to the molar enthalpy of fusion. Students complete heat of fusion and vaporization phase-change calculations. Students graph data on changes of state and predict enthalpy of vaporization.
THIRD QUARTER (46 days)				
UNIT (Storylines)	PACING	TOPICS (Investigations)	STANDARDS	LEARNING OBJECTIVES (Experiences)
Storyline 3: The Chemistry of Climate Change	5 Weeks	9. The Behavior of Gases	<ul style="list-style-type: none"> • Chem1.PS.10 • Chem1.PS.11 • Chem1.PS.12 • Chem1.PS3.1 	<ul style="list-style-type: none"> • Properties of Gases: Students investigate gases and the effects of changes in volume, temperature, pressure and the number of particles. Students will use the kinetic theory to explain the properties of gases. • The Gas Laws: Students explore the gas laws of Boyle, Charles, Gay-Lussac and Avogadro and how the laws are combined into a single mathematic expression known as the combined gas law. • Ideal Gases: Students investigate how a real gas differs from an ideal gas. Students relate the interaction between gas particles at the molecular scale and patterns of gas behavior at the macroscopic scale. • Gases in Earth's Atmosphere: Explore and explain atomospheric gases in familiar scenarios. Students examine how the atmosphere's mixture of gases affects atmospheric pressure by applying Dalton's law of partial pressures. Students investigate what happens to air as it moves from an area of high pressure to an area of low pressure.
		10. Weather and Climate		<ul style="list-style-type: none"> • Earth's Surface Systems: Explore and explain activities to detect carbon dioxide and how carbon from familiar objects moves through the carbon cycle. Students investigate the water, carbon, and rock cycles. Students develop a model of reinforcing and counter balancing feedbacks. Students explore a model of land use in the United States.

				<ul style="list-style-type: none"> • Water and Energy in the Atmosphere: Explore and explain specific heat and its effects on climate. Students analyze models of convection in the atmosphere and pressure systems. Students explore colliding air masses. Students explain the pattern of evaporating water from certain currents. • Atmospheric System Feedbacks: Explore and explain climate forcing and atmospheric system feedbacks. Students construct an explanation for why crop lands would have a higher albedo than forests. Students design a solution for how humans can reduce carbon dioxide. • Long-Term Climate Factors: Explore and explain the factors that cause climate to change over very long periods of time. Students construct an explanation about what will happen to the ocean as the global temperature increases. • Short-Term Climate Factors: Explore and explain the short term and intermediate term factors that affect earth's climate. Students use computational thinking to calculate and explain earth's exposure to the sun's rays.
		11. Global Climate Change		<ul style="list-style-type: none"> • The Chemistry of Earth's Atmosphere: Explore and explain the chemistry of Earth's atmosphere and how it affects climate. Students investigate greenhouse gases. Students relate greenhouse gases to absorption of incoming and outgoing radiation. • Evidence of Climate Change: Explore and explain past changes to earth's climate. Students analyze data of ice cores, sea level changes, melting ice, human history, and tree rings. Students correlate the cause and effect of these pieces of evidence. • Anthropogenic Carbon Emissions: Explore and explain anthropogenic carbon emissions and their effects on Earth's atmospheric chemistry and climate. Students explain the role of fossil fuels and human consumption on climate change. • Climate Models: Explore and explain different models of weather and climate. Students investigate system models of climate change. Students analyze data of projected temperatures, sea level rise, and changes in extreme weather. • Consequences of Climate Change: Explore and explain the effects to Earth's systems of continued climate change. Students explore patterns of climate change consequences such as disappearing glaciers, coastal flooding, droughts, and spread of diseases. • Responses to Climate Change: Explore and explain responses and proposed solutions to climate change. Students examine how we respond to climate change in relation to energy sources, transportation, infrastructure, carbon capture and sequestration, geoengineering and sustainability.
Storyline 4: The Dynamics of Chemical Reactions and Ocean Acidification	4 weeks	12. Reaction Rates and Equilibrium	<ul style="list-style-type: none"> • Chem1.PS3.1 • Chem1.PS3.4 	<ul style="list-style-type: none"> • Rates of Reaction: Explore and explain the relationships among particle collisions, temperature, concentration and reaction rates. Students use mathematics to calculate and explain reaction rates. Students develop models of collision theory. • The Progress of Chemical Reactions: Explore and explain what is needed for colliding molecules to undergo chemical reaction. Students develop models for the energy changes that happen in one step and multi step reactions, including the underlying reason for those energy changes. • Reversible Reactions and Equilibrium: Explore and explain how reversible

				<p>chemical reactions respond to changing conditions. Students relate chemical equilibrium to everyday examples. Students explore Le Chatelier's principle. Students describe patterns in how temperature, concentration, and pressure affect equilibrium.</p> <ul style="list-style-type: none"> • Free Energy and Entropy: Explore and explain how entropy and free energy determine whether a physical or chemical process occurs. Students investigate enthalpy, free energy, and entropy. Students learn about four kinds of changes that increase the entropy of a system. Students use particle level models to explain entropy changes.
		13. Acid-Base Equilibria	<ul style="list-style-type: none"> • Chem1.PS1.16 	<ul style="list-style-type: none"> • Acids, Bases, and Salts: Explore and explain the properties of acids and bases and their effects on the pH of solutions. Students define acids and bases and explore conjugate acid-base pairs. Students investigate different models of acids and bases. Students analyze data on pH relationships. • Strong and Weak Acids and Bases: Explore and explain the differences between strong and weak acids and bases. Students analyze the difference between strong acids and bases and weak acids and bases. Students explore the relationship between H_3O^+ concentration and pH.

FOURTH QUARTER (44 days)

UNIT (Storylines)	PACING	TOPICS (Investigations)	STANDARDS	LEARNING OBJECTIVES (Experiences)
Storyline 4: The Dynamics of Chemical Reactions and Ocean Acidification	2 Weeks	13. Acid-Base Equilibria	<ul style="list-style-type: none"> • Chem1.PS1.16 	<ul style="list-style-type: none"> • Reactions of Acids and Bases: Explore and explain neutralization reactions and acid-base titrations. Students explore acid-base neutralization reactions. Students investigate titrations with strong/weak acids and bases. Students use mathematical thinking to determine concentration by titration. • Buffers and Equilibria: Explore and explain how the components of a buffer system work together to maintain pH. Students classify and model salt solutions. Students discover patterns in buffers. Students describe buffer systems and explore examples of them.
		14. Ocean Acidification		<ul style="list-style-type: none"> • Ocean pH levels: Explore and explain ocean pH and acidification. Students describe the patterns of ocean flow. Students construct explanations on ocean salinity and alkalinity. Students apply LeChatelier's principle to predict future ocean pH. • The Ocean as a Carbon Sink: Explore and explain how carbon dioxide is exchanged between the ocean and the atmosphere. Students analyze data on carbon accumulation. Students explore carbon in the biosphere. Students explain stability and change of methane hydrates. • The Ocean and Climate Change: Explore and explain how the ocean influences Earth's climate. Students analyze data of ocean surface currents. They develop models of the Coriolis effect. Students explore deep ocean

				<p>currents. Students use computational thinking to explain ocean deoxygenation and construct explanations of thermoclines. Students identify patterns in El Nino and La Nina events.</p> <ul style="list-style-type: none"> • Consequences of Ocean Acidification: Explore and explain the effects of ocean acidification. Students explore calcification. They explain marine shell dissolution of organisms. Students explain the importance of coral reefs and the detriment of coral bleaching. Students develop models of aragonite maps. They use mathematical thinking to calculate rates of change in the ocean.
Storyline 5: Industrial Applications	7 Weeks	15. Oxidation-Reduction Reactions	<ul style="list-style-type: none"> • Chem1.PS1.9 	<ul style="list-style-type: none"> • Oxidation vs. Reduction: Explore and explain the processes of oxidation and reduction. Students focus on redox reactions at the atomic level. • Modeling Redox Reactions: Explore and explain how to model redox reactions. Students use models of redox reactions to learn how to balance redox reactions using oxidation states and half-reactions. • Electrochemical Cells: Explore and explain how electrochemical cells function. Students investigate the energy transformations that occur when energy is produced, stored and used.
		16. Organic Chemistry		<ul style="list-style-type: none"> • Hydrocarbons: Explore and explain the structures and properties of hydrocarbons and the energy stored within hydrocarbons. Students are introduced to hydrocarbon structure and how saturation and isomerization influence hydrocarbon properties. Students relate the degree of saturation in a hydrocarbon to the average oxidation state of the atoms. • Functional Groups and Polymers: Explore and explain identifying compounds using functional groups and synthesizing polymers. Students explore the functional groups that add to the carbon backbone of organic compounds. They learn about different organic reactions (substitution, addition, condensation, and polymerization). • The Chemistry of Life: Explore and explain the chemical composition of biomolecules such as starch, maino acids, and proteins. Students are introduced to the classes of biomolecules (carbohydrates, proteins, lipids, nucleic acids), including their structures and functions. Students also explore cellular respiration.
		17. Nuclear Processes	<ul style="list-style-type: none"> • Chem1.PS1.17 • Chem1.PS1.18 	<ul style="list-style-type: none"> • Radioactivity and Half-Life: Explore and explain radioactive decay chains and how to model radioactive decay processes. Students explore the fundamental particles, the major types of radioactive decay, transmutation, strong and weak nuclear forces, and half life. Students calculate the age of old materials using radiometric dating. • Fission and Fusion: Explore and explain how particles change and energy

				<p>is released during the processes of fission and fusion. Students investigate fission, fusion, artificial transmutation, solar fusion, and the star life cycle. Students explore patterns in the binding energies of elements and the conversions between mass and energy.</p> <ul style="list-style-type: none"> • Nuclear Technologies: Explore and explain the health risks of nuclear radiation. Students learn about the opportunities and risks associated with nuclear technologies and the damaging effects of ionizing radiation and cosmic rays. Students investigate how fission and fusion reactors generate electricity and the use of radiation in medicine.
		18. Green Processes		<ul style="list-style-type: none"> • Industrial chemicals and the Environment: Explore and explain industrial chemical processes and why the field of green chemistry began. Students explore the chemical industry and its challenges resulting from limited feedstocks, rising energy costs, and expanded regulations. • Principles of Green Chemistry: Explore and explain the use of different types of catalysts and to revise a chemical process to make it greener. Students explore the 12 principles of green chemistry and draw information from various chemistry concepts from their past learning. • Designing Sustainable Chemical Processes: Explore and explain how green chemistry can be applied to improve industrial processes and why waste prevention is advantageous for a company. Students explore tradeoffs and synergies among green chemistry principles. Students learn about the triple bottom line. Students explore sustainable management of resources, waste, and energy.