Chemistry

Unit 1 – Matter and Measurement

Big Ideas	Essential Question	Concepts	Competencies	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Chemistry and chemicals have a central place in science, and safe chemical practices are the basic and most fundamental parts of any lesson.	Why should students acquire good chemical safety habits?	Chemicals are hazardous, but they all can be used safely if we know how to control their hazardous characteristics while we use them.	Demonstrate safe practices during laboratory investigations including the use of safety showers, eyewash fountains, safety goggles, aprons and fire extinguishers.	Safety goggles Apron Fire blanket Fire extinguisher Eyes wash station Emergency shower Fire alarm Flammability Toxicity		The Chem Games Video on Lab Safety Flinn Safety Multiple Choice Lab Equipment Matching
Scientists use specific methods to investigate problems.	How can one explain the structure, properties and interactions of matter?	Everything can be classified as matter, energy or space.	Identify five traditional areas of study in chemistry Relate pure and applied chemistry. Explain why collaboration and communication are important in science.	Matter Chemistry Organic chemistry Inorganic chemistry Biochemistry Analytical chemistry Physical chemistry Pure chemistry	A.1.1.1	

				Applied chemistry Technology		
Scientists use specific methods to investigate problems.	How can one explain the structure, properties and interactions of matter?	A systematic process for investigating and solving problems must be followed to generate repeatable, verifiable results.	Apply the scientific method to various scenarios in an attempt to solve a problem. Identify independent variable, dependent variable constants and use those to write an if … then . . . because statements for the hypothesis.	Observation Hypothesis Independent Variable Dependent Variable If … then…because statements Experiment Analyze Theory Law		Mr. Edmonds "Scientific Method Song" https://www.youtube.com/watch?v=WEXMB5wsl0w Spongebob and The Simpson's Scientific Method Scenarios.
Chemistry is the study of matter and the changes it undergoes. Periodic trends in the properties of atoms allow for the prediction of physical and chemical properties	What are differences between pure substances and mixtures? How does the distribution of electrons affect the formation of a compound?	Changes in mater can be chemical or physical. Elements and compounds are identified as pure substances according to the law of definite composition. Different compounds can be formed from different combinations of the same elements according to the	Identify properties of matter as extensive or intensive. Define physical property and list several common physical properties of substances. Differentiate among three states of matter. Identify and distinguish between mixtures, elements, and compounds.	Mass Volume Extensive property Intensive property Substance Physical property Solid Liquid Gas Vapor Physical change Mixture	A.1.1.1 A.1.2.2	Fill it Up Lab Matter Flow Chart – Graphic Organizer Law of Conservation of Mass Lab (Alka-Seltzer)

		law of multiple proportions. Observations of matter can be qualitative, quantitative, direct or indirect. Physical properties of matter can be classified as intensive or extensive. Mixtures can be separated by physical means because the different components have different properties. Matter cannot be created or destroyed.	Describe and identify characteristics of physical change and chemical changes. Identify the chemical symbols of elements, and name elements, given their symbols. Apply the law of conservation of mass to chemical reactions.	Heterogeneous mixture Homogeneous mixture Solution Phase Filtration Distillation Element Compound Chemical change Chemical symbol Chemical property Chemical reaction Reactant Product Precipitate Law of Conservation of Mass		

There are many units with different origins to measure different quantities.	What are the systems of measurement used and how do you use those systems to accurately and precisely reflect your measurement?	The use of significant figures assures that quantitative observations are both accurate and precise.	Draw and explain a diagram of accuracy versus precision. Convert measurements to scientific notation. Determine the significant figures in a measurement and in a calculated answer. List SI units of measurement and common SI prefixes. Make measurements using the appropriate standard for that measurement in the metric system. Convert between Celsius and Kelvin scales. Compute conversions of units between English and metric systems using dimensional analysis. Calculate density using the water displacement method. Calculate density from mass and volume using graphing techniques. Convert complex units, using dimensional analysis.	Accuracy Precision Qualitative Quantitative Measurement Scientific notation Significant (digit) figures International System of Units (SI) Meter Liter Kilogram Temperature Celsius Kelvin Absolute zero Conversion factor Dimensional analysis Density Percent error	A.1.1.2 A.1.1.3	Measurement of all things Part 1 – Time and Distance (BBC) Measuring Significant Digit Lab (Graduated Cylinder) Measurement and Conversion Lab Mass and Volume Lab (Density)

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Unit 2 – Structure of the Atom and Arrangement of the Periodic Table

Big Ideas	Essential Question	Concepts	Competencies	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Atomic theory is the foundation for the study of chemistry.	In what ways has the theory of the atom changed over time due to technological improvements?	All matter is made up of atoms. Atoms are the smallest pieces of an element that still retain the properties of that element. Isotopes are atoms of the same element with different numbers of neutrons. Average atomic masses of the elements are reported on the periodic table. The theory of the atom has changed over time because of improvements in technology.	Describe Democritus's ideas about atoms. Explain Dalton's atomic theory. Identify three types of subatomic particles. Describe the structure of atoms according to the Rutherford atomic model. Explain what makes elements and isotopes different from each other. Calculate the number of neutrons in an atom. Calculate the atomic mass of an element. Identify the inadequacies in the Rutherford model. Describe the Bohr model of the atom.	Dalton's Theory Atom Cathode Ray Electrons Protons Neutrons Nucleus J.J. Thomson Robert Millikan Millikan Oil Drop Experiment Gold Foil Experiment Atomic number Mass number Isotopes Atomic mass unit Atomic mass Periodic table Period	A.1.1.4 A.2.1.1 A.2.1.2	POGIL – Average Atomic Mass POGIL – Isotopes History of atom Part I Video (SciShow) History of the atom Part II Video (SciShow)

			Describe the energies and positions of electrons according to the quantum mechanical model.	Group Energy levels Plum Pudding Model Nuclear Model Bohr Model Quantum Quantum Mechanical Model Atomic orbital		
Periodic trends in the properties of atoms allow for the prediction of physical and chemical properties.	How does the distribution of electrons in the atoms affect the formation of compounds?	Properties of matter can be explained by its atomic or molecular structure. Trends in the periodic table can predict the properties and behaviors of elements. Chemical periodicity is the basis for the arrangement of the periodic table.	Explain how elements are organized in a periodic table. Compare early and modern periodic tables. List and describe properties and locations on the periodic table of metals, nonmetals and metalloid. Label and give properties of for the families of the periodic table. Describe trends of the periodic table such as atomic radius, ionization energy and electronegativity.	Periodic Law Metals Nonmetals Metalloid Alkali Metals Alkaline Earth Metals Transition Metals Aluminum Family Carbon Family Nitrogen Family Chalcogens Halogens Noble Gases	A.2.3.1 A.2.3.2	The Elements Video (Discovery Channel) Properties of the Elements DVD's (Discovery Channel) Tom Lehrer's Animated Periodic Table Son (YouTube) Nova "Hunting the Elements" Series Graphing Trends of the Periodic Table Activity

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Unit 3 – Nomenclature and Chemical Quantities

Big Ideas	Essential Question	Concepts	Competencies	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Chemistry is the study of matter and the changes it undergoes.	What are the differences between pure substances and mixtures?	Formula writing and naming of compounds follows a systematic set of rules.	Determine the number of valence electrons in an atom of a representative element. Explain how the octet rule applies to atoms of metallic and nonmetallic elements. Describe how cations and anions form. Describe periodic trends for properties of ions such as ionic radius. Identify the charges of monatomic ions by using the periodic table, and name the ions. Explain the electrical charge of an ionic compound. Apply the rules of naming and writing formulas for binary ionic compounds. Define a polyatomic ion and write the names and	Valence electrons Electron Dot Structures Octet Rule Anion Cation Chemical formula Monatomic ion Polyatomic ion Binary Compound Ionic Compound Covalent Compound Law of definite proportions Law of multiple proportions	A.2.2.2 A.1.1.4 A.1.1.5 B.1.2.2	POGIL - Ions POGIL – Naming Ionic Compounds POGIL – Naming Molecular Compounds Bohr Model Activity (Manipulative) for Ions Crayon Lab – Collecting and Graphing Data

			formulas of the most common polyatomic ions. Apply the rules for naming and writing formulas for compounds with polyatomic ions. Interpret the prefixes in the names of molecular compounds in terms of their chemical formulas. Apply the rules for naming and writing formulas for binary molecular compounds. Define the law of definite proportions and multiple proportions.			
Changes in matter are accompanied by changes in energy.	How are changes in matter accompanied by changes in energy.	Average atomic masses are reported on the periodic table.	Define Avogadro's number as it relates to a mole of a substance. Distinguish between the atomic mass of an element and its molar mass. Describe how the mass of mole of a compound is calculated. Describe how to convert the mass of a substance to the number of moles of a substance, and the moles to mass. Identify the volume of gas at STP.	Avogadro's number Mole Molar mass STP Molar Volume Percent Composition Empirical Formula Molecular Formula	B.1.1.1 B.1.2.1 B.1.2.2 B.1.2.3	What's the Count Lab (Moles and Grams) Determining the Percent of sugar in Bubble Gum (Lab) Determining the formula of a hydrate (Lab) Molar Airlines – Empirical and Molecular Formula Activity Determining an Empirical Formula of a Compound (Lab)

			Describe how to calculate the percent by mass of an element in a compound. Distinguish between empirical and molecular formulas. Describe how to calculate an empirical formula. Describe how to calculate a molecular formula from an empirical formula.			

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Unit 4 –Chemical Reactions and Stoichiometry

Big Ideas	Essential Question	Concepts	Competency	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Chemical reactions are predictable.	What factors identify the types of chemical reactions?	According to the law of conservation of matter, the mass of the products in a chemical reaction is equal to the mass of the reactants. Common chemical reactions can be categorized as synthesis, decomposition, single replacement, double replacement, or combustion.	Describe how to write a word equation. Describe how to write a skeleton equation. Describe the steps for writing a balanced equation. Describe the five general types of reactions. Predict the products of the five general types of reactions.	Chemical equation Reactant Product Solid Liquid Gas Aqueous Coefficients Balanced equation Law of Conservation of Mass Precipitate Gas Evolution Combination or Synthesis reaction	B.2.1.3 B.2.1.4	POGIL – Types of Chemical Reactions Chemical Drop Out Lab

				Decomposition Reaction Single displacement reaction Double displacement reaction Combustion Reaction		
Chemical reactions are predictable.	How do stoichiometric ratios relate reactants to products in a chemical reaction? What factors identify the types of chemical reactions?	According to the law of conservation of matter, the mass of the products in a chemical reaction is equal to the mass of the reactants. The amounts of reactants and products involved in a chemical reaction can be predicted using mole relationships. Dimensional analysis is a mathematical technique that can be used to express stoichiometric relationships. A chemical reaction will proceed until equilibrium is reached or until a limiting reactant is exhausted.	Interpret balanced chemical equations in terms of moles, particles and mass. Identify the quantities that are always conserved in chemical reactions. Construct mole ratio from balanced equations and apply these rations in stoichiometric calculations. Calculate stoichiometric quantities from balanced chemical equations using units of moles, mass, and particles. Identify the limiting reactant in a reaction. Calculate theoretical yield, actual yield, or percent yield given appropriate information.	Stoichiometry Mole ratio Molar Mass Limiting Reactant Excess Reactant Theoretical Yield Actual Yield Percent Yield	B.2.1.5 B.2.1.2 B.2.1.1	POGIL – Mole Ratios POGIL – Limiting and Excess Reactants Relating Moles to Coefficients Lab Mole and Mass Relationship Lab Mass-Mass Relationships Lab Limiting Reactant Candy Lab Limiting Reactant S'mores Lab

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Unit 5 – Thermochemistry

Big Ideas	Essential Question	Concepts	Competency	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
The nature of solids, liquids, and gases.	Matter comes in what type of forms? How does the movement of atoms/molecules effect phase changes?	The theory of the atom has changed over time because of improvements in technology.	Explain how energy, heat and work are related. Classify processes as either exothermic or endothermic. Identify the units used to measure heat transfer. Distinguish between the individual specific heats for elements and compounds. Describe how calorimeters are used to measure heat flow. Construct thermochemical equations. Solve for enthalpy changes in chemical reactions by using heats of reaction. Classify the enthalpy change that occurs when a substance goes through a phase change. Calculate the heat change for the phase change of water	Thermochemistry Chemical potential energy Heat System Surroundings Law of conservation of energy Endothermic process Exothermic process Heat capacity Specific heat	A.1.1.1	Heat of Fusion of Ice Lab Heat of Crystallization of Wax (Crayon Lab) Specific Heat of Aluminum and Antifreeze

			from ice to steam above 100ºC. State Hess's law of heat summation and describe how it is used in chemistry. Solve for enthalpy changes by using Hess' law or standard heats of formation.	Phase Change Diagram for water Calorimetry Calorimeter Enthalpy Thermochemical Equation Heat of reaction Heat of combustion Freezing Melting Condensation Evaporation Sublimation Molar heat of fusion Molar heat of solidification Molar heat of vaporization		

				Molar heat of condensation Molar heat of solution Hess's Law of Heat Summation Standard Heat of Formation		

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Unit 6 – Gas Laws

Big Ideas	Essential Question	Concepts	Competency	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Chemistry is the study of matter and the changes it undergoes Changes in matter are accompanied by changes in energy Atomic Theory is the foundation for the study of chemistry The nature of solids, liquids, and gases.	What are the differences between pure substances and mixtures? How are changes in matter accompanied by changes in energy? How will gas in a closed setting change if a variable (pressure, volume, temperature, etc.) changes?	Mathematical relationships can be used to predict changes in temperature and pressure of gaseous systems.	Explain why gases are easier to compress than solids or liquids are. Describe the three factors that affect gas pressure. Describe the relationship among the temperature pressure, and volume of a gas. Use the combined gas law to solve problems. Discuss the relationship between gas laws and scuba diving. Compute the value of an unknown using the ideal gas law. Relate the total pressure of a mixture of gases to the partial pressures of the component gases.	Compressibility Pressure Temperature Kelvin Kinetic Energy Volume Barometer Millimeters of Hg Atmospheres Pascals Kilopascals Torr Solution Boyle's law Charles's law Gay-Lussac's law Combined gas law	B.2.2.1 B.2.2.2	What Charles' Law "Boyles" Down to Lab Molar volume of Gas Lab (CO_2) Molar Volume of a Gas (Butane)

			Explain how the molar mass of a gas affects the rate at which the gas diffuses and effuses.	Ideal gas constant Ideal gas law STP Partial Pressure Dalton's law of partial pressure Diffusion Effusion Graham's law of effusion		

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Unit 7 – Electronic Structure and Bonding

Big Ideas	Essential Question	Concepts	Competency	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Chemical bonding occurs as a result of attractive forces between particles.	What factors determine the type of chemical bonds that form between particles	Electrons are found in quantized energy levels within the atom. The electronic structure within atoms is predicted by the Aufbau Principle, the Pauli Exclusion Principle, and Hund's	Describe the energies and positions of electrons according to the quantum mechanical model. Describe how the relationship between the shapes of orbitals and sublevels. Describe how to write the electron configuration for an atom. Explain why the actual electron configurations for some elements differ from those predicted by the aufbau principle. Describe the relationship between the wavelength and frequency of light. Explain how the frequencies of emitted light are related to changes in electron energies.	Atomic orbital Principle quantum number Sublevels Orbitals Electron Configurations Ground State Aufbau principle Pauli exclusion principle Hund's rule Amplitude Wavelength Frequency Hertz	A.2.2.1 A.2.2.3 A.2.2.4	POGIL – Cracking the Periodic Table Code POGIL – Electron Configurations Atomic Orbitals Manipulative Activity Flame Tests for Metals Lab

				Electromagnetic radiation Spectrum Atomic Emission Spectrum Ground State Photons Heisenberg uncertainty principle		
Chemical bonding occurs as a result of attractive forces between particles. Periodic trends in the properties of atoms allow for the prediction of physical and	What factors determine the type of chemical bonds that form between particles How does the distribution of electrons in atoms affect the	The type of bonding that occurs between atoms is related to the valence electrons of those atoms. Chemical bonding can be covalent, polar covalent or ionic. Lewis dot diagrams are useful for studying the structure and bonding nature of atoms.	Explain the electrical charge of an ionic compound Describe three properties of ionic compounds. Describe the arrangement of atoms in a metal. Explain the importance of alloys.	Ionic compounds Ionic bonds Lewis dot Structures Metallic bonds Alloys	A.1.1.4 A.2.2.2 A.2.2.3 A.2.3.2	Crystal Structure Lab

chemical properties.	formation of a compound?	The type of bonding which holds the substance together determines its physical properties such as melting point, boiling point, electrical conductivity and water solubility and vapor pressure.				
Chemical bonding occurs as a result of attractive forces between particles. Periodic trends in the properties of atoms allow for the prediction of physical and chemical properties.	What factors determine the type of chemical bonds that form between particles How does the distribution of electrons in atoms affect the formation of a compound?	The type of bonding that occurs between atoms is related to the valence electrons of those atoms. Chemical bonding can be covalent, polar covalent or ionic. Lewis dot diagrams are useful for studying the structure and bonding nature of atoms. The type of bonding which holds the	Distinguish between melting points and boiling points of molecular compounds and ionic compounds. Describe how electrons are shared to form covalent bonds and identify exceptions to the octet rule. Demonstrate how electron dot structures represent shared electrons. Describe how atoms from double or triple covalent bonds. Distinguish between bond length and strengths for single bonds, double bonds or triple bonds. Describe how VSEPR theory helps predict the shapes of molecules.	Covalent bond Molecule Diatomic molecule Molecular compound Molecular formula Lewis Dot Structures Single covalent bond Unshared pair Double covalent bond Triple covalent bond	A.1.1.4 A.2.3.2 B.1.3.1 B.1.3.2 B.1.3.3 B.1.4.1 B.1.4.2	POGIL – Molecular Geometry 3-D Models of Covalent Molecules

	How does the distribution of electrons in atoms affect the formation of a compound?	substance together determines its physical properties such as melting point, boiling point, electrical conductivity and water solubility and vapor pressure. The polarity of a molecule can be determined by the distribution of electrons around the molecule. The type of bonding which holds the substance together determines its physical properties such as melting point, boiling point, electrical conductivity and water solubility and vapor pressure.	Using molecular geometry and electronegativity determine whether a molecule is polar or nonpolar. Describe how electronegativity values determine the distribution of charge in a polar molecule.	Polyatomic ion Resonance structure Bonding orbital Sigma bond Pi bond VSEPR theory Nonpolar covalent bond Polar covalent bond Polar bond Polar molecule Dipole		

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Unit 8 – Properties of Solutions

Big Ideas	Essential Question	Concepts	Competency	Vocabulary	PA Keystone Standard	Suggested Lessons & Activities
Changes in matter are accompanied by changes in energy. Behavior of solutions depends on the compound itself and how much is present, i.e. on the concentration. Periodic trends in the properties of atoms allow for the prediction of physical and chemical properties.	How are changes in matter accompanied by changes in energy? What is one way to measure the concentration of a solution? How does the distribution of electrons in atoms affect the formation of a compound?	Atoms are the smallest pieces of an element that retain the properties of that element. Molarity is one way to measure the concentration of a solution. The polarity of a molecule can be determined by the distribution of electrons around the nucleus.	Identify the factors that determine the rate at which a solute dissolves. Identify the units usually used to express the solubility of a solute. Identify the factors that determine the mass of solute that will dissolve in a given mass of solute. Solve problems involving the molarity of a solution. Describe the effect of dilution of the total moles of solute in solution.	Saturated solution Solubility Unsaturated solution Miscible Immiscible Supersaturated solution Henry's law Concentration Dilute solution Concentrated solution Molarity	A.1.2.1 A.1.2.3 A.1.2.4 A.1.2.5	POGIL – Molarity POGIL – Solubility POGIL – Saturated and Unsaturated Solutions Solubility of a salt lab Supersaturation Lab