Grade	Big Idea	Essential Questions	Concepts	Competencies	Vocabulary	2002 Standards	SAS Standards	Assessment Anchor Eligible Content
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Stable forms of matter are those in which the electric potential energy is minimized.	Construct models showing that stable forms of matter are those with minimum electrical field energy.	Coulomb's Law Geometries and orbital shapes Lewis dot structures Molecular Octet rule	3.2.10B 3.4.10C	3.2.C.A1 3.2.C.A5 3.2.12.A2	CHEM.A.1.1.1 CHEM.A.2.2.4
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	A stable molecule has lower energy, by an amount known as the binding energy, than the same set of atoms separated; this energy must be provided to break the bond.	Construct models showing that energy is needed to break bonds and overcome intermolecular forces and that energy is released when bonds form (Enthalpy, Lattice energy are beyond the Eligible Content).	Activation Binding Energy Bond Energy Endothermic Energy Enthalpy Exothermic Lattice energy Physical properties	3.2.10B 3.4.10A	3.2.1.C.A2 3.2.C.A1 3.2.10.A4 3.4.10.A	CHEM.A.1.1.4
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements in increasing number of protons and places those with similar chemical properties in columns.	Use the atomic model and the periodic table to predict and explain trends in properties of elements.	Atomic radius Charge Chemical Configuration Effective nuclear charge Electron affinity Electronegativity Electrons Elements Energy Ionization Neutrons	3.1.10C 3.4.10A	3.2.10.A1 3.2.C.A1 3.2.C.A2	CHEM.A.2.1 CHEM.A.2.3

					Nucleus Orbital diagram Particles Physical properties Protons Reactivity Shielding effect Subatomic			
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, and surrounding electrons.	Develop a model showing the likely position of electrons as determined by the quantized energy levels of atoms.	Bohr Configuration Dalton Electronic Emission Energy levels Excited state Ground state Orbitals Quantized Sublevels Rutherford Spectra Thomson	3.4.1.10A	3.2.10.A1 3.2.C.A1 3.2.C.A2 3.2.10.A5 3.2.12.A2	CHEM.A.2.2 CHEM.A.2.2.1 CHEM.A.2.2.2 CHEM.A.2.2.3 CHEM.A.2.2.4
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The solubility of solutions depends on their properties and other factors. e.g., dissolving, dissociating	Develop explanations and/or mathematical expressions comparing solutions made from ionic and covalent solutes and how various factors affect the solubility of these solutions	Colligative Heterogeneous Homogeneous "Like dissolves like" Molarity Percent by mass Percent by volume Polarity Properties Solubility Solute	3.4.12.A	3.2.C.A1 3.2.C.A2 3.2.C.A4 3.2.10.A2 3.2.10.A4 3.2.10.A5 3.2.12.A1	CHEM.A.1.2 CHEM.A.1.2.1 CHEM.A.1.2.2 CHEM.A.1.2.3 CHEM.A.1.2.4 CHEM.A.1.2.5

					Solvent			
9 -12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The fact that atoms are conserved, together with knowledge of chemical properties of the elements involved, can be used to describe and predict chemical reactions and calculate quantities of reactants and products.	Analyze and interpret data sets, using the mole concept, to mathematically determine amounts of representative particles in macroscopic, measureable quantities.	Density Dimensional analysis Excess reactants Limiting reactants Molar mass Mole Percent yield Proportion/ratios Stoichiometric relationships	3.4.12.A 3.1.12.D	3.2.C.A2 3.2.C.A4 3.2.10.A5	CHEM. B.1.1 CHEM.B.1.1.1 CHEM.B.1.2.1
9 -12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The mole, as a fundamental unit, is used to represent a specific quantity of atomic particles such as atoms, ions, formula units, and molecules.	Analyze and interpret data to apply the laws of definite proportions and multiple proportions, to determine empirical and molecular formulas of compounds, percent composition and mass of elements in a compound.	Avogadro's number Empirical Formula Law of definite proportions Law of multiple proportions Molar mass Molar volume Molecular Percent composition Ratio	3.4.10.A	3.2.C.A1 3.2.C.A2 3.2.C.A4 3.2.10.A5	CHEM.B.1.2 CHEM.B.1.2.3
9 -12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The kinetic molecular theory and Gas Laws are used to explain and predict the behavior of gases.	Utilize mathematical relationships to predict changes in the number of particles (moles), the temperature, the pressure, and the volume in a gaseous system (i.e., Boyle's Law, Charles' Law, Avogadro's Law, Dalton's Law of partial pressures, the combined gas law, and the ideal gas law).	Avogadro's law Boyle's law Charles's law Combined gas law Dalton's law of density Partial pressures Gay-Lussac's law Ideal Gas Law	3.4.10.A	3.2.10.A3 3.2.C.A3	CHEM.B.2.2.1 CHEM.B.2.2.2

					Molar mass Molar volume Pressure STP			
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Properties of chemical compounds are related to electrostatic interaction between particles.	Use Lewis Structures and VSEPR to predict and explain charge distribution across a particle (atom, ion, molecule or formula unit)	Atoms Covalent bond Electronegativity scale Ions Ionic Bond Lattice / crystal structure Metallic Bonding Molecules Polarity VSEPR/shape	3.1.10B	3.2.10.A1 3.2.C.A5	CHEM.B.1.4 CHEM.B.1.4.1
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Properties of chemical compounds are related to electrostatic interaction between particles.	Analyze and interpret data obtained from measuring the bulk properties of various substances to explain the relative strength of the interactions among particles in the substance.	Boiling point Bonding Dispersion Forces Freezing point Hydrogen Intermolecular "Like dissolves like" London Van der Waals Melting point Polarity Surface tension Vapor pressure	3.4.1.12.a 3.4.12.a	3.2.C.A1 3.2.C.A2 3.2.C.A4 3.2.10.A 3.2.10.A1 3.2.10.A4 3.2.10.A5 3.2.12.A1	CHEM.A.1.1 CHEM.A.1.2 CHEM.A.1.2.1 CHEM.A.1.2.2 CHEM.A.1.2.3 CHEM.A.1.2.4 CHEM.A.1.2.5

9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Chemical processes, their rates, and energy changes can be understood in terms of the arrangement and energy of colliding particles and the subsequent rearrangements of atoms.	Use models to understand the effect of concentration, temperature, and surface area on frequency of collisions and subsequently rate. Describe the function of catalysts.	Activation Bond energy Collision theory Energy Reaction rate	3.4.10A 3.4.12A	S11.C.1.1 3.2.C.A4	CHEM.B.2.1.1 CHEM.B.2.1.2 CHEM.B.2.1.3 CHEM.B.2.1.4 CHEM.B.2.1.5
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	Develop and use models to explain that atoms (and therefore mass) are conserved during a chemical reaction. Models can include computer models, ball and stick models, and drawings.	Balance Chemical properties Combustion Decomposition Double replacement Mole ratio Net ionic equations Physical properties Products Reactants Single replacement Synthesis redox (reduction and oxidation)	3.4.10A 3.4.12A 3.1.10B	3.2.10.A2 3.2.C.A2 3.2.10.A4 3.2.C.A4 3.2.C.B3	CHEM.B.2.1.3 CHEM.B.2.1.4 CHEM.B.2.1.5
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	In many situations, a dynamic and condition-dependent balance between the rates of a forward and the reverse reaction determines the concentration of reaction components.	Develop a model for chemical systems to support/predict changes in reaction conditions limited to simple equilibrium reactions.	Equilibrium Percent yield Le Chatelier's overlap Le Chatelier's principle	3.4.10A 3.4.12A	3.2.10.A4 3.2.C.A2 3.2.C.A4	CHEM.B.2.1

9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	In many situations, a dynamic and condition-dependent balance between the rates of a forward and the reverse reaction determines the concentration of reaction components.	Use system models (computers or drawings) to construct molecular-level explanations to predict the behavior of systems where a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.	Reaction Reverse	3.4.10A 3.1.10B	3.2.10.A4 3.2.C.A4 3.2.12.A5	CHEM.B.2.1
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Nuclear processes, including fusion, fission, and radioactive decays involve changes in unstable nuclei The total number of neutrons plus protons does not change in any nuclear process.	Construct models to explain changes in nuclei during the processes of fission, fusion, and radioactive decay and the subatomic interactions that determine nuclear stability.	Alpha radiation Beta radiation Gamma radiation Nuclear fission Nuclear fusion Radioactivity Stable nuclei Unstable nuclei	3.4.12.A	3.2.12.A2 3.2.C.A3	CHEM.A.2.1
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the maximum ages of rocks and other materials from the isotope ratios present.	Analyze and interpret data sets to determine the maximum age of samples (rocks, organic material) using the mathematical model of radioactive decay.	Decay Half-Life Isotopes Radioactive	3.4.12.A	3.2.12.A2	
	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms.	How can one explain the structure, properties, and interactions of matter?	Acids and bases are identified by their characteristics and interactions. pH scale is a log scale that reflects the	Using models, differentiate between acid and bases and acid-base systems. Determine neutralization	Acid Arrhenius Base Bronsted Lowry	3.4.12A	3.2.12.A	

			concentration of protons in a solution.	point of a reaction. Determine pH of a solution. Show understanding of log scale.	pH pH scale Proton Titration			
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms	How can one explain the structure, properties, and interactions of matter?		Apply a systematic set of rules (IUPAC) for naming compounds and writing chemical formulas (e.g., binary covalent, binary ionic, ionic compounds containing polyatomic ions)	Nomenclature IUPAC	3.2.C.A2 3.2.C.A4 3.4.12A		CHEM.A.1.1.5
9-12	Matter can be understood in terms of the types of atoms present and the interactions both between and within atoms	How can one explain the structure, properties, and interactions of matter?		Utilize significant figures to communicate the precision in a quantitative observation Accuracy discussion: Calculate error and percent error given experimental data and the accepted value.	Accuracy Error Figures Percent error Precision Significant	3.2.C.A3		CHEM.A.1.1.3 CHEM.A.1.1.3
9-12	Interactions between any two objects can cause changes in one or both of them.	How can one explain and predict interactions between objects within systems?	The motion of an object is determined by the interactions between the object and any other objects in the system.	Construct an explanation for the motion of an object based on the interactions that occur between the object and other objects in the system.	Force System Velocity	3.4.10C	3.2.P.B1 3.2.P.B6 3.2.12.B6	
9-12	Interactions between any two objects can cause changes in one or both of them.	How can one explain and predict interactions between objects within systems?	Newton's Second Law provides a mathematical model that describes the relationship between the net force on an object, the mass of the object, and the acceleration of the object.	Plan and carry out investigations to show how the mathematical relationship of Newton's Second Law of motion accurately predicts the relationship between the net force on objects, their mass, and the resulting	Acceleration Mass Net Force	3.2.10B 3.4.10C	3.2.P.B1 3.2.P.B6 3.2.12.B6	

				change in motion.				
9-12	Interactions between any two objects can cause changes in one or both of them.	How can one explain and predict interactions between objects within systems?	Newton's Law of Universal Gravitation provides a mathematical model that describes and predicts the effects of gravitational forces acting between masses.	Use mathematical representations of Newton's Law of Gravitation to describe and predict the gravitational forces between objects.	Gravitational forces Mathematical representation Newton's Law of Gravitation	3.4.10D	3.2.P.B1 3.2.P.B6 3.2.12.B6	
9-12	Interactions between any two objects can cause changes in one or both of them.	How can one explain and predict interactions between objects within systems?	Coulomb's Law provides a mathematical model that describes and predicts the effect of electrostatic forces acting between electrically charged objects.	Use mathematical representations of Coulomb's Law to describe and predict the electrostatic forces between objects.	Electrostatic force	3.4.10C	3.2.12.B4	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	The energy an object has within a system depends on the object's motion and interactions with other objects in that system.	Construct an explanation for the energy of an object has in a system based on the object's motion and the object's interaction with other objects in the system.	Kinetic energy Mechanical energy Potential energy	3.4.10B	3.2.P.B2	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	Any change in an object's energy is the result of interactions with other objects in a system or a transfer of energy between systems, changing in the total energy of the systems involved.	Develop and use a model to explain how an object's energy is transferred or transformed as objects interact within a system.	Energy transfer Model System	3.4.10B	3.2.P.B2 3.2.12.B6	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and	How is energy transferred and conserved?	Any energy gain or loss in a system will result in a corresponding energy loss or gain in another system.	Identify problems and suggest design solutions to optimize the energy transfer between objects or systems of objects.	Design Energy transfer Solution System	3.2.12D 3.4.10B	3.2.P.B2 3.2.12.B6	

	conservation.							
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	Mathematical expressions for the kinetic and potential energy of objects allow for the concept of the conservation of energy to be used to describe and predict the behavior of objects in a system.	Construct mathematical models to show how energy is transformed and transferred within a system.	Mathematical model Transfer Transform	3.4.10B	3.2.P.B2 3.2.12.B6	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	Mathematical expressions for the kinetic and potential energy of objects allow for the concept of the conservation of energy to be used to describe and predict the behavior of objects in a system.	Plan and carry out an investigation to provide evidence that energy is conserved in a system.	Conservation of energy Evidence Investigation	3.2.10B 3.4.10B	3.2.P.B2 3.2.12.B6	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	The transfer of energy through interactions of objects or systems of objects cause a change in the momentum of objects or systems of objects.	Generate and analyze data to support the claim that the total momentum of a closed system of objects is conserved.	Elastic collision Impulse Inelastic collision Momentum	3.2.10B 3.4.10B	3.2.P.B2	
9-12	Interactions of objects or systems of objects can be predicted and explained using the concept of energy transfer and conservation.	How is energy transferred and conserved?	For any system of interacting objects, the total momentum within the system changes due to transfer of momentum or energy into or out of the system.	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved through the transfer of momentum between objects when there is no net force on the system.	Claims Mathematical representation Momentum Net force System	3.4.10B	3.2.P.B2 3.2.12B2 3.2.12.B6	
9-12	Interactions of objects or systems of objects can be predicted and explained	How is energy transferred and conserved?	For any system of interacting objects, the total momentum within the system changes	Apply scientific and engineering ideas to design, evaluate, and refine a device	Macroscopic object	3.2.12D 3.4.10B	3.2.P.B2 3.2.12B2 3.2.12.B6	

	using the concept of energy transfer and conservation.		due to transfer of momentum or energy into or out of the system.	that minimizes the force on a macroscopic object during a collision.				
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	The speed of a wave in any medium is the product of the wave's frequency and wavelength.	Analyze and interpret data to support the claim that the speed of a wave in a medium is the product of the wave's frequency and the wave's wavelength.	Medium Frequency Wave Wavelength	3.4.12C	3.2.P.B5	
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Wave transmission, reflection, refraction, and/or absorption occurs when waves travel between two different mediums.	Construct explanations for the transmission, reflection, refraction and/or absorption of waves as they pass from one medium to another medium.	Absorption Reflection Refraction Transmission	3.4.12C	3.2.P.B5	
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Wave transmission, reflection, refraction, and/or absorption occurs when waves travel between two different mediums.	Develop a claim and reasoning supported by evidence that describes the behavior of a wave as it passes from one medium to another medium.		3.4.12C	3.2.P.B5	
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Objects have natural frequencies and when they are forced to vibrate at a natural frequency they resonate with large vibrations.	Construct an explanation for the application of resonance in everyday phenomena (e.g., waves in a stretched string, speech, the design of all musical instruments).	Resonance	3.4.10C		
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without	How are waves used to transfer energy and information?	As waves pass through each other they create new waves with characteristics that are derived from the	Investigate the patterns created when waves of different frequencies combine, and explain how	Constructive interference Destructive interference Encode	3.4.12C		

	overall displacement of matter.		characteristics of the original waves.	these patterns are used to encode and transmit information	Superposition			
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Electromagnetic waves are particle-like photons that travel through a vacuum at the speed of light and have an energy that is directly proportional to the frequency of the wave.	Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.	Electromagnetic wave Particle model Photon Wave model	3.4.12C 3.4.12D	3.2.P.B5	
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Electromagnetic waves are particle-like photons that travel through a vacuum at the speed of light and have an energy that is directly proportional to the frequency of the wave.	Generate and analyze data to support the claim that the energy of an electromagnetic wave is directly proportional to the frequency of the wave.	Electromagnetic wave Frequency Proportional	3.2.10B 3.4.12C	3.2.P.B5	
~~9-12~~	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Several useful technologies digitize information by producing, transmitting, and capturing pulses of electromagnetic waves.	Construct explanations for why the wavelength of an electromagnetic waves determines its use for certain applications.	Electromagnetic wave Pulses Wavelength	3.4.12C 3.4.12D 3.6.12B	3.2.P.B5 3.2.12.B5	
9-12	Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter.	How are waves used to transfer energy and information?	Several useful technologies digitize information by producing, transmitting, and capturing pulses of electromagnetic waves.	Obtain, evaluate, and communicate information regarding the advantages of using a digital transmission and storage of information.	Digital transmission Storage	3.4.10D 3.6.10B 3.7.10B	3.2.P.B5 3.2.12.B5	
9-12	Waves are a repeating pattern of motion that	How are waves used to transfer energy and	Several useful technologies digitize information by	Communicate technical information about how some	Matter Technical	3.4.12D 3.6.10B	3.2.P.B5 3.2.12.B5	

	transfers energy from place to place without overall displacement of matter.	information?	producing, transmitting, and capturing pulses of electromagnetic waves.	technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.	information Wave behavior Wave interactions	3.7.10B		