8th Grade Physical Science

Inquiry and Process Skills within the Content:

- Learn and apply safe laboratory techniques.
- Apply and analyze all components of the scientific method. (For example: Experimental Design Lab Outline and Vocabulary)
- Integrate science process skills (asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating).
- Select and use the appropriate tools and technology. (For example: calculators, computers, balance scales, microscopes, probe ware, and graduated cylinders.)
- Apply the appropriate SI measurements (metric system) in a lab setting.
- Differentiate between scientific hypothesis, theories, and laws.
- Recognize and investigate the contributions of diverse individuals in advancing science and technology.
- Develop, use, and revise models to describe, test, or predict interactions and scientific phenomena.
- Differentiate between science and engineering approaches.
- Evaluate multiple solutions based on scientifically obtained evidence.
- Recognize that scientific knowledge is refined over time as new evidence emerges.
- Identify and evaluate the sources used to support scientific statements.

Matter and its Interactions

Standard	Objective	Examples/Evidence Statements
MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures. **MS-PS1.A** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	Students will: • Understand substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. • Model that solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). • Analyze and interpret data to determine similarities and differences in findings.	• Emphasis is on developing models of molecules that vary in complexity. • Examples of simple molecules could include ammonia and methanol. • Examples of extended structures could include sodium chloride or diamonds. • Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.
Local Standard Model and label the structure of an atom (i.e. protons, neutrons, and electron) and using the periodic table, draw Bohr models to represent the arrangement of electrons of a specific atom.	Students will: • Predict the number of valence electrons in an atom based on location on the periodic table. • Identify trends in the periodic table.	
MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **MS-PS1.A** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **MS-PS1.B** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into	Students will: • Classify pure substances by the physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Recognize that substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	• Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.

different molecules, and these new substances have different properties from those of the reactants.	• Analyze and interpret data to determine similarities and differences in findings.	
MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. **MS-PS1.A** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **MS-PS1.B** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	Students will: • Classify pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Recognize that substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence.	• Emphasis is on natural resources that undergo a chemical process to form the synthetic material. • Examples of new materials could include new medicine, foods, and alternative fuels.
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. **MS-PS1.A** Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.	Students will: • Understand that solid, gases, and plasma are made of molecules or inert atoms that are moving about relative to each other. • Compare and contrast in a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. In a plasma the particles break apart. • Model that the changes of state that occur with variations in temperature or pressure can be described and predicted.	• Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. • Examples of models could include drawing and diagrams. • Examples of particles could include molecules or inert atoms. • Examples of pure substances could include water, carbon dioxide, and helium.
MS-PS1-5. Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. **MS-PS1.B** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change.	Students will: • Understand that substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. • Show that the total number of each type of atom is conserved, and thus the mass does not change. • Develop a model to describe unobservable mechanisms.	• Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.

MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. **MS-PS1.B** Some chemical reactions release energy, others store energy.	Students will: • Understand that some chemical reactions release energy, others store energy. • Understand that potential chemical energy is held within chemical bonds. • Understand that when bonds are broken, energy (of various forms) is released. • Compare exothermic and endothermic reactions. In an exothermic reaction, thermal energy is released when a bond is broken. • Demonstrate that the total energy prior to a chemical reaction equals the total energy after a chemical reaction by balancing chemical equations.	• Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. • Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.

Motion & Stability: Forces & Interactions

Standard	Objective	Examples/Evidence Statements
MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two objects. **MS-PS2.A** For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).	Students will: • Design a solution for any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). • Apply scientific ideas or principles to design an object, tool, process or system.	• Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.
MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. **MS-PS2.A** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.	Students will: • Recognize that inertia is resistance to change in motion and is equivalent to mass. • Recognize that rotational inertia is resistance to change in rotational motion. • Understand that Newton's Second Law, the motion of an object is determined by the sum of the forces acting on it; if the net force on the object is not zero, its motion will change. The force required to change an objects motion is equivalent to the objects mass multiplied by the quantity of change in motion (acceleration). • Develop the positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	• Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.

MS-PS2-3. Ask questions about data to define the interrelationship between electric and magnetic forces. **MS-PS2.B** Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	Students will: • Understand that electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles.	• Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. • Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.
MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. **MS-PS2.B** Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.	Students will: • Understand that gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. • Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	• Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.
MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. **MS-PS2.B** Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).	Students will: • Understand how forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). • Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	• Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. • Examples of investigations could include first-hand experiences or simulations.

Energy

Standard	Objective	Examples/Evidence Statements
MS-PS3-1. Energy is the ability to do work. **MS-PS3.A** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	Students will: • Recognize that work is expressed as a force applied over a distance. • Know that energy is expressed in units called joules, equivalent to one Newton over one meter. • Recognize that motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. • Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	• Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. • Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a whiffle ball versus a tennis ball.

MS-PS3-2. Develop a model to describe the relationship between stored potential energy and the kinetic energy in motion within objects in a system. **MS-PS3.A** A system of objects that may also contain stored (potential) energy, depending on their relative positions. **MS-PS3.C** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.	Students will: • Develop a system of objects that may also contain stored (potential) energy, depending on their relative positions. • Compare and contrast that kinetic energy is energy in motion and potential energy decreases as it becomes kinetic. • Understand that when two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. • Develop a model to describe unobservable mechanisms.	• Emphasis is on relative amounts of potential energy, not on calculations of potential energy. • Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. • Examples of models could include representations, diagrams, pictures, and written descriptions of systems.
MS-PS3-3. Apply scientific principles to design, construct, and test devices that transfer thermal energy by conduction, convection or radiation. **MS-PS3.A** Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. **MS-PS3.B** Energy is spontaneously transferred out of hotter regions or objects and into colder ones. **ETS1.B** A solution of needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.	Students will: • Understand that temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. • Know that energy is spontaneously transferred out of hotter regions or objects and into colder ones. • Design and construct on how conduction is thermal energy transferred by direct contact and convection is thermal energy transfer via convection current • Understand that radiation is energy transferred by electromagnetic waves. • Develop a solution of needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. • Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.	• Examples of devices could include a transferring heat through metal rods, lava lamp and light bulb.
Local Standard: Demonstrate an understanding of how energy can be transformed, transferred and conserved.	Students will: • Understand that most of what happens in the universe involved energy changing form. • Understand that there is kinetic energy involved with interactions between mechanical, chemical, nuclear, thermal, and electrical energy.	

MS-PS4. Waves and Their Applications in Technologies for Information Transfer		
Standard	**Objective**	**Examples/Evidence Statements**
MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. **MS-PS4.A** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	Students will: • Develop how a simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. • Use mathematical representations to describe and/or support scientific conclusions and design solutions.	• Emphasis is on describing waves with both qualitative and quantitative thinking.
MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. **MS-PS4.A** A sound wave needs a medium through which it is transmitted. **MS-PS4.B** When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	Students will: • Develop on how a sound wave needs a medium through which it is transmitted. • Understand that when light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. • Understand that the path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. • Understand how a wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. • Know that light can travel through space, it cannot be a matter wave, like sound or water waves. • Develop and use a model to describe phenomena.	• Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.
MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. **MS-PS4.C** Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	Students will: • Understand that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. • Understand that the integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	• Emphasis is on a basic understanding that waves can be used for communication purposes. • Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in WIFI devices, and conversion of stored binary patterns to make sound or text on a computer screen.