Performance Expectation *and Louisiana Connectors*
6-MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures. **LC-6-MS-PS1-1a Identify a model that shows an atom's nucleus is made of protons and neutrons, and is surrounded by electrons.** **LC-6-MS-PS1-1b Identify a model that shows individual atoms of the same or different types that repeat to form compounds (e.g., sodium chloride).**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. **Models can be used to describe phenomena.** **Models can be used to predict phenomena.**	**STRUCTURE AND PROPERTIES OF MATTER** 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. (MS.PS1.A.a) **All matter is composed of tiny particles called atoms.** **Atoms are the basic unit of a chemical element.** **Substances are made from different types of atoms.** **Atoms form molecules ranging from small to very complex structures.** **A molecule is a group of atoms that are joined together and act as a single unit.** **Molecules can contain as many as a billion atoms or as few as two.** **The arrangement, motion, and interaction of these particles determine the three states of matter (solid, liquid, and gas).** Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS.PS1A.e) **Solids have a definite volume and a definite shape.** **Solids may be formed from molecules.** **Solids can be extended structures with repeating subunits.** **Repeating subunits can create crystal structures.** **Salt, sugar, sand, and snow are examples of crystalline solids.**	**SCALE, PROPORTION, AND QUANTITY** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **Phenomena can be observed at different scales (micro and macro) in a system.** **Phenomena can be studied using models.** **Models can be used to explain time, space, and energy phenomena.**

Clarification Statement
Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include carbon dioxide and water. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3-D models, or computer representations showing different molecules with different types of atoms.

Performance Expectation *and Louisiana Connectors*
6-MS-PS2-1 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. **LC-6-MS-PS2-1a Describe the motion of two colliding objects in terms of the strength of the force and the relationship of action and reaction forces given a model or scenario.** **LC-6-MS-PS2-1b Develop a solution to a problem involving the motion of two colliding objects.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing explanations and designing solutions: Constructing explanations (science) and designing solutions (engineering) in 6-8 builds on K-5 experiences and progresses to include designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system. **To design an object, tool, process or system, scientists and engineers use scientific ideas and principles.** **To construct an object, tool, process or system, scientists and engineers use scientific ideas and principles.** **In science and engineering, a design plan includes testing an object, tool, process, or system.**	**FORCES AND MOTION** 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). (MS.PS2A.a) **Forces can be used to transfer energy from one object to another.** **Force is required in order to change the speed or direction of an object's motion.** **Whenever an object pushes or pulls another object, it gets pushed or pulled back in the opposite direction with an equal force.** **Forces are equal and opposite in magnitude or strength.** **DEVELOPING POSSIBLE SOLUTIONS** A solution needs to be tested, to prove the validity of the design 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 the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions. (MS.ETS1B.a) **Design solutions must be tested.** **Tests are often designed to identify failure points or difficulties.** **Testing a solution involves investigating how well it performs under a range of likely conditions.** **Solutions are modified on the basis of the test results.** **Different solutions can be combined to create a better solution.** **Designing solutions to problems is a systematic process.**	**SYSTEMS AND SYSTEM MODELS** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Models can represent systems and their interactions.** **In many systems there are cycles of various types of interactions.** **Energy flows within systems.** **Matter flows within systems.** **Information flows within systems.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	There are many types of models. **Models can be used to investigate how a design might work.** **Models allow the designer to better understand the features of a design problem.**	

Clarification Statement
Examples of practical problems could include reducing the effects of impact of two objects such as two cars hitting each other, an object hitting a stationary object, or a meteor hitting a spacecraft.

Performance Expectation *and Louisiana Connectors*
6-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. **LC-6-MS-PS2-2a Identify using provided data, that a change in an object's motion is due to the mass of an object and the forces acting on that object.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Planning and carrying out investigations: Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. • 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. **Scientific investigations may be undertaken to support a claim.** **Scientific investigations should be planned.** **Scientific investigations can be developed with others.** **The design plan must include what tools are needed.**	**FORCES AND MOTION** 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 (acceleration) (MS.PS2A.b) **Multiple forces can act on an object.** **The motion of an object depends on the sum of the forces acting on it.** **If an object is moving, the total of the forces acting on it does not have a sum of zero.** **If an object is not moving, the total sum of the forces action in it is equal to zero.** **An object subject to balanced forces does not change its motion. It will continue in a straight line at the same speed.** **An object subject to unbalanced forces changes its motion over time.** **Unbalanced forces cause an object to speed up, slow down, and/or change direction.** **The change in motion of an object is affected by the mass of the object and the size of the force applied.** **A larger force will cause a larger change in motion (acceleration) when compared to a smaller force.** 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. (MS.PS2A.c) **Forces and motions can be described using units.** **To describe the direction of forces and motions, there needs to be a reference frame or 3-dimensional coordinate system associated with the measurement.** **To describe the position of objects, there needs to be a reference frame or 3-dimensional**	**STABILITY AND CHANGE** Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales, including atomic scales. **Stability is a condition in which some aspects of a system (natural or designed) are unchanging.** **Change can be observed at different scales (large and small/atomic) in a system.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
The design plan must include how measurements will be recorded. **The design plan must include what kind of data must be gathered.** **The design plan must include experimental variables including independent, dependent, and controls.**	**coordinate system associated with the measurement.** **The units of measurement and reference frame must be defined.** **To share information about forces and motions with others, the units and reference frame must be shared as well.** The motion of an object is dependent upon the reference frame of the observer. The reference frame must be shared when discussing the motion of an object. (MS.PS2A.d) **The motion of an object depends on the reference frame or 3-dimensional coordinate system defined by the observer.** **To share information about the motion of an object with others, the reference frame must be shared as well.**	

Clarification Statement
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) in one dimension to a given frame of reference, or specification of units.

Performance Expectation *and Louisiana Connectors*
6-MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. **LC-6-MS-PS2-3a Identify that electricity can be used to produce magnetism, or magnetism can be used to make electricity.** **LC-6-MS-PS2-3b Examine data of objects (e.g., a model that demonstrates that a piece of metal, when magnetized by electricity, can pick up many times its own weight) to identify cause and effect relationships that affect electromagnetic forces.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Asking questions and defining problems: Asking questions (science) and defining problems (engineering) in grades 6-8 builds from grades K-5 experiences and progresses to specifying relationships between variables, and clarifying arguments and making models. • 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. **Scientific questions can be investigated in a variety of ways.** **The answers to scientific questions can be supported with available resources.** **Questions can be framed by a hypothesis based on observations.** **Questions can be framed by a**	**TYPES OF INTERACTIONS** Electric and magnetic (electromagnetic) forces can be attractive (opposite charges) or repulsive (like charges), have polar charges (north and south poles) and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS.PS2B.a) **Electrical energy is a form of energy that can be transferred.** **Some materials are magnetic and can be pushed or pulled by other magnets.** **Electric forces can be attractive or repulsive.** **Magnetic forces can be attractive or repulsive.** **Electric forces have polar charges.** **Magnetic forces have polar charges.** **The size of electric forces depends on the magnitudes of the charges, currents, or magnetic strengths between the interacting objects.** **The size of magnetic forces depends on the magnitudes of the charges, currents, or magnetic strengths between the interacting objects.** **The size of electric forces depends on the distances between the interacting objects.** **The size of magnetic forces depends on the distances between the interacting objects.**	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Cause and effect relationships may be used to predict phenomena.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
hypothesis based on scientific principles.		

Clarification Statement
Questions about data might require quantitative answers related to proportional reasoning and algebraic thinking. Examples of devices that use electric and magnetic forces could include electromagnets. 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.

Performance Expectation *and Louisiana Connectors*
6-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. **LC-6-MS-PS2-4a Using a chart displaying the mass of those objects and the strength of interaction, compare the magnitude of gravitational force on interacting objects of different mass (e.g., the Earth and the sun)**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Engaging in argument from evidence: Engaging in argument from evidence in 6-8 builds from K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct, use, and/or present an oral and written argument 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. **Use empirical evidence to construct an argument.** **Use empirical evidence to support an argument.** **Use scientific reasoning to construct an argument.** **Use scientific reasoning to support an argument.** **Use an argument to support a**	**TYPES OF INTERACTIONS** 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). (MS.PS2B.b) **Objects with mass are sources of gravitational fields and are affected by the gravitational fields of all other objects with mass.** **Gravity is a force that acts between masses over very large distances.** **The force of gravity is always attractive.** **The force of gravity is always present.** **The strength of the force of gravity between objects depends on the objects' masses.** **An object with a large mass (e.g., Earth) will cause a larger force of gravity between objects when compared to an object with a small mass.**	**SYSTEMS AND SYSTEM MODELS** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Models can represent systems and their interactions.** **In many systems there are cycles of various types of interactions.** **Energy flows within systems.** **Matter flows within systems.** **Information flows within systems.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
model for a phenomena. **Use an argument to refute a model for a phenomena.** **Use an argument to support a solution to a problem.** **Use an argument to refute a solution to a problem.**		

Clarification Statement
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, or orbital periods of objects within the solar system, not necessarily including Newton's Law of Gravitation or Kepler's Laws.

Performance Expectation ***and Louisiana Connectors***
6-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. **LC-6-MS-PS2-5a Evaluate a change in the strength of a force (i.e., electric and magnetic) using data.** **LC-6-MS-PS2-5b Identify evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Planning and carrying out investigations: Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. **Use data as evidence to answer scientific questions.** **Use data as evidence to test design solutions.** **Collect evidence under a range of conditions.**	**TYPES OF INTERACTIONS** 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). (MS.PS2B.c) **Forces can be used to transfer energy from one object to another.** **Gravitational, electric, and magnetic forces between a pair of objects do not require that they be in contact.** **Gravitational, electric, and magnetic forces are explained by force fields that contain energy and can transfer energy through space.** **Electric forces have fields that extend through space.** **Magnetic forces have fields that extend through space.** **Gravitational forces have fields that extend through space.** **Electric forces have fields that can be mapped by their effect on a test object.** **Magnetic forces have fields that can be mapped by their effect on a test object.** **Gravitational forces have fields that can be mapped by their effect on a test object.**	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Cause and effect relationships may be used to predict phenomena.**

Clarification Statement
Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, or electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations designed to provide qualitative evidence for the existence of fields.

Performance Expectation *and Louisiana Connectors*
6-MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. **LC-6-MS-PS3-1a Use graphical displays of data to describe the relationship of kinetic energy to the mass of an object and to the speed of an object.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Analyzing and interpreting data: Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships. **Use graphical displays of data to identify linear relationships.** **Use graphical displays of data to identify nonlinear relationships.** **Use large data sets to identify linear relationships.** **Use large data sets to identify nonlinear relationships.**	**DEFINITIONS OF ENERGY** 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. (MS.PS3A.a) **When an object is in motion, the energy it contains is called kinetic energy.** **The kinetic energy of an object is the energy that it possesses due to its motion.** **The kinetic energy of an object is proportional to its mass.** **Kinetic energy doubles as the mass of an object doubles.** **The kinetic energy of an object grows with the square of its speed. If velocity is doubled, kinetic energy is quadrupled.**	**SCALE, PROPORTION, AND QUANTITY** Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. **Ratio and proportionality are used in science.** **Ratio and proportionality provide information about the magnitude of properties.** **Ratio and proportionality provide information about the magnitude of processes.**

Clarification Statement
Emphasis is on descriptive relationships between kinetic energy and mass as well as kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different masses of rocks downhill, or the impact of a wiffle ball versus a tennis ball.

Performance Expectation *and Louisiana Connectors*
6-MS-PS3-2 Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. **LC-6-MS-PS3-2a Describe, using models, how changing distance changes the amount of potential energy stored in the system (e.g., carts at varying positions on a hill).**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to describe unobservable mechanisms**.** **A model can be used to describe a mechanism which cannot be seen.**	**DEFINITIONS OF ENERGY** An object or system of objects may also contain stored (potential) energy, depending on their relative positions. (MS.PS3A.b) **When an object is at rest, the energy it contains is called potential energy.** **An object may contain stored (potential) energy depending on its relative position.** **A system of objects may contain stored (potential) energy depending on their relative positions.** **As the relative position of two objects changes, the potential energy of the system changes.** **RELATIONSHIP BETWEEN ENERGY AND FORCES** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS.PS3C.a) **Whenever an object pushes or pulls another object, it gets pushed or pulled back by that object.** **Energy can be transferred to or from one object to another when they interact.** **The transfer of energy can happen when two objects interact.**	**SYSTEMS AND SYSTEM MODELS** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Models can represent systems.** **In many systems there are cycles of various types.** **Energy flows within systems.** **Matter flows within systems.** **Information flows within systems.**

Clarification Statement
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

Clarification Statement
of a magnet, or a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, or written descriptions of systems.

Performance Expectation *and Louisiana Connectors*
6-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 and how the frequency and wavelength change the expression of the wave. **LC-6-MS-PS4-1a Identify how the amplitude of a wave is related to the energy in a wave using a mathematical or graphical representation.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Using mathematics and computational thinking: Mathematical and computational thinking in 6-8 builds on K-5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. • Use mathematical representations to describe and/or support scientific conclusions and design solutions. **Use mathematical representations to describe scientific conclusions.** **Use mathematical representations to support scientific conclusions.** **Use mathematical representations to describe design solutions.** **Use mathematical representations to support design solutions.**	**WAVE PROPERTIES** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS.PS4A.a) **A simple wave has a repeating pattern.** **A simple wave has a specific wavelength.** **A simple wave has a specific frequency.** **A simple wave has a specific amplitude.** **The wavelength and frequency of a wave are related to one another by the speed of travel of the wave.** **The higher the frequency of the wave the shorter the wavelength.** **The lower the frequency of the wave the longer the wavelength.** **The higher the frequency of the wave the higher the amplitude.** **The lower the frequency of the wave the lower the amplitude.**	**PATTERNS** Graphs, charts, and images can be used to identify patterns in data. **Graphs can be used to identify patterns.** **Charts can be used to identify patterns.** **Images can be used to identify patterns.**

Clarification Statement
Emphasis is on describing mechanical waves with both qualitative and quantitative thinking.

Performance Expectation *and Louisiana Connectors*
6-MS-PS4-2 Develop and use a model to describe that waves are refracted, reflected, absorbed, transmitted, or scattered through various materials. **LC-6-MS-PS4-2a Describe, using a model, how sound waves are reflected, absorbed, or transmitted through various materials (e.g., water, air, glass).** **LC-6-MS-PS4-2b Describe, using a model, how light waves are reflected, absorbed, or transmitted through various materials (e.g., water, air, glass).**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. **Use a model to predict phenomena.** **Use a model to describe phenomena.** **Develop a model to predict phenomena.** **Develop a model to describe phenomena.**	**WAVE PROPERTIES** A sound wave needs a medium through which it is transmitted. (MS.PS4A.b) **Sound waves need a medium (air, water, or solid material) to travel through.** **ELECTROMAGNETIC RADIATION** When light shines on an object, it is reflected, absorbed, transmitted, or scattered through the object, depending on the object's material and the frequency (color) of the light. (MS.PS4B.a) **When light shines on an object, it can be reflected by the object.** **When light shines on an object, it can be absorbed by the object.** **When light shines on an object, it can be transmitted by the object.** **When light shines on an object, it can be scattered through the object.** **What happens to light when it shines on an object depends on the object's material.** **What happens to light when it shines on an object depends on the frequency (color) of the light.** **The selective absorption of different wavelengths of white light determines the color of most objects.** 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 (Refraction). (MS.PS4B.b) **The path of light travels in a straight line.** **The path of light bends at surfaces between different transparent materials (e.g., air and**	**STRUCTURE AND FUNCTION** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **Structures can be designed to serve different functions.** **The design of a structure must be based on the properties of its materials.** **The design of a structure must be based on its shape.** **The design of a structure must be based on how it is being used.** **Structure does not**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	water, air, and glass). **Light usually refracts when passing from one material into another.** 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 a vacuum, it cannot be a mechanical wave, like sound or water waves. (MS.PS4B.c) **Light can be described using a wave model.** **A wave model of light can be used to explain its brightness.** **A wave model of light can be used to explain its color.** **A wave model of light can be used to explain the bending of light at a surface between media.** **Light can travel through a vacuum.** **Light cannot be described as a mechanical wave.** **At the surface between two media, like any wave, light can be reflected, refracted (its path bent), or absorbed.**	**always determine function.** **Differentiating structures can have the same function.**

Clarification Statement
Emphasis is on both light and mechanical waves interacting with various objects such as light striking a mirror or a water wave striking a jetty. Examples of models could include drawings, simulations, or written descriptions.

Performance Expectation *and Louisiana Connectors*
6-MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the reoccurring patterns of lunar phases, eclipses of the sun and moon, and seasons. **LC-6-MS-ESS1-1a Use an Earth-sun-moon model to show that the Earth-moon system orbits the sun once an Earth year and the orbit of the moon around Earth corresponds to a month.** **LC-6-MS-ESS1-1b Use an Earth-sun-moon model to explain eclipses of the sun and the moon.** **LC-6-MS-ESS1-1c Use an Earth-sun-moon model to explain how variations in the amount of the sun's energy hitting Earth's surface results in seasons.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena. **Use a model to describe phenomena.** **Develop a model to describe phenomena.**	**THE UNIVERSE AND ITS STARS** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS.ESS1A.a) **Earth rotates on its tilted axis once an Earth day.** **The moon orbits Earth approximately once a month.** **Earth-moon system orbits the sun once an Earth year.** **The Earth's rotation axis is tilted with respect to its orbital plane around the sun. Earth maintains the same relative orientation in space, with its North Pole pointed toward the North Star throughout its orbit.** **Models can be used to explain the relationship and motion of the sun, the moon, and the stars.** **Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed.** **Patterns of the apparent motion of the sun, the moon, and stars in the sky can be described.** **Patterns of the apparent motion of the sun, the moon, and stars in the sky can be predicted.** **Patterns of the apparent motion of the sun, the moon, and stars in the sky can be explained with models.** **EARTH AND THE SOLAR SYSTEM** This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The	**PATTERNS** Patterns can be used to identify cause and effect relationships. **Scientists use patterns to identify cause and effect relationships.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS.ESS1B.b) **Models of the solar system can be used to explain eclipses of the sun and the moon.** **In the shadow of the moon that falls on Earth during a total solar eclipse, sunlight is prevented from reaching that part of Earth because the moon is located between the sun and Earth.** **Earth's axis is tilted relative to its orbit around the sun.** **As the Earth orbits around the sun, the angle at which the sun's rays strike Earth's surface changes due to the position of Earth's tilted axis relative to the sun.** **Different seasons are caused by the intensity of sunlight on the Earth at different times of the year.** **Summer occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted toward the sun.** **Winter occurs in the Northern Hemisphere at times in the Earth's orbit when the northern axis of Earth is tilted away from the sun.**	

Clarification Statement
Earth's rotation relative to the positions of the moon and sun describes the occurrence of tides; the revolution of Earth around the sun explains the annual cycle of the apparent movement of the constellations in the night sky; the moon's revolution around Earth explains the cycle of spring/neap tides and the occurrence of eclipses; the moon's elliptical orbit mostly explains the occurrence of total and annular eclipses. Examples of models can be physical, graphical, or conceptual.

Performance Expectation *and Louisiana Connectors*
6-MS-ESS1-2 Use a model to describe the role of gravity in the motions within galaxies and the solar system. **LC-6-MS-ESS1-2a Use a model to identify the solar system as one of many systems orbiting the center of the larger system of the Milky Way galaxy, which is one of many galaxy systems in the universe.** **LC-6-MS-ESS1-2b Use a model to describe the relationships and interactions between components of the solar system as a collection of many varied objects held together by gravity.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. **Use a model to predict phenomena.** **Use a model to describe phenomena.** **Develop a model to predict phenomena.** **Develop a model to describe phenomena.**	**THE UNIVERSE AND ITS STARS** Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS.ESS1A.b) **Earth is a part of the solar system.** **The solar system is part of the Milky Way galaxy.** **The Milky Way galaxy is one of many galaxies in the universe.** **There are many other galaxies in the universe, each containing many other stars.** **EARTH AND THE SOLAR SYSTEM** The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS.ESS1B.a) **The solar system contains the sun, planets, moons, and asteroids.** **The solar system is held together by the sun's gravitational force.** **The sun's gravity keeps all planets in a predictable orbit around it.** **The gravitational forces from the center of the Milky Way cause stars and stellar systems to orbit around the center of the galaxy.** The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS.ESS1B.c) **The solar system formed from dust and gas.**	**SYSTEMS AND MODELS** Models (e.g., physical, mathematical, computer models) can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. **Models can represent systems.** **In many systems there are cycles of various types.** **Energy flows within systems.** **Matter flows within systems.** **Information flows within systems.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	The components of the solar system are drawn together by gravity. **The result was the formation of moon-planet and planet-sun orbiting systems.**	

Clarification Statement
Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).

Performance Expectation *and Louisiana Connectors*
6- MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system. **LC-6-MS-ESS1-3a Use data (e.g., statistical information, drawings and photographs, and models) to determine similarities and differences among solar system objects.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Analyzing and interpreting data: Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. **Use data to determine similarities in findings.** **Use data to determine differences in findings.**	**EARTH AND THE SOLAR SYSTEM** The solar system consists of the sun and a collection of objects, including planets, their natural satellite(s) (moons), comets, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS.ESS1B.a) **The solar system contains the sun, planets, moons, and asteroids.** **The solar system is held together by the sun's gravitational force.** **The sun's gravity keeps all planets in a predictable orbit around it.** **The gravitational forces from the center of the Milky Way cause stars and stellar systems to orbit around the center of the galaxy.**	**SCALE, PROPORTION, AND QUANTITY** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **Phenomena can be observed at different scales (micro and macro) in a system.** **Phenomena can be studied using models.** **Models can be used to explain time, space, and energy phenomena.**

Clarification Statement
Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), atmospheric composition, surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.

Performance Expectation *and Louisiana Connectors*
6-MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. **LC-6-MS-ESS3-4 Identify changes that human populations have made to Earth's natural systems using a variety of resources.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Engaging in argument from evidence: Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). • Construct, use, and/or present an oral and written argument 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. **Use empirical evidence to construct an argument.** **Use empirical evidence to support an argument.** **Use scientific reasoning to construct an argument.** **Use scientific reasoning to support an argument.** **Use an argument to support a**	**HUMAN IMPACTS ON EARTH SYSTEMS** Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS.ESS3C.b) **As the human population grows, so does the consumption of natural resources.** **As the human population grows, so do the human impacts on the planet.** **People impact the environment by:** **• poor agricultural practices (e.g., wasteful water),** **• polluting the air, water, and ground,** **• tourism and recreational development (e.g., ski resorts, golf courses), and** **• clearing forests and grasslands for cities.** **People can minimize the impact on the environment by:** **• practicing proper agriculture (e.g., rotating crops),** **• reusing, reducing, and recycling materials,** **• natural resource management,** **• conserving water and electricity, and** **• maintaining some forest and grassland areas.** **Some negative effects of human activities are reversible using technology.** **The sustainability of human societies and of the biodiversity that supports them requires responsible management of natural resources.** **BIOGEOLOGY** Living organisms interact with Earth materials resulting in changes of the Earth. (MS.ESS2E.a) **Living things have changed the makeup of Earth's geosphere, hydrosphere, and atmosphere**	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Cause and effect relationships may be used to predict phenomena.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
model for a phenomena. **Use an argument to refute a model for a phenomena.** **Use an argument to support a solution to a problem.** **Use an argument to refute a solution to a problem.**	**over geological time.** **The flow of water can be affected by living organisms.** **Ground cover can be affected by living organisms.** **The slope of the land can be affected by living organisms.** **RESOURCE MANAGEMENT FOR LOUISIANA** Responsible management of Louisiana's natural resources promotes economic growth, a healthy environment, and vibrant productive ecosystems. (MS.EVS1B.a) **Responsible management of Louisiana's natural resources helps create economic growth.** **Responsible management of Louisiana's natural resources helps create a healthy environment.** **Responsible management of Louisiana's natural resources helps sustain vibrant productive ecosystems.**	

Clarification Statement
Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions.

Performance Expectation *and Louisiana Connectors*
6-MS-LS1-1 Conduct an investigation to provide evidence that living things are made of cells, either one or many different numbers and types. **LC-6-MS-LS1-1a Identify that living things may be made of one cell or many different numbers and types of cells.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Planning and carrying out investigations: Planning and carrying out investigations to answer questions (science) or test solutions (engineering) to problems in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. • Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation. **Conduct an investigation to produce data to meet its goals.** **Evaluate the experimental design to ensure it meets its goals.** **Revise the experimental design to ensure it meets it goals.** **Data may serve as evidence that an investigation has met its goals.**	**STRUCTURE AND FUNCTION** All living things are made up of cells, which are the smallest living unit. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS.LS1A.a) **All living things are made up of cells.** **The cell is the smallest living unit.** **The cell is the fundamental unit of life.** **An organism can consist of a single cell.** **An organism can consist of many cells.** **An organism can consist of many different types of cells.** **Single-celled organisms are composed of one cell that can survive independently.** **Multi-cellular organisms consist of individual cells that cannot survive independently.**	**SCALE, PROPORTION, AND QUANTITY** Phenomena that can be observed at one scale may not be observable at another scale. **Different phenomena correspond to different scales.** **Some phenomena are observable at some scales.** **Some phenomena cannot be observed at certain scales.**

Clarification Statement
Emphasis is on developing evidence that living things are made of cells, distinguishing between living and nonliving things, and understanding that living things may be made of one or many cells, including specialized cells. Examples could include animal cells (blood, muscle, skin, nerve, bone, or reproductive) or plant cells (root, leaf, or reproductive).

Performance Expectation *and Louisiana Connectors*
6-MS-LS1-2 Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. **LC-6-MS-LS1-2a Using a model(s), identify the function of a cell as a whole.** **LC-6-MS-LS1-2b Using a model(s), identify special structures within cells are responsible for particular functions.** **LC-6-MS-LS1-2c Using a model(s), identify the components of a cell.** **LC-6-MS-LS1-2d Using a model(s), identify the functions of components of a cell.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. **Models can be used to describe phenomena.** **Models can be used to predict phenomena.**	**STRUCTURE AND FUNCTION** Within cells, special structures (organelles) are responsible for particular functions. The cell membrane forms the boundary that controls the material(s) that enter and leave the cells in order to maintain homeostasis. (MS.LS1A.b) **Organelles are structures within cells.** **Most cells contain a set of observable structures called organelles which allow them to carry out life processes.** **Organelles perform specific functions.** **A living cell depends on its organelles to function properly.** **Major organelles include vacuoles, cell membrane, nucleus, and mitochondria.** **Plant cells are structurally and functionally different from animal cells.** **Plants contain organelles such as cell wall and chloroplasts that are not found in animal cells.** **A cell membrane surrounds every cell.** **The cell membrane controls what goes in and out of a cell.** **Plant cells have a cell wall in addition to a cell membrane, whereas animal cells have only a cell membrane. Plants use cell walls to provide structure to the plant.** **A living cell maintains stable internal conditions (homeostasis) despite changes in its surroundings.** **The functions of the organelles contribute to the cell's overall function as a whole (e.g., maintain the cells internal processes, the structure of the cell, what enters and leaves the cell, and overall cellular function).**	**STRUCTURE AND FUNCTION** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function. **Complex structures can be visualized.** **Microscopic structures can be visualized.** **Complex structures can be modeled.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
		Microscopic structures can be modeled. The function of a structure depends on its shape. The function of a structure depends on its composition. The function of a structure depends on relationships among its parts. Designed structures/systems can be analyzed to determine how they function.

Clarification Statement
Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, such as the nucleus, chloroplasts, mitochondria, cell membrane, or cell wall.

Performance Expectation *and Louisiana Connectors*
6-MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. **LC-6-MS-LS2-1a Recognize data that shows growth of organisms and population increases are limited by access to resources.** **LC-6-MS-LS2-1b Identify factors (e.g., resources, climate or competition) in an ecosystem that influence growth in populations of organisms.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Analyzing and interpreting data: Analyzing data in 6-8 builds on K-5 experiences and progresses extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence for phenomena. **Interpret data to provide evidence for phenomena.** **Analyze data to provide evidence for phenomena.**	**INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS.LS2A.a) **In any ecosystem, there are physical and biological factors.** **All living organisms interact with the living and nonliving parts of their surroundings to meet their needs for survival.** **Organisms are dependent on other living things.** **Organisms are dependent on nonliving factors.** **Populations are dependent on other living things.** **Populations are dependent on nonliving factors.** **The size of populations may change as a result of the interrelationships among organisms.** In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS.LS2A.b) **A population consists of all individuals of a species that occur together at a given place and time.** **All populations living together (biotic factors) and the physical factors with which they interact (abiotic factors) compose an ecosystem.** **Organisms and populations cope with the physical conditions of their immediate surroundings.** **Organisms may compete with other organisms for resources (e.g., food, water, oxygen, shelter).** **Availability of resources (e.g., food, water, oxygen, shelter) can lead to changes in**	**CAUSE AND EFFECT** Cause and effect relationships may be used to predict phenomena in natural or designed systems. **Cause and effect relationships may be used to predict phenomena.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	populations. **Access to resources is needed for organisms to grow and reproduce.** Growth of organisms and population increases are limited by access to resources. (MS.LS2A.c) **Growth of organisms are limited by access to resources.** **Population increases are limited by access to resources.** **In order to survive, populations within an ecosystem require a balance of resources.**	

Clarification Statement
Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant or scarce resources.

Performance Expectation *and Louisiana Connectors*
6-MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. **LC-6-MS-LS2-2a Use an explanation of interactions between organisms in an ecosystem to identify examples of competitive, predatory, or symbiotic relationships.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Constructing explanations and designing solutions: Constructing explanations (science) and designing solutions (engineering) in 6-8 builds on K- 5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation that includes qualitative or quantitative relationships between variables that predict(s) and/or describe(s) phenomena. **Construct an explanation that includes qualitative relationships to predict a phenomena.** **Construct an explanation that includes qualitative relationships to describe a phenomena.** **Construct an explanation that includes quantitative relationships to predict a phenomena.** **Construct an explanation that**	**INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS** Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS.LS2A.d) **A predatory species can reduce the number of organisms in a population.** **A predatory species can eliminate whole populations.** **Predator/Prey relationships can have a negative correlation.** **Different organisms may be interdependent on each other for survival.** **When organisms depend on each other, it is called a mutually beneficial interaction.** **The species in these cause and effect relationships (competitive, predatory, and mutually beneficial) vary across ecosystems.** **Patterns can be observed in these cause and effect relationships (competitive, predatory, and mutually beneficial) across ecosystems.** **Organisms within an ecosystem may interact symbiotically through mutualism, parasitism, and commensalism.**	**PATTERNS** Patterns can be used to identify cause and effect relationships. **Scientists use patterns to identify cause and effect relationships.**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
includes quantitative relationships to describe a phenomena.		

Clarification Statement
Emphasis is on (1) predicting consistent patterns of interactions in different ecosystems and (2) relationships among and between biotic and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, mutually beneficial, or other symbiotic relationships.

Performance Expectation *and Louisiana Connectors*
6-MS-LS2-3 Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. **LC-6-MS-LS2-3a Using a model(s), describe energy transfer between producers and consumers in an ecosystem using a model (e.g., producers provide energy for consumers).** **LC-6-MS-LS2-3b Using a model(s), describe the cycling of matter among living and nonliving parts of a defined system (e.g., the atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem).**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
Developing and using models: Modeling in 6-8 builds on K-5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and/or use a model to predict and/or describe phenomena. **Models can be used to describe phenomena.** **Models can be used to predict phenomena.**	**CYCLE OF MATTER AND ENERGY TRANSFER IN ECOSYSTEMS** Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. (MS.LS2B.a) **Matter and energy cycle through both living and non-living parts of ecosystems.** **Matter and energy are transferred between producers, consumers, and decomposers within an ecosystem.** **In most ecosystems, energy enters as sunlight and is transformed by producers into a biologically usable form of matter through photosynthesis.** **Food webs are models that show how matter and energy is transferred within and across groups of organisms in an ecosystem.** **Some animals are herbivores, eat plants and algae.** **Some animals are omnivores, eat plants and/or animals.** **Some animals are carnivores, which eat animals that have eaten photosynthetic organisms.** Transfers of matter into and out of the physical environment occur at every level. (MS.LS2B.b) **Matter cycles through living systems and between living systems and the physical environment.** **Over time, matter is transferred repeatedly from one organism to another and between organisms and their physical environment.** **When a consumer eats a producer, matter is transferred.** **When a producer or consumer decomposes, matter is transferred.** **When a consumer eats a consumer, matter is transferred.**	**ENERGY** The transfer of energy can be tracked as energy flows through a designed or natural system. **Energy cannot be created or destroyed.** **Energy can be transferred.** **Energy flows through systems (natural and designed).**

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
	Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. (MS.LS2B.c) **Dead plants and animals are broken down by decomposers.** **Decomposers recycle nutrients and material back into the soil in terrestrial environments.** **Decomposers recycle nutrients and material back into the water in aquatic environments.** **Food webs recycle matter continuously as organisms are decomposed after death to return food materials to the environment where it re-enters a food web.** The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. Geochemical cycles include carbon, nitrogen, and the water cycle. (MS.LS2B.d) **Living things are composed of atoms.** **All the atoms that make up organisms are repeatedly cycled between living and nonliving parts of the ecosystem.** **The total amount of matter remains constant, even though its form and location change.** **Matter and energy continually cycle through Earth's geochemical cycles (carbon, nitrogen, and the water cycle).**	

Clarification Statement
Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.