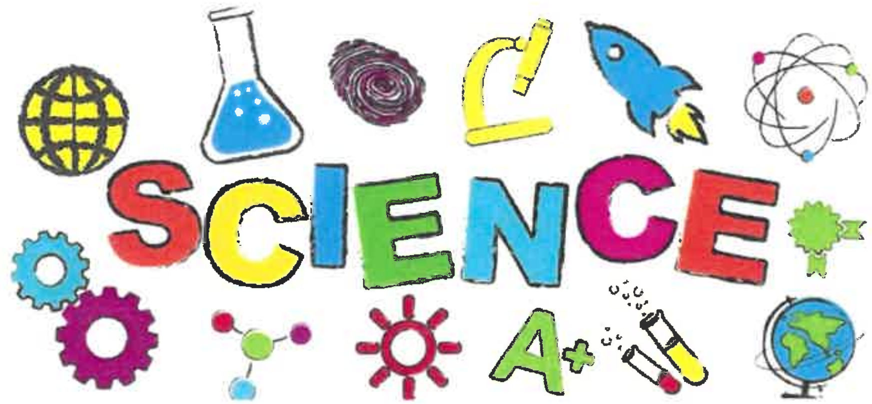

EHPS Science Curriculum
Revised - 2018

East Helena Public Schools
East Helena, Montana

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History

The EHPS science curriculum revision committee approached our work with this revision by relying heavily on the new Montana Science Standards (Adopted September 16, 2016 by the Board of Public Education) and the Next Generation Science Standards (2013). These are the most current standards available for our project. Once our curriculum document was aligned to the new standards, we researched new programs that most closely supported our curriculum goals and the implementation of STEM (Science, Technology, Engineering, and Math) concepts into classroom instruction.

The 2018 Science Curriculum

The science curriculum is based on the Next Generation Science Standards (NGSS). It includes columns for Topics, Disciplinary Core Ideas, Performance Expectations, Essential Vocabulary and Clarification Statements. The curriculum is organized by grade level. The K-5 component focuses on a spiraling curriculum emphasizing the beginnings of observation, critical thinking, and inquiry. These years are designed to provide a solid foundation of future scientific studies.

Within the 6-8 portion of the curriculum, there is still an emphasis on spiraling the disciplines of science—earth, physical, life, space science, and engineering--but now the focus is developing and extending those areas even more.

Definitions

DCI - Disciplinary Core Ideas are the key ideas in science that have broad importance within or across multiple science or engineering disciplines. These core ideas build on each other as students progress through grade levels and are grouped into the following four domains: Physical Science, Life Science, Earth and Space Science, and Engineering. They are statements of what students should be able to do after instruction.

Performance Expectation - These expectations state what students should be able to do in order to demonstrate that they have met the standard, thus providing the same clear and specific targets for curriculum, instruction, and assessment.

Clarification Statement - These statements expand upon the information provided in the performance expectations. They provide examples and information about assessment boundaries.

NGSS (Next Generation Science Standards) - The new standards were developed by the National Research Council, the staffing arm of the National Academy of Science. They are based on the *Framework for K-12 Science Education*. Their purpose is to stimulate and build interest in STEM given the many advances that have occurred in the fields of science and science education, as well as in our innovation-driven economy. The standards integrate rigorous content that reflects how science is practiced in the real world.

Standard: See list for YOUR grade off of NGSS pages for your grade				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
Are outlined in the attached standards (google docs)	1. PAO Summary (process assessment outcome from OPI - this is very DETAILED)	These are the bulleted statements listed in the Montana Science Content Standards (You have been given a copy, or you can find it on OPI)	Have a list, but they are not separated by grade	
	2. NGSS Appendix E chart (short version)	They are also the bolded statements at the top of the original NGSS standards. (Given a copy for your grade)		
	3. Bottom of the actual NGSS standards (have been given your grade) It is under the column labeled DCI. There is additional info in written as clarification statement under each performance expectation.	Linked NGSS Standards		

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STANDARD				
Topic	Disciplinary Core Idea	Performance Expectation	Essential Vocabulary	Clarification Statement

Standard: PS 1: Forces and Interactions: Pushes and Pulls				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
PS2.A: Forces and Motion	Pushes and pulls can have different strengths and directions. (KPS2-1),(K-PS2-2) Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2)	K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*	push pull friction motion force	K-PS2-1.Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets. K-PS2-Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.] [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]
PS2.B: Types of Interactions	When objects touch or collide, they push on one another and can change motion. (K-PS2-1)	K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	push pull friction motion force	
PS3.C: Relationship Between Energy and Forces	A bigger push or pull makes things speed up or slow down more quickly. (secondary to K-PS2-1)	K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.	push pull friction motion force	
ETS1.A: Defining Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to KPS2-2)	K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.*	push pull friction motion force	

Standard: LS 1: Interdependent Relationships in Ecosystems: Animals, Plants, and Their Environment				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
LS1.C: Organization for Matter and Energy Flow in Organisms	All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow. (K-LS1-1)	K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive.	habitat forest grassland	K-LS1-1.Examples of patterns could include that animals need to take in food but plants do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and that all living things need water.] K-ESS2-2 Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete.] K-ESS3-1. Examples of relationships could include that deer eat buds and leaves, therefore, they usually live in forested areas, and grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.] K-ESS3-3.Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.]
ESS2.E: Biogeology	Plants and animals can change their environment. (K-ESS2-2)	K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.	enviornment adapt camouflage	
ESS3.A: Natural Resources	Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do. (K-ESS3-1)	K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live	natural resource needs wants	

ESS3.C: Human Impacts on Earth Systems	Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (secondary to K-ESS2-2),(K-ESS3-3)	K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.* K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.	reduce reuse recycle	
ETS1.B: Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to K-ESS3-3)			

Standard: PS 3: Weather and Climate				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**

PS3.B: Conservation of Energy and Energy Transfer	Sunlight warms Earth's surface. (K-PS3-1),(K-PS3-2)	K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface. K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*	Earth surface weather	K-PS3-1. Examples of Earth's surface could include sand, soil, rocks, and water [Assessment Boundary: Assessment of temperature is limited to relative measures such as warmer/cooler.] K-PS3-2. Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.] K-ESS2-1. Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.] [Assessment Boundary: Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler. K-ESS3-2. Emphasis is on local forms of severe weather.
ESS2.D: Weather and Climate	Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time. (K-ESS2-1)	K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.	temperature weather	

ESS3.B: Natural Hazards	Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. (K-ESS3-2)	K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.*	forecast	
ETS1.A: Defining and Delimiting an Engineering Problem	Asking questions, making observations, and gathering information are helpful in thinking about problems. (secondary to K-ESS3-2)	K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.*		

Standard: ETS 1: Engineering Design				
Topic	**Disciplinary Core Ideas**	**Performance Expectations**	**Essential Vocabulary**	**Clarification Statement**
ETS1.A Defining and Delimiting Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2- ETS1-1) Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)	K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool	engineer, design problem solve	None provided by NGSS at this time.
ETS1.B Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)	K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	sketch, model	None provided by NGSS at this time.

ETS1.C Optimizing the Design Solution	Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	compare, strength, weakness	None provided by NGSS at this time.

Standard: PS4 Waves: Light and Sound				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarifying Statements**
PS4.A Wave Properties	Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4-1)	1-PS4-1 Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	matter vibrate	[Clarification Statement: Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.]
PS4.B Electromagnetic Radiation	Objects can be seen if light is available to illuminate them or if they give off their own light. (1-PS4-2) Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.) (1- PS4-3)	1-PS4-2. Make observations to construct an evidence-based account that objects can be seen only when illuminated. 1-PS4-3. Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.	shadow	[Clarification Statement: Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.] [Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).] [Assessment Boundary: Assessment does not include the speed of light.]
PS4.C Information Technologies and Instrumentation	People also use a variety of devices to communicate (send and receive information) over long distances. (1- PS4-4)	1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.*	communicate	[Clarification Statement: Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drum beats.] [Assessment Boundary: Assessment does not include technological details for how communication devices work.]

Standard: LS1 Structure, Function, and Information Processing				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarifying Statements**

LS1.A Structure and Function	All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)	1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*	root leaf stem flower seedling protect	[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]
LS1.B Growth and Development of Organisms	Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. (1-LS1-2)	1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.	camouflage food chain life cycle pupa offspring	[Clarification Statement: Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).]
LS1.D Information Processing	Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. (1-LS1-1)	1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.*	comouflage nocturnal survive habitat	[Clarification Statement: Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.]
LS3.A Inheritance of Traits	Young animals are very much, but not exactly, like their parents. Plants also are very much, but not exactly, like their parents. (1- LS3-1)	1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.		[Clarification Statement: Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.] [Assessment Boundary: Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.]
LS3.B Variation of Traits	Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways. (1-LS3-1)	1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents.	similar	

Standard: ESS1 Space Systems: Patterns and Cycles				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarifying Statements**
ESS1.A The Universe and its Stars	Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. (1- ESS1-1)	1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.	rotation sun star planet moon telesope	[Clarification Statement: Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.] [Assessment Boundary: Assessment of star patterns is limited to stars being seen at night and not during the day.]
ESS1.B Earth and the Solar System	Seasonal patterns of sunrise and sunset can be observed, described, and predicted. (1-ESS1-2)	1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.	season	[Clarification Statement: Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.] [Assessment Boundary: Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.]

Standard: K-2 Engineering Design				
Topic	**Disciplinary Core Ideas**	**Performance Expectations**	**Essential Vocabulary**	
ETS1.A Defining and Delimiting Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2- ETS1-1) Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)	K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.	solution problem	None provided by NGSS at this time.

ETS1.B Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)	K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	sketch model	
ETS1.C Optimizing the Design Solution	Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	compare data	

Standard: 2.Structure and Properties of Matter				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS1.A: Structure and Properties of Matter	Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1) Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3) A great variety of objects can be built up from a small set of pieces. (2-PS1-3)	2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.* 2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.	liquiud solid gas property matter	Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properites that different materials share. Examples of properties could include, strength, flexibility, hardness, texture and absorbency. Examples of pieces could include blocks, building bricks, or other assorted small objects.
PS1.B: Chemical Reactions	Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1-4)	2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.	heating cooling	Examples of reversitble changes could include matherials such as water and butter at differnt temperatures. Examples of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.

Standard: Interdependent Relationships in Ecosystems				
Topic	**Disciplinary Core Idea**	**Performance Expectations**	**Essential Vocabulary**	**Clarification Statements**
LS2.A: Interdependent Relationships in Ecosystems	Plants depend on water and light to grow. (2-LS2-1)	2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*	disperse pollination nutrient root stem seedling	

	Plants depend on animals for pollination or to move their seeds around. (2-LS2-2)	2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*	life cycle	
LS4.D: Biodiversity and Humans	There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)	LS4.D: There are many different kinds of living things in any area, and they exist in different places on land and in water. (2-LS4-1)	habitat	Emphasis is on the diversity of living things in each of a variety of different habitats.
ETS1.B: Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (secondary to 2-LS2-2			

Standard: Earth's Systems: Processes that Shape the Earth				
Topic	**Disciplinary Core Idea**	**Performance Expectations**	**Essential Vocabulary**	**Clarification Statements**
ESS1.C: The History of Planet Earth	Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)	2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slow	volcano earthquake	Examples of eventsand timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.
ESS2.A: Earth Materials and Systems	Wind and water can change the shape of the land. (2-ESS2-1)	2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*	erosion windbreak dike	Examples of solutions could include different designs of dikes and windbreks to hold back wind and water, and different designs for using shrubs, grass and trees to hold back the land.
ESS2.B: Plate Tectonics and Large-Scale System Interactions	Maps show where things are located. One can map the shapes and kinds of land and water in any area. (2-ESS2- 2	2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.	landform	

ESS2.C: The Roles of Water in Earth's Surface Processes	Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. (2-ESS2-3)	2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.		
ETS1.C: Optimizing the Design Solution	Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (secondary to 2-ESS2-1)	2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*		

Standard: K-2.Engineering Design				
Topic	**Disciplinary Core Ideas**	**Performance Expectations**	**Essential Vocabulary**	**Clarification Statements**
ETS1.A: Defining and Delimiting Engineering Problems	A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2- ETS1-1) Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1) Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)	K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool	inquiry observe conclusion hypothesis data goal tool	None provided by NGSS at this time
ETS1.B: Developing Possible Solutions	Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2)	K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.	technology simple machine invent	None provided by NGSS at this time

ETS1.C: Optimizing the Design Solutio	Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)	K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.		None provided by NGSS at this time

Standard PS2 Forces and Interactions				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
PS2.A: Forces and Motion	Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.) (3-PS2-1) The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)	3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. 3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.	friction force position speed balanced forces unbalanced forces accelerate distance direction motion	PS2-1 Examples include an unbalanced force on one side of a ball can make it start moving; and balanced forces pushing on a box from both sides will not produce any motion at all. PS2-2 Exmples of motion with a predictable pattern could include a child swinging in a swing, a ball rollig back and forth in a bowl, and two children on a see-saw.
PS2.B: Types of Interactions	Objects in contact exert forces on each other. (3-PS2-1) Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. 3-PS2-4. Define a simple design problem that can be solved by applying scientific ideas about magnets.*	magnetism static electricity electrical charge attract repel magnet magnetic field	PS2-3 Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. PS2-4 Example of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.

LS4: Interdependent Relationships in Ecosystems				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
LS2.C: Ecosystem Dynamics, Functioning, and Resilience	When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)	3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*	adaptation camouflage hibernation migration mimicry	

LS2.D: Social Interactions and Group Behavior	Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (Note: Moved from K–2) (3-LS2-1)	3-LS2-1.Construct an argument that some animals form groups that help members survive.	pollution population ecosystem migrate organism accomodation food chain food web	
LS4.A: Evidence of Common Ancestry and Diversity	Some kinds of plants and animals that once lived on Earth are no longer found anywhere. (Note: Moved from K–2) (3-LS4-1) Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments. (3-LS4-1)	3-LS4-1 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.	endangered extinct fossil paleontologist skeleton	LS4-1 Data could include type, size, and distrubatations of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossild found in Arctic areas, and fossils of extinct organisms.
LS4.C: Adaptation	For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all. (3-LS4-3)	3-LS4-3 Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	competition natural selection predator	LS4-3 Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system which the parts depend on each other.
LS4.D: Biodiversity and Humans	Populations live in a variety of habitats, and change in those habitats affects the organisms living there. (3-LS4-4)	3-LS4-4 Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.*	competition	LS4-4 Environment changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.

Standard: LS1 Inheritance and Variation of Traits: Life Cycles and Traits				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
LS1.B: Growth and Development of Organisms	Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)	3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	germinate life cycle reproduction	LS1- 1 Changes organismsgo through during their life form a pattern

LS3.A: Inheritance of Traits	Many characteristics of organisms are inherited from their parents. (3-LS3-1) Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3- LS3-2)	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.	inherit instinct variation	LS3-1 Patterns are the similarities and differences in traits shared between offspring and their parents, or among sibilings. Emphasis is on organism other than human LS3-2 Examples of the environmentaffecting a trait could include normally tall plants grown with sufficient eater are stunted; and a pet dog that is given too much food and little exercise.
LS3.B: Variation of Traits	Different organisms vary in how they look and function because they have different inherited information. (3-LS3-1) The environment also affects the traits that an organism develops. (3-LS3-2)	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.	group survive population	
LS4.B: Natural Selection	Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing. (3-LS4-2)	3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.	birth metamorphosis offspring	LS4-2 Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and animals that have better camoflauge coloration than other animals may be more likely to survive and therefore more likely to leave offspring.

Standard ESS2 Weather and Climate				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
ESS2.D: Weather and Climate	Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next. (3-ESS2-1) Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years. (3-ESS2-2)	3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. 3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.	weather climate atmosphere humidity air pressure axis cloud precipitation wind season	ESS2-1 Examples of data could include average temperature, precipitation, ad wind direction.

ESS3.B: Natural Hazards	A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3-1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)	3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*	environment natural hazard earthquakes flood landslide tornado levee floodwall lightning rod	ESS3-1 Design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, and lightning rods

Standard 3-5. Engineering Design				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
ETS1.A: Defining and Delimiting Engineering Problems	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)	3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	design process research technology	
ETS1.B: Developing Possible Solutions	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)	3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	infer inquiry invesigate model procedure scientist tool	
ETS1.C: Optimizing the Design Solution	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.	prototype evaluate redesign	

Standard: 4. Energy				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS3.A: Definitions of Energy	The faster a given object is moving, the more energy it possesses. (4- PS3-1) Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2),(4-PS3-3)	4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.	energy kinetic energy potential energy sound frequency wavelength pitch wavelength amplitude volume refraction reflection absorption conduction convection radiation	4-PS3-1 Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy. 4-PS3-2 Assessment Boundary: Assessment does not include quantitative measurements of energy. 4-PS3-3 Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact. Assessment Boundary: Assessment does not include quantitative measurements of energy.
PS3.B: Conservation of Energy and Energy Transfer	Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3) Light also transfers energy from place to place. (4-PS3-2) Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2),(4-PS3-4)	4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. 4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*	static electricity electric force electric current conductor filament series circuit parallel circuit	4-PS3-2 Assessment Boundary: Assessment does not include quantitative measurements of energy. 4-PS3-3 Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact. Assessment Boundary: Assessment does not include quantitative measurements of energy. 4-PS3-4 Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.

PS3.C: Relationship Between Energy and Forces	When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3)	4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.	motion force reference point gravity speed velocity	4-PS3-3 Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact. Assessment Boundary: Assessment does not include quantitative measurements of energy.
PS3.D: Energy in Chemical Processes and Everyday Life	The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4)	4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*	energy kinetic energy potential energy	4-PS3-4 Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.
ESS3.A: Natural Resources	Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1)	4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment.	mineral igneous sedimentary metamorphic magma fossil fuels renewable/nonrenewable resources	4-ESS3-1 Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.
ETS1.A: Defining Engineering Problems	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (secondary to 4-PS3-4)	4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*	inquiry investigation	4-PS3-4 Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device. Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.

Standard: 4. Waves: Waves and Information				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

PS4.A: Wave Properties	Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note:This grade band endpoint was moved from K–2). (4-PS4-1) Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)	4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	wavelength amplitude frequency	4-PS4-1 Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves. Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.
PS4.C: Information Technologies and Instrumentation	Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)	4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.*		4-PS4-3 Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves. Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.
ETS1.C: Optimizing The Design Solution	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (secondary to 4-PS4-3)	4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.*		4-PS4-3 Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves. Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

Standard: 4. Structure, Function, and Information Processing				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS4.B: Electromagnetic Radiation	An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2)	4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	refraction reflection absorption	4-PS4-2 Assessment Boundary: Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.

LS1.A: Structure and Function	Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)	4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	classify vertabrates invertabrates sepal pistal stamen pollination fertilization germinate photosynthesis cholorophyll adaptation characteristics inherit advantage stimulus instinct migration	4-LS1-1 Clarification Statement: Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin. Assessment Boundary: Assessment is limited to macroscopic structures within plant and animal systems.
LS1.D: Information Processing	Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions. (4-LS1-2)	4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.	adaptation characteristics inherit advantage stimulus instinct migration	4-LS1-2 Clarification Statement: Emphasis is on systems of information transfer. Assessment Boundary: Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.

Standard: 4. Earth's Systems: Processes that Shape the Earth				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS1.C: The History of Planet Earth	Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)	4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	mineral igneous sedimentary metamorphic weathering erosion landform fault groundwater precipitation water cycle	4-ESS1-1 Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock. Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.

ESS2.A: Earth Materials and Systems	Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4-ESS2-1)	4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.	erosion weathering precipitation water cycle	4-ESS2-1. Make observations and/or measurements to provide evidence of the effect
ESS2.B: Plate Tectonics and Large-Scale System Interactions	The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth. (4-ESS2-2)	4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.		4-ESS2-2 Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.
ESS2.E: Biogeology	Living things affect the physical characteristics of their regions. (4- ESS2-1)	4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.		4-ESS2-1 Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow. Assessment Boundary: Assessment is limited to a single form of weathering or erosion.
ESS3.B: Natural Hazards	A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2) (Note: This Disciplinary Core Idea can also be found in 3.WC.)	4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*		4-ESS3-2 Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity. Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.
ETS1.B: Designing Solutions to Engineering Problems	Testing a solution involves investigating how well it performs under a range of likely conditions. (secondary to 4-ESS3-2)	4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.*		4-ESS3-2 Clarification Statement: Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity. Assessment Boundary: Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.

Standard: 4. 3-5.Engineering Design

Topic	Disciplinary Core Idea	Performance Expectation	Essential Vocabulary	Clarification Statements
ETS1.A: Defining and Delimiting Engineering Problems	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)	3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.		
ETS1.B: Developing Possible Solutions	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)	3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		
ETS1.C: Optimizing the Design Solution	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		

Standard: Structure and Properties of Matter				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS1A Structure and Properties of Matter	Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects. (5-PS1-1) The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3)	5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen. 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. 5-PS1-3. Make observations and measurements to identify materials based on their properties.	atom atomic theory compound mass mixture molecule physical change solution temperature volume	5-PS1-1. Clarification Statement: Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water. 5-PS1-1. Assessment Boundary: Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles. 5-PS1-2. Clarification Statement: Examples of reactions or changes could include phase changes, dissolving, and mixing that form new substances. 5-PS1-2. Assessment Boundary: Assessment does not include distinguishing mass and weight. 5-PS1-3. Clarification Statement: Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property. 5-PS1-3.Assessment Boundary: Assessment does not include density or distinguishing mass and weight.

PS1.B: Chemical Reactions	- When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) - No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)	5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances. 5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.		

Standard 5. Matter and Energy in Organisms and Ecosystems				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS3.D: Energy in Chemical Processes and Everyday Life	The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). (5-PS3-1)	5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.		5-PS3-1. Clarification Statement: Examples of models could include diagrams, and flow charts.
LS1.C: Organization for Matter and Energy Flow in Organisms	Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1) Plants acquire their material for growth chiefly from air and water. (5-LS1-1)	5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. 5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.	photosynthesis	5-PS3-1. Clarification Statement: Examples of models could include diagrams, and flow charts. 5-LS1-1. Clarification Statement: Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.

LS2.A: Interdependent Relationships in Ecosystems	The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. (5-LS2-1)	5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment	food chain food web community predator prey producer consumer decomposer ecosystem habitat population environment competition	5-LS2-1. Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth. 5-LS2-1. Assessment Boundary: Assessment does not include molecular explanations.
LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1)	5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment	pollution conservation	5-LS2-1. Clarification Statement: Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth. 5-LS2-1. Assessment Boundary: Assessment does not include molecular explanations.

Standard 5. Earth's Systems				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

ESS2.A: Earth Materials and Systems	Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)	5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact		5-ESS2-1. Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system. 5-ESS2-1. Assessment Boundary: Assessment is limited to the interactions of two systems at a time.
ESS2.C: The Roles of Water in Earth's Surface Processes	Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere. (5-ESS2-2)	5-ESS2-2. Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.		5-ESS2-2. Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.

Standard 5. Space Systems: Stars and the Solar System				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS2.B: Types of Interactions	The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)	5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down		5-PS2-1. Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth. 5-PS2-1. Assessment Boundary: Assessment does not include mathematical representation of gravitational force.
ESS1.A: The Universe and its Stars	The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth. (5-ESS1-1)	5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.		5-ESS1-1. Assessment Boundary: Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).

ESS1.B: Earth and the Solar System	The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1-2)	5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.		5-ESS1-2. Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months. 5-ESS1-2. Assessment Boundary: Assessment does not include causes of seasons.

Standard 3-5. Engineering Design				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ETS1.A: Defining and Delimiting Engineering Problems	Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1)	3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.		
ETS1.B: Developing Possible Solutions	Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3)	3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		
ETS1.C: Optimizing the Design Solution	Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3)	3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		

Standard: ESS1 Earth's Place in the Universe				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS1A 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-ESS1-1) Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.	universe pale glow distance fasten vast violent fiery extremely leap unit probe telescope pattern collect vary temperature orbit galaxy	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS1B Earth and the Solar System	The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (MS-ESS1-2),(MS-ESS1-3) 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 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-ESS1-1) The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)	MS-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases,eclipses of the sun and moon, and seasons. MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.	Revolution Rotation Phase Lunar eclipse Solar eclipse Tide Neap tide Spring tide Analyze data	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

ESS1C The History of Planet Earth	ESS1.C: The History of Planet Earth The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4) Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS.ESS1.C GBE) (secondary to MS-ESS2-3) ESS2.A: Earth's Materials and Systems	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.	Geologic Time .Geology Fossils Paleontologist Evolve Adaptation Dinosaur Extinct Imprint Reptile Scientific Name Sprawl Stride Time Line Trackway Trilobite Precambrian Era Paleozoic Era Mesozoic Era Cenozoic Era	

Standard: ESS2 Earth's Systems				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS2A Earth Materials and Systems	The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)	MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales	Weathering Chemical Weathering Physical (Mechanical) Weathering Drainage basin Divide Floodplain Alluvial fan Delta Sinkhole Cut bank Point bar Meanders Oxbow lake cut off Natural levees Stream load Sand, Silt Clay Bed Load Dissolved Load. Deposition Discharge cfs Incipient Oxbow lake	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

ESS2B Plate Tectonics and Large-Scale System Interactions	Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)	MS-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	Fossil Strata crust Lithosphere Mantle Tectonic Plate Plate boundary Tsunami Epicenter Seismic wave Sea-floor spreading Focus	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS2C The Roles of Water in Earth's Surface Processes	Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (MS-ESS2-2) The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5) Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)	MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]	Fossil fuel Renewable resource Solar Energy Hydroelectric energy Geothermal energy Biomass Use numbers Use models Predict Nonrenewable resource	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

ESS2D Weather and Climate	Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6) Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. MS-ESS2-6. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	Atmosphere Convection current Precipitation Thunderstorm Blizzard Coriolis effect Jet stream Prevailing wind Ocean wind Planetary wind belt Air Mass Front Hurricane Climate Tornado	

Standard: ESS3 Earth and Human Activity				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
ESS3A Natural Resources	Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (MS-ESS3-1)	MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.	Renewable resources Resource depletion Analysis Aquifer Asteroid mining Biofuel Biomass Biosphere Nuclear Disaster Climate Change Ocean Currents Correlations Rainforest Earth systems	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

ESS3B Natural Hazards	Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)	MS-ESS1- 4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 -billion- year-old history. MS-ESS2- 2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. MS-ESS2- 3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	Sanitation Scale of human impact Seabed mining Solar Energy Solid waste NOAA Storm prediction Paleo Climate data Overbank flood PHA (Potentially Hazardous Asteroid) Hazard Preparation Severe Storms SST Sea Surface Temperatures VEI Volcanic Explosivity Index	

Standard: ESS3C Human Impacts on Earth Systems				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
	Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3) 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. (MSESS3-3),(MS-ESS3-4)	MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* 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	acid rain biodegradable conservation desalination environment geothermal energy hard water hydroelectric power litter natural resource nuclear energy pollutant pollution recycling sewage smog soft water solar cell solar energy wildlife	

Standard: ESS3D Global Climate Change				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**

	Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)	MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past.	Adaptation Acclimatize Anthropogenic Methane Mitigation Particulate matter Weather Urban heat island Stakeholder Parts per million (ppm) Isostatic Sea Level Change Gross Domestic Product (GDP) Greenhouse gases Global Climate Change Fossil fuels Fixation of Carbon Eustatic Sea Level Change Cryosphere CO2 Sequestration Climate Chlorofluorocarbon (CFC) Carbon Sink Carbon Dioxide (CO2) Biodiversity	

Standard: MS.Engineering Design				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	
Defining and Delimiting Engineering Problems	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1- 1)	MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	scientific method observation problem hypothesis controlled experiment procedure conclusion theory scientific law scientific knowledge variable independent variable dependent variable constant variable control group qualitative data quantitative data trial	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	

Developing Possible Sol	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MSETS1-4)	MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterativ	Data Hypothesis Validity Independent Variable Dependent Variable Qualitative Observation Quantitative Observation Technological Design Evaluate(Evaluate is the final step) Scientific Model Inference Hypothesis Valid Conclusion Variables Scientific Observation quantitative qualatative. Graphs Controlled Scientific Investigation Sample Control Group	
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	
Optimizing the Design Solution	Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved	Design Industrial Design Innovation Brainstorming Ideation Concept Development Design Research Product Development: (PD) Aesthetics Ergonomics Semantics Product Styling Design Engineering Thumbnail Sketch Product Rendering CAD CAE CAM Color Study Design for Manufacturing Assembly Drawing Materials and Materials Science: Bill of Materials (BOM) Prototype Design Patent	

Standard: LS1 From Molecules to Organisms: Structures and Processes

Topic	Disciplinary Core Idea	Performance Expectation	Essential Vocabulary	Clarification Statements
LS1A Structure and Function	All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1) Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2) In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)	MS-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. 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. MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	biotic abiotic unicellular multicellular cell membrane nucleus chloroplasts mitochondria cell membrane cell wall cell tissue organ organ system organism circulatory system excretory system digestive system respiratory system muscular system nervous system	MS-LS1-1 . [Clarification Statement: Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.] MS-LS1-2 [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.] MS-LS1-3 [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.]

LS1B Growth and Development in Organisms	Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (secondary to MS-LS3-2) Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4) Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4) Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)	MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	sexual reproduction asexual reproduction heredity genetics trait fertilization gametes purebred hybrid homozygous heterozygous gene allele dominant trait recessive trait genotype phenotype probablility Punnett square offspring Gregor Mendel DNA protein flower pollination seed root stem leaf structural, functional, and behavioral adaptations	MS-LS3-2 [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.] MS-LS1-4 [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.] MS-LS1-5 [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]
LS1C Organization for Matter and Energy Flow in Organisms	Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6) Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecule to support growth, or to release energy (MS-LS1-7)	MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.	matter molecule producer consumer decomposer chemical reaction photosynthesis cellular respiration	MS-LS1-6 [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.] MS-LS1-7 [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]
PS3D Energy in Chemical Processes and Everyday Life	The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6) Cellular respiration in plants and animals involves chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)	MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.	matter molecule producer consumer decomposer chemical reaction photosynthesis cellular respiration	MS-LS1-6 [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.] MS-LS1-7 [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

LS1D Information Processing	Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1- 8)	MS-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	homeostasis sensory receptors memory behavior	MS-LS1-8 [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]

Standard: LS2 Ecosystems: Interactions, Energy, and Dynamics				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
LS2A 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-LS2-1) 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-LS2- 1) Growth of organisms and population increases are limited by access to resources. (MS-LS2-1) Similarly, 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-LS2-2)	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. MS-LS2-2. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	biotic factors abiotic factors organism population community ecosystem biosphere birth rate death rate immigration emigration population density limiting factor carrying capacity niche competition predation predator prey symbiosis mutualism commensalism parasitism host parasite	MS-LS2-1 [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 and scarce resources.] MS-LS2-2 [Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.]
LS2B Cycles 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. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. (MS-LS2-3)	producer consumer decomposer autotroph heterotroph herbivore carnivore omnivore scavenger decomposer food chain food web energy pyramid the water cycle the carbon cycle the nitrogen cycle	MS-LS2-3 [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.] [Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.]

LS2C Ecosystem Dynamics, Functioning and Resiliance	Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)	MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	ecosystem dynamic biodiversity disturbance succession primary succession secondary succession	MS-LS2-4 [Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.] MS-LS2-5 [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]
ETS1B Developing Possible Solutions	There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (secondary to MS-LS2-5)	MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	ecosystem service habitat destruction habitat fragmentation biodiversity	MS-LS2-5 [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]
LS2D Social Interactions and Group Behavior	Groups may form because of genetic relatedness, physical proximity, or other recognition mechanisms (which may be species specific). They engage in a variety of signaling behaviors to maintain the group's integrity or to warn of threats. Groups often dissolve if they no longer function to meet individual's needs, if dominant members lose their place, or if other key members are removed from the group through death, predation, or exclusion by other members.	none identified	behavioral adaptations	none identified

Standard: LS3 Heredity: Inheritance and Variation of Traits				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
LS3A Inheritance of Traits	Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1) Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)	MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.	heredity, gene chromosome proteins mutations protein DNA adaptation	MS-LS3-1 [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.] MS-LS3-2 [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

LS3B Variation of Traits	In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2) In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)	MS-LS3-2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. MS-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.	sexual reproduction egg (ovum/ova) sperm zygote embryo gene allele chromosome variation traits mutation beneficial harmful neutral	MS-LS3-2 [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.] MS-LS3-1 [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.]

Standard: LS4 Biological Evolution: Unity and Diversity				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
LS4A Biological Evolution: Unity and Diversity	The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1) Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2) Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)	MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.	diversity species adaptation evolution scientific theory natural selection overproduction variation competition selection environmental change genes fossils fossil record index fossils radiometric dating geologic time scale diversity extinction embryology anatomy	MS-LS4-1 . [Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] MS-LS4-2 [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.] MS-LS4-3 [Clarification Statement:Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]
LS4B Natural Selection	Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)	MS-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.	natural selection genetic variation traits population probability artificial selection	MS-LS4-4 [Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations
LS4C Adaptation	Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)	MS-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.	adaptation natural selection species allele frequency	MS-LS4-6 [Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]

Standard: PS1 Matter and Its Interactions				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statements**
PS1A 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-PS1-1) Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.) Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) 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. (MS-PS1-4) Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)	MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. 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-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. 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-PS1-5. 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-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*	Atom Change of State Chemical bond Chemical Equation Chemical formula Chemical Reaction Compound Crystal Density Element Gas Law of conservation of matter Liquid Mass Matter Molecule Natural resource Periodic Table Polymer Pressure Product Pure substance Reactant Solid Sythetic material Thermal energy Volume Weight	MS-PS1-1 [Clarification Statement: 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.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.] MS-PS1-3 [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to qualitative information.] MS-PS1-4 [Clarification Statement: 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 drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.] MS-PS1-2 [Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.] MS-PS1-5 [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.] MS-PS1-6[Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]

PS1B Chemical Reactions	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. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-5.) The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) Some chemical reactions release energy, others store energy. (MS-PS1-6)	MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. 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-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. 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-PS1-5. 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-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*		
PS1C Nuclear Processes				

Standard: PS2 Motion and Stability: Forces and Interactions				
Topic	Disciplinary Core Idea	Performance Expectation	Essential Vocabulary	Clarification Statement

PS2A 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-PS2-1) 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. (MS-PS2-2) 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 withother people, these choices must also be shared. (MS-PS2-2)	MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* 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-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. 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-PS2-5. 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.	Acceleration Electric Charge Electric Current Electric field Electromagnet Electromagnetic induction Electromagnetism Field Force Friction Gravitational field Gravity Inertia Magent Magnetic domain Magnetic field Magnetic Force Motion Newton Reference point Speed Velocity	MS-PS2-1 [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] MS-PS2-2 [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), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.] MS-PS2-3 [Clarification Statement: 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.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.] MS-PS2-4 [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, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.] MS-PS2-5 [Clarification Statement: 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.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]

PS2B Types of Interactions	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. (MS-PS2-3) ▪ 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-PS2-4) ▪ 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-PS2-5)	MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* 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-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. 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-PS2-5. 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.		
PS2C Stability and Instability in Physical Systems				

Standard: PS3 Energy				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**

PS3A Definitions of Energy	The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary to MSPS1-4) The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary to MS-PS1-4) 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-PS3-1) A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) 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-PS3-3),(MS-PS3-4)	MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. 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-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. 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. MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	Energy Energy transfer Energy tranformation Field Heat Kinetic Energy Potential energy System Temperature Thermal Energy Work	MS-PS3-1 [Clarification Statement: 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 wiffle ball versus a tennis ball.] MS-PS3-2 [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 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.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.] MS-PS3-3 [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] MS-PS3-4 [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] MS-PS3-5 [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]

PS3B Conservation of Energy and Energy Transfer	When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)	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. 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. MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.		
PS3C 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-PS3-2)	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. 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. MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.		
PS3D Energy and Chemical Processes in Everyday Life				

Standard: PS4 Waves and Their Applications in Technologies for Information Transfer				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**

PS4A Wave Properties	A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) A sound wave needs a medium through which it is transmitted. (MS-PS4-2)	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-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. 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.	Absorption Amplitude Analog signal Digital signal Encode Frequency Light Mechanical wave Medium Noise Reflection Refraction Signal Sound wave Transmission Wave Wavelength Wave speed	MS-PS4-1 [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.] MS-PS4-2 [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.] MS-PS4-3 [Clarification Statement: 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.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.]
PS4B Electromagnetic Radiation	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. (MS-PS4-2) 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. (MS-PS4-2) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)	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-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. 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.		
PS4C Information Technologies and Instrumentation	Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	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-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. 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.		

Standard: MS.Engineering Design				
Topic	**Disciplinary Core Idea**	**Performance Expectation**	**Essential Vocabulary**	**Clarification Statement**
ETS1.A: Defining and Delimiting Engineering Problems	The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1- 1)	MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.		

ETS1.B: Developing Possible Solutions	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MSETS1-4)	MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.		
ETS1.C: Optimizing the Design Solution	Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.		