Disciplinary Core Idea

MS.ESS2.A: Earth Materials and Systems

All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)

Disciplinary Core Idea

MS.ESS2.C: The Roles of Water in Earth's Surface Processes

Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)

Disciplinary Core Idea

MS.ESS2.C: The Roles of Water in Earth's Surface Processes

Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)

Disciplinary Core Idea

MS.ESS3.A: 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)

Disciplinary Core Idea

MS.PS1.A: 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)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

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)

Disciplinary Core Idea

MS.PS1.B: 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-PS1-2)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

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)

Disciplinary Core Idea

MS.PS1.B: 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)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

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)

Disciplinary Core Idea

MS.PS1.A: Structure and Properties of Matter

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)

Disciplinary Core Idea

MS.PS3.A: 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. (MS-PS1-4)

Disciplinary Core Idea

MS.PS3.A: Definitions of Energy

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. (MS-PS1-4)

Disciplinary Core Idea

MS.PS1.B: Chemical Reactions

Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are re-grouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-5)

Disciplinary Core Idea

MS.PS1.B: Chemical Reactions

The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5)

Disciplinary Core Idea

MS.PS1.B: Chemical Reactions

Some chemical reactions release energy, others store energy. (MS-PS1-6)

Disciplinary Core Idea

MS.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-PS1-6)

Disciplinary Core Idea

MS.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 the characteristics may be incorporated into the new design. (MS-PS1-6)

Disciplinary Core Idea

MS.ETS1.C: Optimizing the Design Solution

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-PS1-6)

Disciplinary Core Idea

MS.PS2.B: 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)

Disciplinary Core Idea

MS.PS2.B: Types of Interactions

Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)

Disciplinary Core Idea

MS.PS2.B: Types of Interactions

Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)

Disciplinary Core Idea

MS.PS3.A: Definitions of Energy

Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)

Disciplinary Core Idea

MS.PS3.A: Definitions of Energy

A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

Disciplinary Core Idea

MS.PS3.C: 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)

Disciplinary Core Idea

MS.PS3.A: Definitions of Energy

Temperature is not a measure of energy; 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)

Disciplinary Core Idea

MS.PS3.B: Conservation of Energy and Energy Transfer

Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

Disciplinary Core Idea

MS.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 is likely to limit possible solutions. (MS-PS3-3)

Disciplinary Core Idea

MS.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. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (MS-PS3-3)

Disciplinary Core Idea

MS.PS3.A: Definitions of Energy

Temperature is not a measure of energy; the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-4)

Disciplinary Core Idea

MS.PS3.B: Conservation of Energy and Energy Transfer

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-PS3-4)

Disciplinary Core Idea

MS.PS3.B: 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)

Disciplinary Core Idea

MS.PS3.D: 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. (MS-LS1-6)

Disciplinary Core Idea

MS.LS1.C: 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)

Disciplinary Core Idea

MS.PS3.D: Energy in Chemical Processes and Everyday Life

Cellular respiration in plants and animals involve 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. (MS-LS1-7)

Disciplinary Core Idea

MS.LS1.C: Organization for Matter and Energy Flow in Organisms

Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

Disciplinary Core Idea

MS.LS2.B: 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)

Disciplinary Core Idea

MS.LS2.C: Ecosystem Dynamics, Functioning, and Resilience

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)

Disciplinary Core Idea

MS.ESS3.C: Human Impacts on Earth Systems

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)

Disciplinary Core Idea

MS.ESS3.C: Human Impacts on Earth Systems

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3)

Disciplinary Core Idea

MS.ESS3.C: Human Impacts on Earth Systems

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4)

Disciplinary Core Idea

MS.ESS2.C: The Roles of Water in Earth's Surface Processes

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)

Disciplinary Core Idea

MS.ESS2.D: Weather and Climate

Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)

Disciplinary Core Idea

MS.ESS2.C: The Roles of Water in Earth's Surface Processes

Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

Disciplinary Core Idea

MS.ESS2.D: 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)

Disciplinary Core Idea

MS.ESS2.D: Weather and Climate

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)

Disciplinary Core Idea

MS.ESS1.A: 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)

Disciplinary Core Idea

MS.ESS1.B: Earth and the Solar System

This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The 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)

Disciplinary Core Idea

MS.ESS1.A: The Universe and Its Stars

Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)

Disciplinary Core Idea

MS.ESS1.B: 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)

Disciplinary Core Idea

MS.ESS1.B: Earth and the Solar System

The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)

Disciplinary Core Idea

MS.ESS1.B: 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-ESS1-3)

Disciplinary Core Idea

MS.LS2.C: Ecosystem Dynamics, Functioning, and Resilience

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)

Disciplinary Core Idea

MS.LS4.D: Biodiversity and Humans

Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on— for example, water purification and recycling. (MS-LS2-5)

Disciplinary Core Idea

MS.ETS1.B: Developing Possible Solutions

There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-LS2-5)

Performance Expectation

MS-ESS2-1: Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.
Assessment Boundary: Assessment does not include the identification and naming of minerals.

Performance Expectation

MS-ESS2-4: Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.
Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.

Performance Expectation

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.

Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock)
Assessment Boundary: none

Performance Expectation

MS-PS1-1: Develop models to describe the atomic composition of simple molecules and extended structures.

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 description of all individual atoms in a complex molecule or extended structure is not required.

Performance Expectation

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.

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.

Performance Expectation

MS-PS1-3: Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the syntheic material. Examples of new materials could include new medicine, foods, and alternative fuels.
Assessment Boundary: Assessment is limited to qualitative information.

Performance Expectation

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.

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 drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.
Assessment Boundary: none

Performance Expectation

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.

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.

Performance Expectation

MS-PS1-6: Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

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.

** This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

Performance Expectation

MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

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.

Performance Expectation

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.

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.

Performance Expectation

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.

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 limited to qualitative evidence for the existence of fields.

Performance Expectation

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.

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.
Assessment Boundary: none

Performance Expectation

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.

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.

Performance Expectation

MS-PS3-3: Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*

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.

** This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

Performance Expectation

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.

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.

Performance Expectation

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.

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.

Performance Expectation

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.

Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.
Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.

Performance Expectation

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.

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.

Performance Expectation

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

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.

Performance Expectation

MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

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.
Assessment Boundary: none

Performance Expectation

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).
Assessment Boundary: none

** This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

Performance Expectation

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.

Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.
Assessment Boundary: none

Performance Expectation

MS-ESS2-5: Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.

Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).
Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.

Performance Expectation

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.

Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations
Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.

Performance Expectation

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.

Clarification Statement: Examples of models can be physical, graphical, or conceptual.
Assessment Boundary: none

Performance Expectation

MS-ESS1-2: Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).
Assessment Boundary: Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.

Performance Expectation

MS-ESS1-3: Analyze and interpret data to determine scale properties of objects in the solar system.

Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.
Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.

Performance Expectation

MS-LS2-5: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

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.
Assessment Boundary: none

** This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop and use a model to describe phenomena. (MS-ESS2-1)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to describe unobservable mechanisms. (MS-ESS2-4)

Science and Engineering Practice

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to predict and/or describe phenomena. (MS-PS1-1)

Science and Engineering Practice

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)

Science and Engineering Practice

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to predict and/or describe phenomena. (MS-PS1-4)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to describe unobservable mechanisms. (MS-PS1-5)

Science and Engineering Practice

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)

Science and Engineering Practice

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3)

Science and Engineering Practice

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

Science and Engineering Practice

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5)

Science and Engineering Practice

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to describe unobservable mechanisms. (MS-PS3-2)

Science and Engineering Practice

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

Science and Engineering Practice

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)

Science and Engineering Practice

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Science and Engineering Practice

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-6)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to describe unobservable mechanisms. (MS-LS1-7)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop a model to describe phenomena. (MS-LS2-3)

Science and Engineering Practice

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)

Science and Engineering Practice

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

Apply scientific ideas or principles to design an object, tool, process or system. (MS-ESS3-3)

Science and Engineering Practice

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Science and Engineering Practice

Planning and Carrying Out Investigations

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

Collect data about the performance of a proposed object, tool, process, or system under a range of conditions. (MS-ESS2-5)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop and use a model to describe phenomena. (MS-ESS2-6)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop and use a model to describe phenomena. (MS-ESS1-1)

Science and Engineering Practice

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

Develop and use a model to describe phenomena. (MS-ESS1-2)

Science and Engineering Practice

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)

Science and Engineering Practice

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1)

Crosscutting Concept

Energy and Matter

Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)

Crosscutting Concept

Stability and Change

Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. (MS-ESS2-1)

Crosscutting Concept

Scale, Proportion, and Quantity

Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)

Crosscutting Concept

Patterns

Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Crosscutting Concept

Structure and Function

Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)

Crosscutting Concept

Energy and Matter

Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5)

Crosscutting Concept

Energy and Matter

The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3)

Crosscutting Concept

Systems and System Models

Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-4)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-5)

Crosscutting Concept

Scale, Proportion, and Quantity

Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1)

Crosscutting Concept

Systems and System Models

Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS3-2)

Crosscutting Concept

Energy and Matter

The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)

Crosscutting Concept

Scale, Proportion, and Quantity

Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-4)

Crosscutting Concept

Energy and Matter

Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)

Crosscutting Concept

Energy and Matter

Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)

Crosscutting Concept

Energy and Matter

Matter is conserved because atoms are conserved in physical and chemical processes. (MS-LS1-7)

Crosscutting Concept

Energy and Matter

The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

Crosscutting Concept

Stability and Change

Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Crosscutting Concept

Cause and Effect

Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

Crosscutting Concept

Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

Crosscutting Concept

Systems and System Models

Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

Crosscutting Concept

Patterns

Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

Crosscutting Concept

Systems and System Models

Models can be used to represent systems and their interactions. (MS-ESS1-2)

Crosscutting Concept

Scale, Proportion, and Quantity

Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3)

Crosscutting Concept

Stability and Change

Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)

Connection to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1)

Connection to Engineering, Technology, and Applications of Science

Science Knowledge Is Based on Empirical Evidence

Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

Connection to Engineering, Technology, and Applications of Science

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

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Science Knowledge Is Based on Empirical Evidence

Science knowledge is based upon logical connections between evidence and explanations. (MS-LS1-6)

Connection to Engineering, Technology, and Applications of Science

Science Knowledge Is Based on Empirical Evidence

Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4)

Connection to Engineering, Technology, and Applications of Science

Science Addresses Questions About the Natural and Material World

Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

Connection to Engineering, Technology, and Applications of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1)

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Connection to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World

The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

Connection to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)

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Common Core State Standards for ELA/Literacy

Reading in Science

RST.6-8.1 - Key Ideas and Details

Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1)

Common Core State Standards for ELA/Literacy

Speaking & Listening

SL.8.5 - Presentation of Knowledge and Ideas

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2-1)

Common Core State Standards for ELA/Literacy

Writing in Science

WHST.6-8.2 - Text Types and Purposes

Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-ESS3-1)

Common Core State Standards for ELA/Literacy

Writing in Science

WHST.6-8.9 - Research to Build and Present Knowledge

Draw evidence from informational texts to support analysis reflection, and research. (MS-ESS3-1)

Common Core State Standards for Mathematics

Expressions & Equations

6.EE.B.6 - Reason about and solve one-variable equations and inequalities.

Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1)

Common Core State Standards for Mathematics

Expressions & Equations

7.EE.B.4 - Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1)