

## DCI: Motion and Stability: Forces and Interactions

### MS.PS2.A: 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)  
UT.7.1.2

## DCI: Motion and Stability: Forces and Interactions

### MS.PS2.A: Forces and Motion

The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.

(MS-PS2-2)  
UT.7.1.1

## DCI: Motion and Stability: Forces and Interactions

### MS.PS2.A: Forces and Motion

All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

(MS-PS2-2)  
UT.7.1.1

#### Performance Expectation

**UT.7.1.2 Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects in a system. Examples could include collisions between two moving objects or between a moving object and a stationary object.**

For Clarification Statements and Assessment Boundaries, please see NGSS.

**MS-PS2-1**

#### Performance Expectation

**UT.7.1.1 Carry out an investigation which provides evidence that a change in an object's motion is dependent on the mass of the object and the sum of the forces acting on it. Various experimental designs should be evaluated to determine how well the investigation measures an object's motion. Emphasize conceptual understanding of Newton's First and Second Laws. Calculations will only focus on one-dimensional movement; the use of vectors will be introduced in high school.**

For Clarification Statements and Assessment Boundaries, please see NGSS.

**MS-PS2-2**

## DCI: Motion and Stability: Forces and Interactions

### 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)

## DCI: Motion and Stability: Forces and Interactions

### 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)

## DCI: Motion and Stability: Forces and Interactions

### 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)

#### 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-PS2-3: 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.

## Science and Engineering Practices

### 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 Practices

### 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-PS2-2)

## Science and Engineering Practices

### 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 Practices

### 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 Practices

### 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-PS2-1)

## Crosscutting Concepts

### 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-PS2-1), (MS-PS2-4)

## Crosscutting Concepts

### Stability and Change

Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

## Crosscutting Concepts

### Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3), (MS-PS2-5)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.7 - Research to Build and Present Knowledge

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-1), (MS-PS2-5)

## 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.



## 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-PS2-1), (MS-PS2-3)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.3 - Key Ideas and Details

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1), (MS-PS2-2), (MS-PS2-5)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.1 - Text Types and Purposes

Cite specific textual evidence to support analysis of science and technical texts. (MS-PS2-2)

## Common Core State Standards for Mathematics

### 6.EE.A.2 - undefined

Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1), (MS-PS2-2)

## Common Core State Standards for Mathematics

### The Number System

#### 6.NS.C.5 - Apply and extend previous understandings of numbers to the system of rational numbers.

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS2-1)

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.A: Evidence of Common Ancestry 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)

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.A: Evidence of Common Ancestry and Diversity

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)

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.A: Evidence of Common Ancestry and Diversity

Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.B: Natural Selection

Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.B: Natural Selection

In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)

## Performance Expectation

**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.**

**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.

## Performance Expectation

**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.**

**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.

## Performance Expectation

**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.**

**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.

**Assessment Boundary:** none

## Performance Expectation

**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.**

**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.

## DCI: Biological Evolution: Unity and Diversity

### MS.LS4.C: 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)

## Science and Engineering Practices

### 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 displays of data to identify linear and nonlinear relationships. (MS-LS4-3)

## Science and Engineering Practices

### 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-LS4-1)

## Science and Engineering Practices

### Using Mathematics and Computational Thinking

Mathematical and computational thinking at the 6–8 level builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)

#### Performance Expectation

**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.**

**Clarification Statement:** Emphasis is on using simple probability statements and proportional reasoning to construct explanations. **Assessment Boundary:** none

#### Performance Expectation

**MS-LS4-5: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.**

**Clarification Statement:** Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries. **Assessment Boundary:** none



## Science and Engineering Practices

### 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 an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

## Science and Engineering Practices

### 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 to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)

## Science and Engineering Practices

### 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-LS4-5)

## Crosscutting Concepts

### Cause and Effect

Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4), (MS-LS4-5), (MS-LS4-6)

## Crosscutting Concepts

### Patterns

Patterns can be used to identify cause-and-effect relationships. (MS-LS4-2)

## 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-LS4-1), (MS-LS4-2), (MS-LS4-3), (MS-LS4-5)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.7 - Integration of Knowledge and Ideas

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS4-1), (MS-LS4-3)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.9 - Integration of Knowledge and Ideas

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3), (MS-LS4-4)

## Common Core State Standards for ELA/Literacy

### Speaking & Listening

#### SL.8.1 - Comprehension and Collaboration

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2), (MS-LS4-4)

## Crosscutting Concepts

### Patterns

Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1), (MS-LS4-3)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.8 - Research to Build and Present Knowledge

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5)

## 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-LS4-2), (MS-LS4-4)

## 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-LS4-1), (MS-LS4-2)

## Common Core State Standards for ELA/Literacy

### Speaking & Listening

#### SL.8.4 - Presentation of Knowledge and Ideas

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2), (MS-LS4-4)

## 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-LS4-2), (MS-LS4-4)

## MS.LS1.B: Growth and Development of Organisms

Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (MS-LS3-2)

## MS.LS3.A: 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)

## MS.LS3.A: Inheritance of Traits

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.B: Variation of Traits

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.B: 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)



## Science and Engineering Practices

### 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-LS3-1), (MS-LS3-2)

### Performance Expectation

**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.**

**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.

**Assessment Boundary:** none

### Performance Expectation

**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.**

**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.

### Crosscutting Concepts

#### Structure and Function

Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

### Crosscutting Concepts

#### Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)

## DCI: Energy

### 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)

## DCI: Energy

### 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)

## DCI: From Molecules to Organisms: Structures and Processes

### MS.LS1.A: 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)

## DCI: From Molecules to Organisms: Structures and Processes

### MS.LS1.A: Structure and Function

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)

## DCI: From Molecules to Organisms: Structures and Processes

### MS.LS1.A: Structure and Function

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)

DCI: From Molecules to Organisms: Structures and Processes

## MS.LS1.B: Growth and Development of Organisms

Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)

DCI: From Molecules to Organisms: Structures and Processes

## MS.LS1.B: Growth and Development of Organisms

Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)

DCI: From Molecules to Organisms: Structures and Processes

## 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)

DCI: From Molecules to Organisms: Structures and Processes

## MS.LS1.B: Growth and Development of Organisms

Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)

DCI: From Molecules to Organisms: Structures and Processes

## MS.LS1.D: 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)

## Performance Expectation

**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.**

**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.

**Assessment Boundary:** none

## Performance Expectation

**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.**

**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.

## Performance Expectation

**MS-LS1-3: Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.**

**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.

DCI: From Molecules to Organisms: Structures and Processes

## 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)

## Science and Engineering Practices

### 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-LS1-8)



## Performance Expectation

**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.**

**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.

**Assessment Boundary:** none

## Performance Expectation

**MS-LS1-5: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.**

**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.

## 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-LS1-8: Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.**

**Clarification Statement:** none

**Assessment Boundary:** Assessment does not include mechanisms for the transmission of this information.

## 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.

## 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). Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)

## 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-LS1-5), (MS-LS1-6)

### Science and Engineering Practices

#### 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-LS1-2)

### Science and Engineering Practices

#### 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 Practices

#### 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 to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)

## Crosscutting Concepts

### Cause and Effect

Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS1-4), (MS-LS1-5)

## Crosscutting Concepts

### Scale, Proportion, and Quantity

Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

## Crosscutting Concepts

### Systems and System Models

Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)

## Crosscutting Concepts

### Cause and Effect

Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)

## Science and Engineering Practices

### 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).

Use 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-LS1-4)

## Crosscutting Concepts

### Energy and Matter

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

## Crosscutting Concepts

### Energy and Matter

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

## Crosscutting Concepts

### Structure and Function

Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.1 - Text Types and Purposes

Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3), (MS-LS1-4)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.7 - Research to Build and Present Knowledge

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-LS1-1)



## 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-LS1-3), (MS-LS1-4), (MS-LS1-5), (MS-LS1-6)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.2 - Key Ideas and Details

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5), (MS-LS1-6)

## 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-LS1-2), (MS-LS1-7)

## 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-LS1-5), (MS-LS1-6)

## Common Core State Standards for ELA/Literacy

### Reading Informational Text

#### RI.6.8 - Integration of Knowledge and Ideas

Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-3), (MS-LS1-4)

### Writing in Science

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

Draw evidence from informational analysis reflection, texts to support and research. (MS-LS1-5), (MS-LS1-6)

### Writing in Science

#### WHST.6-8.8 - Research to Build and Present Knowledge

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS1-8)

## Common Core State Standards for Mathematics Statistics & Probability

### 6.SP.A.2 - Develop understanding of statistical variability.

Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4), (MS-LS1-5)

## Common Core State Standards for Mathematics Statistics & Probability

### 6.SP.B.4 - Summarize and describe distributions.

Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-LS1-4), (MS-LS1-5)

## Common Core State Standards for Mathematics Expressions & Equations

### 6.EE.C.9 - Represent and analyze quantitative relationships between dependent and independent variables.

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-1), (MS-LS1-2), (MS-LS1-3), (MS-LS1-6)

## DCI: Engineering Design

### 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-ETS1-1)

## DCI: Engineering Design

### 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-ETS1-4)

## DCI: Engineering Design

### 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-ETS1-2), (MS-ETS1-3)

## DCI: Engineering Design

### MS.ETS1.B: Developing Possible Solutions

Models of all kinds are important for testing solutions. (MS-ETS1-4)

## DCI: Engineering Design

### MS.ETS1.B: Developing Possible Solutions

Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)

## Performance Expectation

**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.\***

**Clarification Statement:** none **Assessment**

**Boundary:** none *\*This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

## Performance Expectation

**MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.\***

**Clarification Statement:** none **Assessment**

**Boundary:** none *\*This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

## Performance Expectation

**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.\***

**Clarification Statement:** none **Assessment**

**Boundary:** none *\*This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

DCI: Engineering Design

## 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-ETS1-4)

DCI: Engineering Design

## 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-ETS1-3)

## Performance Expectation

**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. \***

**Clarification Statement:** none **Assessment**

**Boundary:** none *\*This performance expectation integrates traditional science content with engineering through a practice or disciplinary code idea.*

## Science and Engineering Practices

### 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.

Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1)

## Science and Engineering Practices

### 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 generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)

## Science and Engineering Practices

### 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-ETS1-2)

## Science and Engineering Practices

### 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-ETS1-3)



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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-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.7 - Integration of Knowledge and Ideas

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ETS1-3)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.9 - Integration of Knowledge and Ideas

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2), (MS-ETS1-3)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.7 - Research to Build and Present Knowledge

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)

## 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-ETS1-4)

**Writing in Science****WHST.6-8.8 - Research to Build and Present Knowledge**

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)

**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-ETS1-2)

**Common Core State Standards for Mathematics****Mathematical Practices****MP.2 - Reason abstractly and quantitatively**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3), (MS-ETS1-4)

**Common Core State Standards for Mathematics****Expressions & Equations****7.EE.B.3 - Solve real-life and mathematical problems using numerical and algebraic expressions and equations.**

Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1), (MS-ETS1-2), (MS-ETS1-3)

**Common Core State Standards for Mathematics****Statistics & Probability****7.SP.C.7 - Investigate chance processes and develop, use, and evaluate probability models.**

Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)



## DCI: Earth's Place in the Universe

### MS.ESS1.C: The History of Planet Earth

Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (MS-ESS2-3)

## DCI: Earth's Systems

### 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)

## DCI: Earth's Systems

### MS.ESS2.A: 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)

## DCI: Earth's Systems

### MS.ESS2.B: 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)

## DCI: Earth's Systems

### 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)

## DCI: Earth's Systems

### 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)

## DCI: Earth's Systems

### 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)

## DCI: Earth's Systems

### MS.ESS2.C: 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)

## DCI: Earth's Systems

### 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)

## 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.

## DCI: Earth's Systems

### 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)

## DCI: Earth's Systems

### MS.ESS2.D: Weather and Climate

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

## DCI: Earth's Systems

### 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)

## Science and Engineering Practices

### 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), (MS-ESS2-6)

## Science and Engineering Practices

### 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-ESS2-2)



## Performance Expectation

**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.**

**Clarification Statement:** Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).

**Assessment Boundary:** Paleomagnetic anomalies in oceanic and continental crust are not assessed.

## 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-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-ESS2-1: 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-ESS2-2: Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.**

**Clarification Statement:** Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.

**Assessment Boundary:** none

## Science and Engineering Practices

### 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 Practices

### 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 Practices

### 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 provide evidence for phenomena. (MS-ESS2-3)

## Crosscutting Concepts

### Patterns

Patterns in rates of change and other numerical relationships can provide information about natural systems. (MS-ESS2-3)

## Common Core State Standards for ELA/Literacy

### Writing in Science

#### WHST.6-8.8 - Research to Build and Present Knowledge

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ESS2-5)

## Crosscutting Concepts

### 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 Concepts

### Cause and Effect

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

## Crosscutting Concepts

### 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-ESS2-2)

## Crosscutting Concepts

### 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 Concepts

### Energy and Matter

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

## Reading in Science

### RST.6-8.1 - Key Ideas and Details

Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)

## Reading in Science

### RST.6-8.7 - Integration of Knowledge and Ideas

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.9 - Integration of Knowledge and Ideas

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3), (MS-ESS2-5)

## 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), (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-6)

## 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-ESS2-2)

## 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)

## 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)

## 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)

## 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)

## DCI: Earth's Place in the Universe

### 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)

## DCI: Earth's Place in the Universe

### 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)

## DCI: Earth's Place in the Universe

### 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), (MS-ESS1-3)



### 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-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.**

**Clarification Statement:** Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.

**Assessment Boundary:** Assessment does not include recalling the names of specific periods or epochs and events within them.

## DCI: Earth's Place in the Universe

### MS.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)

### 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.



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**Reading in Science****RST.6-8.7 - Integration of Knowledge and Ideas**

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)

**Reading in Science****RST.6-8.1 - Key Ideas and Details**

Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3), (MS-ESS1-4)

**Science and Engineering Practices****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 Practices****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), (MS-ESS1-2)

**Science and Engineering Practices****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-ESS1-4)

### 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-ESS1-1)

### 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-ESS1-4)

## Crosscutting Concepts

### Patterns

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

## Crosscutting Concepts

### 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), (MS-ESS1-4)

## Crosscutting Concepts

### Systems and System Models

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

## 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-LS3-1), (MS-LS3-2)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.4 - Craft and Structure

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics. (MS-LS3-1), (MS-LS3-2)

## Common Core State Standards for ELA/Literacy

### Reading in Science

#### RST.6-8.7 - Integration of Knowledge and Ideas

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)

## Common Core State Standards for Mathematics

### Ratios & Proportional Relationships

#### 6.RP.A.1 - Understand ratio concepts and use ratio reasoning to solve problems.

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4), (MS-LS4-6)

## Common Core State Standards for Mathematics

### Statistics & Probability

#### 6.SP.B.5 - Summarize and describe distributions.

Summarize numerical data sets in relation to their context. (MS-LS4-4), (MS-LS4-6)

## Common Core State Standards for Mathematics

### Ratios & Proportional Relationships

#### 7.RP.A.2 - Analyze proportional relationships and use them to solve real-world and mathematical problems.

Recognize and represent proportional relationships between quantities. (MS-LS4-4), (MS-LS4-6)

## Common Core State Standards for Mathematics

### Expressions & Equations

#### 7.EE.B.3 - Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1), (MS-PS2-2)

## Common Core State Standards for Mathematics

### Mathematical Practices

#### MP.4 - Model with mathematics

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. A student might apply proportional reasoning to plan a school event or analyze a problem in the community. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. (MS-LS4-6)



## 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-LS3-1), (MS-LS3-2)

## Common Core State Standards for Mathematics

### Statistics & Probability

#### 6.SP.B.5 - Summarize and describe distributions.

Summarize numerical data sets in relation to their context. (MS-LS3-2)

## Common Core State Standards for Mathematics

### Mathematical Practices

#### MP.4 - Model with mathematics

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. A student might apply proportional reasoning to plan a school event or analyze a problem in the community. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. (MS-LS3-2)

## 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-PS2-1), (MS-PS2-2)

## Common Core State Standards for Mathematics

### Mathematical Practices

#### MP.2 - Reason abstractly and quantitatively

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects. (MS-PS2-1), (MS-PS2-2), (MS-PS2-3)

## Common Core State Standards for Mathematics

### Mathematical Practices

#### MP.2 - Reason abstractly and quantitatively

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects. (MS-ESS1-3)

## Common Core State Standards for Mathematics

### Mathematical Practices

#### MP.4 - Model with mathematics

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. A student might apply proportional reasoning to plan a school event or analyze a problem in the community. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose. (MS-ESS1-1), (MS-ESS1-2)

## 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-ESS1-2), (MS-ESS1-4)

## 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-ESS2-2), (MS-ESS2-3)

## Common Core State Standards for Mathematics

### The Number System

#### 6.NS.C.5 - Apply and extend previous understandings of numbers to the system of rational numbers.

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-ESS2-5)

Mathematical Practices

**MP.2 - Reason abstractly and quantitatively**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects. (MS-ESS2-2), (MS-ESS2-3), (MS-ESS2-5)

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-ESS2-2), (MS-ESS2-3)

Ratios & Proportional Relationships

**6.RP.A.1 - Understand ratio concepts and use ratio reasoning to solve problems.**

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)

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-ESS1-2), (MS-ESS1-4)

Ratios & Proportional Relationships

**7.RP.A.2 - Analyze proportional relationships and use them to solve real-world and mathematical problems.**

Recognize and represent proportional relationships between quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)