



# **New Jersey Student Learning Standards**

## **Science**

### **(NJSLS-Science)**

Division of Teaching and Learning Services  
New Jersey Department of Education

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## Introduction

N.J.A.C. 6A:8-2.1 directs the Commissioner to engage in the review and readoption of the New Jersey Student Learning Standards (NJSLS) every five years. Science (NJSLS-S) standards were most recently adopted in 2020; the review process began in May 2025. After months of intensive review and discussion, including with external expert committees, the New Jersey Department of Education (Department) is presenting recommendations for revisions.

The external committees involved in the review and revision of the 2020 New Jersey Student Learning Standards for Science (NJSLS-S) were committed to continuing the implementation trajectory established by the adoption of the *Next Generation Science Standards: For States, By States* in 2014. As a result, revisions were made only when absolutely necessary to enhance progression of disciplinary core ideas. Revisions were recommended for only four performance expectations.

## Science Framework

The New Jersey Student Learning Standards for Science (NJSLS-S) are grounded in the principles and vision outlined in the National Research Council's 2012 consensus study, *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, and are aligned with the performance expectations of the *Next Generation Science Standards: For States, By States* (NRC, 2013).

The New Jersey Student Learning Standards for Science (NJSLS-S) are organized into four disciplines:

- Physical Science (PS),
- Life Science (LS),
- Earth and Space Sciences (ESS), and
- Engineering, Technology, and Applications of Science (ETS).

Each discipline is comprised of Disciplinary Core Ideas and their components. The following describe the Disciplinary Core Ideas and their components in Physical Science, Life Science, Earth and Space Sciences, and Engineering, Technology, and the Applications of Science.

## Physical Science (PS)

**PS1. Matter and Its Interactions:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of the structure, properties, and interactions of matter.

**PS1.A. Structures and Properties of Matter**

**PS1.B. Chemical Reactions**

**PS1.C. Nuclear Processes**

**PS2. Motion and Stability: Forces and Interactions:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how to explain and predict interactions between objects and within systems of objects.

**PS2.A. Forces and Motion**

**PS2.B. Types of Interactions**

**PS2.C. Stability and Instability in Physical Systems**

**PS3. Energy:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of what is meant by conservation of energy, and how energy is transferred between objects or systems.

**PS3.A. Definitions of Energy**

**PS3.B. Conservation of Energy and Energy Transfer**

**PS3.C. Relationship Between Energy and Forces**

**PS3.D. Energy in Chemical Processes and Everyday Life**

**PS4. Waves and Their Applications in Technologies for Information Transfer:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how and why waves are used to transfer energy and information.

**PS4.A. Wave Properties**

**PS4.B. Electromagnetic Radiation**

**PS4.C. Information Technologies and Instrumentation**

## Life Science (LS)

**LS1. From Molecules to Organisms: Structures and Processes:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how organisms live, grow, reproduce, and respond to their environment.

**LS1.A. Structure and Function**

**LS1.B. Growth and Development of Organisms**

**LS1.C. Organization for Matter and Energy Flow in Organisms**

**LS1.D. Information Processing**

**LS2. Ecosystems: Interactions, Energy, and Dynamics:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how and why organisms interact with their environment and the effects of these interactions.

**LS2.A. Interdependent Relationships in Ecosystems**

**LS2.B. Cycles of Matter and Energy Transfer in Ecosystems**

**LS2.C. Ecosystem Dynamics, Functioning, and Resilience**

**LS2.D. Social Interactions and Group Behavior**

**LS3. Heredity: Inheritance and Variation of Traits:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how characteristics are passed from one generation to the next, and why individuals of the same species—even siblings—exhibit different traits.

**LS3.A. Inheritance of Traits**

**LS3.B. Variation of Traits**

**LS4. Biological Evolution: Unity and Diversity:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how there can be so many similarities among organisms.

**LS4.A. Evidence of Common Ancestry and Diversity**

**LS4.B. Natural Selection**

**LS4.C. Adaptation**

**LS4.D. Biodiversity and Humans**

## Earth and Space Sciences (ESS)

**ESS1. Earth’s Place in the Universe:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of the universe and Earth’s place in it.

**ESS1.A. The Universe and Its Stars**

**ESS1.B. Earth and the Solar System**

**ESS1.C. The History of Planet Earth**

**ESS2. Earth’s Systems:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how and why the Earth is constantly changing including:

**ESS2.A. Earth Materials and Systems**

**ESS2.B. Plate Tectonics and Large-Scale System Interactions**

**ESS2.C. The Roles of Water in Earth’s Surface Processes**

**ESS2.D. Weather and Climate**

**ESS2.E. Biogeology**

**ESS3. Earth and Human Activity:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of the Earth’s surface processes, and how human activities affect each other.

**ESS3.A. Natural Resources**

**ESS3.B. Natural Hazards**

**ESS3.C. Human Impacts on Earth Systems**

**ESS3.D. Global Climate Change**

## Engineering, Technology, and the Application of Science (ETS)

**ETS1. Engineering Design:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how engineers solve problems including:

**ETS1.A. Defining and Delimiting Engineering Problems**

**ETS1.B. Developing Possible Solutions**

**ETS2. Links Among Engineering, Technology, Science, and Society:** Beginning in the earliest grades, students develop increasingly sophisticated understandings of how engineering, technology, science, and society are interconnected.

**ETS2.A. Interdependence of Science, Engineering, and Technology**

**ETS2.B. Influence of Engineering, Technology, and Science on Society and the Natural World**

## Coding of Performance Expectations

Each performance expectation has a unique code that follows a specific format, which is designed to provide a clear, structured way to identify and organize the standards across grade levels and scientific disciplines. For example, 5-PS1-2.

The first number indicates a grade K–5 or specifies MS (middle school) or HS (high school). The next alphanumeric code specifies the disciplinary core idea. Finally, the number at the end of each code indicates the order in which the PE appears in the standards.

**5** - Grade 5

**PS1** - Matter and Its Interactions

**2** - second PE in sequence

**5-PS1-2** Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

## Structure of This Document

### Developmental Progressions

This portion of the document presents the performance expectations by disciplinary core idea(s) in K–12 learning progressions. Presenting learning standards in K–12 progressions helps educators understand how students build knowledge and skills over time, allowing for more intentional and coherent curriculum design. By mapping performance expectations across grades and levels, teachers and curriculum developers can see how foundational concepts introduced in early grades evolve into more complex and nuanced understandings in later years. This vertical alignment supports scaffolding, ensuring that instruction is developmentally appropriate and that students are prepared for increasingly sophisticated tasks. It also enables educators to identify gaps or redundancies in instruction, promote continuity in learning, and better support students' long-term mastery of essential concepts.

Some of the NJSLS-S are based on more than one disciplinary core idea. In these cases, all of the relevant DCIs will be identified following the performance expectation. For example, 5-PS1-2 is developed using PS1.A: Structure and Properties of Matter and PS1.B: Chemical Reactions. 5-PS1-2 will appear in both rows. Both DCIs will be noted using its alphanumeric code. For example:

5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (PS1.A, PS1.B)

In the NJSLS-S, a secondary DCI refers to a content idea that is not the primary focus of a specific performance expectation but is still naturally connected and relevant to the learning.

## Physical Science

An overarching goal for learning in the physical sciences is to help students see that there are mechanisms of cause and effect in all systems and processes that can be understood through a common set of physical and chemical principles. The first three physical science core ideas answer two fundamental questions: “What is everything made of?” and “Why do things happen?” These core ideas can be applied to explain and predict a wide variety of phenomena that occur in people’s everyday lives, such as the evaporation of a puddle of water, the transmission of sound, the digital storage and transmission of information, the tarnishing of metals, and photosynthesis. And because such explanations and predictions rely on a basic understanding of matter and energy, students’ abilities to conceive of the interactions of matter and energy are central to their science education. The fourth core idea, Waves and Their Applications in Technologies for Information Transfer, introduces students to the ways in which advances in the physical sciences during the 20<sup>th</sup> century underlay all sophisticated technologies available today. This fourth idea stresses the interplay of physical science and technology, as well as expanding students’ understanding of light and sound as mechanisms of both energy transfer and transfer of information between objects that are not in contact. Modern communication, information, and imaging technologies are applications of scientific understandings of light and sound and their interactions with matter.

### PS1 Matter and Its Interactions

**PS1 Matter and Its Interactions** examines how one can explain the structure, properties, and interactions of matter. The atomic model helps explain both qualitative and quantitative observations of matter. Matter is understood through the types of atoms it contains and their interactions, which determine its states, properties, and behaviors. Chemical reactions rearrange atoms into new molecules while conserving their number, and nuclear reactions alter atomic nuclei, playing a key role in phenomena like solar energy and isotope formation.

Core Idea	K–2	3–5	6–8	9–12
<b>PS1.A. Structures and Properties of Matter</b>	<p>2-PS1-1. Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.</p> <p>2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.</p> <p>2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be</p>	<p>5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.</p> <p>5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (PS1.A, PS1.B)</p> <p>5-PS1-3. Make observations and measurements to identify materials based on their properties.</p>	<p>MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures.</p> <p>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. (PS1.A, PS1.B)</p> <p>MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (PS1.A, PS1.B)</p>	<p>HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.</p> <p>HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the</p>

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Core Idea	K–2	3–5	6–8	9–12
	disassembled and made into a new object.		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. (PS1.A, PS3.A)	<p>patterns of chemical properties. (PS1.A, PS1.B)</p> <p>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (PS1.A, PS2.A)</p> <p>HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. (PS1.A, PS3.A)</p>
<b>PS1.B. Chemical Reactions</b>	2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.	<p>5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved. (PS1.A, PS1.B)</p> <p>5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.</p>	<p>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. (PS1.A, PS1.B)</p> <p>MS-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. (PS1.A, PS1.B)</p> <p>MS-PS1-5. Develop and use a model to describe how the total number of atoms does not</p>	<p>HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. (PS1.A, PS1.B)</p> <p>HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in</p>

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Core Idea	K–2	3–5	6–8	9–12
			change in a chemical reaction and thus mass is conserved.	total bond energy. (PS1.A, PS1.B)
			MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. (PS1.B, <i>secondary to ETS1.B and ETS1.C</i> )	HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
				HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history. (ESS1.C, <i>secondary to PS1.C</i> )
				HS-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
<b>PS1.C. Nuclear Processes</b>	Intentionally left blank	Intentionally left blank	Intentionally left blank	HS-PS1-8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and

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Core Idea	K–2	3–5	6–8	9–12
				radioactive decay.  HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. (ESS1.C, <i>secondary to ESS2.B and PS1.C</i> )

## PS2 Motion and Stability: Forces and Interactions

**PS2 Motion and Stability: Forces and Interactions** examines how one can explain and predict interactions between objects and within systems of objects. Interactions between any two objects can cause changes in one or both of them. An understanding of the forces between objects is important for describing how their motions change, as well as for predicting stability or instability in systems at any scale. All forces between objects arise from a few types of interactions: gravity, electromagnetism, and the strong and weak nuclear interactions.

Core Idea	K–2	3–5	6–8	9–12
<b>PS2.A. Forces and Motion</b>	K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (PS2.A, PS2.B, <i>secondary to PS3.C</i> )  K-PS2-2. Analyze data to determine if a design solution	3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. (PS2.A, PS2.B)  3-PS2-2. Make observations and/or measurements of an object’s motion to provide evidence that a	MS-PS2-1. Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.  MS-PS2-2. Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces	HS-PS2-1. Analyze data to support the claim that Newton’s second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.

## PS2 Motion and Stability: Forces and Interactions

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Core Idea	K–2	3–5	6–8	9–12
	works as intended to change the speed or direction of an object with a push or a pull. (PS2.A and ETS1.A)	pattern can be used to predict future motion.	on the object and the mass of the object.	<p>HS-PS2-2. Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.</p> <p>HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. (PS2.A, secondary to ETS1.A and ETS1.C)</p>
<b>PS2.B. Types of Interactions</b>	K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (PS2.A, PS2.B, secondary to PS3.C)	<p>3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. (PS2.A, PS2.B)</p> <p>3-PS2-3. Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.</p> <p>3-PS2-4. Define a simple design problem that can be solved by</p>	<p>MS-PS2-3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.</p> <p>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.</p> <p>MS-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between</p>	<p>HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles. (PS1.A, PS2.B)</p> <p>HS-PS2-4. Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.</p>

## PS2 Motion and Stability: Forces and Interactions

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Core Idea	K-2	3-5	6-8	9-12
		applying scientific ideas about magnets.  5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down.	objects exerting forces on each other even though the objects are not in contact.	HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. (PS2.B, PS3.A)  HS-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

## PS3: Energy

**PS3: Energy** focuses on how energy is transferred and conserved. Interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another. The total energy within a defined system changes only by the transfer of energy into or out of the system.

Core Idea	K-2	3-5	6-8	9-12
<b>PS3.A. Definitions of Energy</b>	Intentionally left blank	4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.  4-PS3-2. Make observations to provide evidence that energy can	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. (PS1.A, PS3.A)	HS-PS2-5. Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can

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Core Idea	K-2	3-5	6-8	9-12
		<p>be transferred from place to place by sound, light, heat, and electric currents. (PS3.A, PS3.B)</p> <p>4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. (PS3.A, PS3.B, PS3.C)</p>	<p>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.</p> <p>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. (PS3.A, PS3.C)</p> <p>MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (PS3.A, PS3.B, <i>secondary to ETS1.A and ETS1.B</i>)</p> <p>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. (PS3.A, PS3.B)</p>	<p>produce an electric current. (PS2.B, PS3.A)</p> <p>HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. (PS3.A, PS3.B)</p> <p>HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).</p> <p>HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (PS3.A, PS3.D, <i>secondary to ETS1.A</i>)</p>

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Core Idea	K–2	3–5	6–8	9–12
<b>PS3.B. Conservation of Energy and Energy Transfer</b>	<p>K-PS3-1. Make observations to determine the effect of sunlight on Earth’s surface.</p> <p>K-PS3-2. Use tools and materials provided to design and build a structure that will reduce the warming effect of sunlight on an area.</p>	<p>4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (PS3.A, PS3.B)</p> <p>4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. (PS3.A, PS3.B, PS3.C)</p> <p>4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (PS3.B, PS3.D, <i>secondary to ETS1.A</i>)</p>	<p>MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (PS3.A, PS3.B, <i>secondary to ETS1.A and ETS1.B</i>)</p> <p>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. (PS3.A, PS3.B)</p> <p>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.</p>	<p>HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other components and energy flows in and out of the system are known. (PS3.A, PS3.B)</p> <p>HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). (PS3.B, PS3.D)</p>
<b>PS3.C. Relationship Between Energy and Forces</b>	<p>K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object. (PS2.A, PS2.B, <i>secondary to PS3.C</i>)</p>	<p>4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. (PS3.A, PS3.B, PS3.C)</p>	<p>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. (PS3.A, PS3.C)</p>	<p>HS-PS3-5. Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.</p>

## PS3: Energy

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Core Idea	K-2	3-5	6-8	9-12
<b>PS3.D. Energy in Chemical Processes and Everyday Life</b>	Intentionally left blank	<p>4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (PS3.B, PS3.D, <i>secondary to ETS1.A</i>)</p> <p>5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. (PS3.D, <i>secondary to LS1.C</i>)</p>	<p>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. (PS3.D, LS1.C)</p> <p>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. (LS1.C, PS3.D)</p>	<p>HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (PS3.A, PS3.D, <i>secondary to ETS1.A</i>)</p> <p>HS-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). (PS3.B, PS3.D)</p> <p>HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. (PS3.D, PS4.A, PS4.B, PS4.C)</p> <p>HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of</p>

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Core Idea	K–2	3–5	6–8	9–12
				carbon among the biosphere, atmosphere, hydrosphere, and geosphere. (LS2.B, LS3.D)  HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation. (ESS1.A, PS3.D)

## PS4: Waves and Their Applications in Technologies for Information Transfer

**PS4: Waves and Their Applications in Technologies for Information Transfer** examines how waves are used to transfer energy and information. Waves are a repeating pattern of motion that transfers energy from place to place without overall displacement of matter. Light and sound are wavelike phenomena. By understanding wave properties and the interactions of electromagnetic radiation with matter, scientists and engineers can design systems for transferring information across long distances, storing information, and investigating nature on many scales—some of them far beyond direct human perception.

Core Idea	K–2	3–5	6–8	9–12
<b>PS4.A. Wave Properties</b>	1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate.	4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.	MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.  MS-PS4-2. Develop and use a model to describe that waves are	HS-PS4-1. Use mathematical representations to describe a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

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Core Idea	K–2	3–5	6–8	9–12
			reflected, absorbed, or transmitted through various materials. (PS4.A, PS4.B)	<p>HS-PS4-2. Evaluate questions about the advantages of using digital transmission and storage of information.</p> <p>HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. (PS4.A, PS4.B)</p> <p>HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. (PS3.D, PS4.A, PS4.B, PS4.C)</p> <p>HS-ESS2-3. Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection. (ESS2.A, ESS2.B, <i>secondary to PS4.A</i>)</p>

## PS4: Waves and Their Applications in Technologies for Information Transfer

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Core Idea	K–2	3–5	6–8	9–12
<b>PS4.B. Electromagnetic Radiation</b>	1-PS4-2. Make observations to construct an evidence-based account that objects in darkness can be seen only when illuminated.	4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.	MS-PS4-2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. (PS4.A, PS4.B)	HS-PS4-3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. (PS4.A, PS4.B)
	1-PS4-3. Plan and conduct investigations to determine the effect of placing objects made with different materials in the path of a beam of light.			HS-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.  HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. (PS3.D, PS4.A, PS4.B, PS4.C)  HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical

## PS4: Waves and Their Applications in Technologies for Information Transfer

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Core Idea	K–2	3–5	6–8	9–12
				evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. (ESS1.A, PS4.B)
<b>PS4.C. Information Technologies and Instrumentation</b>	1-PS4-4. Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.	4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information. (PS4.C, <i>secondary to ETS1.C</i> )	MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.	HS-PS4-5. Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy. (PS3.D, PS4.A, PS4.B, PS4.C)

# Life Science

Life Sciences provide a framework for building students’ understanding of biological concepts across grade levels. They are organized into four main strands. LS1: From Molecules to Organisms – Structures and Processes emphasizes how living organisms function, grow, and reproduce. It includes instruction on cells, body systems, and the role of energy in sustaining life. LS2: Ecosystems – Interactions, Energy, and Dynamics focusses on how organisms interact within ecosystems, focusing on energy transfer, food webs, population dynamics, and the impact of environmental changes. LS3: Heredity – Inheritance and Variation of Traits This includes how genetic information is passed from one generation to the next, and how traits vary due to genetic and environmental factors. LS4: Biological Evolution – Unity and Diversity investigates the evidence for evolution, mechanisms like natural selection, and the diversity of life resulting from common ancestry.

## LS1: From Molecules to Organisms: Structures and Processes

**LS1: From Molecules to Organisms: Structures and Processes** addresses how individual organisms are configured and how these structures function to support life, growth, behavior, and reproduction. The first core idea hinges on the unifying principle that cells are the basic unit of life.

Core Idea	K–2	3–5	6–8	9–12
<b>LS1.A: Structure and Function</b>	1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. (LS1.A, LS1.D)	4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.	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.	HS-LS1-1. Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
			MS-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	HS-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
			MS-LS1-3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	HS-LS1-3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

## LS1: From Molecules to Organisms: Structures and Processes

**LS1: From Molecules to Organisms: Structures and Processes** addresses how individual organisms are configured and how these structures function to support life, growth, behavior, and reproduction. The first core idea hinges on the unifying principle that cells are the basic unit of life.

Core Idea	K–2	3–5	6–8	9–12
<b>LS1.B: Growth and Development of Organisms</b>	1-LS1-2. Read texts and use media to determine patterns in behavior of parents and offspring that help offspring survive.	3-LS1-1. Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.	MS-LS1-4. Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants, respectively.  MS-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.  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. (LS1.B, LS3.A, LS3.B)	HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (LS1.A, LS3.A)
				HS-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.

## LS1: From Molecules to Organisms: Structures and Processes

**LS1: From Molecules to Organisms: Structures and Processes** addresses how individual organisms are configured and how these structures function to support life, growth, behavior, and reproduction. The first core idea hinges on the unifying principle that cells are the basic unit of life.

Core Idea	K–2	3–5	6–8	9–12
<b>LS1.C: Organization for Matter and Energy Flow in Organisms</b>	K-LS1-1. Use observations to describe patterns of what plants and animals including humans need to survive.	5-PS3-1. Use models to describe that energy in animals’ food (used for body repair, growth, and motion and to maintain body warmth) was once energy from the sun. (PS3.D, <i>secondary to LS1.C</i> )  5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.	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. (PS3.D, LS1.C)  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. (LS1.C, PS3.D)	HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.  HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.  HS-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
	<b>LS1.D: Information Processing</b>	1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs. (LS1.A, LS1.D)	4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.	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.

## LS2: Ecosystems: Interactions, Energy, and Dynamics

**LS2: Ecosystems: Interactions, Energy, and Dynamics** explores organisms’ interactions with each other and their physical environment. This includes how organisms obtain resources, how they change their environment, how changing environmental factors affect organisms and ecosystems, how social interactions and group behavior play out within and between species, and how these factors all combine to determine ecosystem functioning.

Core Idea	K–2	3–5	6–8	9–12
<b>LS2.A: Interdependent Relationships in Ecosystems</b>	<p>2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.</p> <p>2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. (LS2.A, secondary to ETS1.B)</p>	<p>5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. (LS2.A, LS2.B)</p>	<p>MS-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.</p> <p>MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.</p>	<p>HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</p> <p>HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (LS2.A, LS2.C)</p>
	Intentionally left blank	<p>5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. (LS2.A, LS2.B)</p>	<p>MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</p>	<p>HS-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.</p> <p>HS-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.</p> <p>HS-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere,</p>
<b>LS2.B: Cycles of Matter and Energy Transfer in Ecosystems</b>	Intentionally left blank			

## LS2: Ecosystems: Interactions, Energy, and Dynamics

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Core Idea	K–2	3–5	6–8	9–12
				atmosphere, hydrosphere, and geosphere. (LS2.B, PS3.D)
<b>LS2.C: Ecosystem Dynamics, Functioning, and Resilience</b>	Intentionally left blank	3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. (LS2.C, LS4.D)	MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.  MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (LS2.C, LS4.D, <i>secondary to ETS1.B</i> )	HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. (LS2.A, LS2.C)  HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.  HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (LS2.C, LS4.D, <i>secondary to ETS1.B</i> )
<b>LS2.D: Social Interactions and Group Behaviors</b>	Intentionally left blank	3-LS2-1. Construct an argument that some animals form groups that help members survive.	Intentionally left blank	HS-LS2-8. Evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.

## LS3: Heredity: Inheritance and Variation of Traits

**LS3: Heredity: Inheritance and Variation of Traits** across generations focuses on the flow of genetic information between generations. This idea explains the mechanisms of genetic inheritance and describes the environmental and genetic causes of gene mutation and the alteration of gene expression.

Core Idea	K–2	3–5	6–8	9–12
<b>LS3.A: Inheritance of Traits</b>	1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. (LS3.A, LS3.B)	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. (LS3.A, LS3.B) 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. (LS3.A, LS3.B)	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. (LS3.A, LS3.B) 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. (LS1.B, LS3.A, LS3.B)	HS-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring. (LS1.A, LS3.A)
<b>LS3.B: Variation of Traits</b>	1-LS3-1. Make observations to construct an evidence-based account that young plants and animals are like, but not exactly like, their parents. (LS3.A, LS3.B)	3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms. (LS3.A, LS3.B) 3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. (LS3.A, LS3.B)	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. (LS3.A, LS3.B) 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. (LS1.B, LS3.A, LS3.B)	HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors. HS-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

## LS4: Biological Evolution: Unity and Diversity

**LS4: Biological Evolution: Unity and Diversity** explores “changes in the traits of populations of organisms over time” and the factors that account for species’ unity and diversity alike.

Core Idea	K–2	3–5	6–8	9–12
<b>LS4.A: Evidence of Common Ancestry and Diversity</b>	Intentionally left blank	3-LS4-1. Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.	MS-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.  MS-LS4-2. Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.  MS-LS4-3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.	HS-LS4-1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
		3-LS4-2. Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.	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.	HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: <ol style="list-style-type: none"><li>(1) the potential for a species to increase in number,</li><li>(2) the heritable genetic variation of individuals in</li></ol>
<b>LS4.B: Natural Selection</b>	Intentionally left blank			

## LS4: Biological Evolution: Unity and Diversity

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Core Idea	K–2	3–5	6–8	9–12
			MS-LS4-5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.	<p>a species due to mutation and sexual reproduction,</p> <p>(3) competition for limited resources, and</p> <p>(4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (LS4.B, LS4.C)</p> <p>HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (LS4.B and LS4.C)</p>
<b>LS4.C: Adaptation</b>	Intentionally left blank	3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.	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.	<p>HS-LS4-2. Construct an explanation based on evidence that the process of evolution primarily results from four factors:</p> <p>(1) the potential for a species to increase in number</p> <p>(2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction</p> <p>(3) competition for limited resources, and</p>

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Core Idea	K–2	3–5	6–8	9–12
				<p>(4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (LS4.B, LS4.C)</p> <p>HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (LS4.B, LS4.C)</p> <p>HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.</p> <p>HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in:</p> <ol style="list-style-type: none"> <li>(1) increases in the number of individuals of some species,</li> <li>(2) the emergence of new species over time, and</li> <li>(3) the extinction of other species.</li> </ol> <p>HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4.C, LS4.D, secondary to ETS1.B)</p>

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Core Idea	K–2	3–5	6–8	9–12
<b>LS4.D: Biodiversity and Humans</b>	2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats.	3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change. (LS2.C, LS4.D)	MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (LS2.C, LS4.D, <i>secondary to ETS1.B</i> )	HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4.C, LS4.D, <i>secondary to ETS1.B</i> ) HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (LS2.C, LS4.D, <i>secondary to ETS1.B</i> )

## Earth and Space Sciences

Earth and space sciences (ESS) investigate processes that operate on Earth and also address its place in the solar system and the galaxy. Thus, ESS involve phenomena that range in scale from the unimaginably large to the invisibly small. Earth and space sciences (ESS) share common ground with other scientific disciplines but also pursue unique inquiries. Early studies in physical sciences such as forces, energy, and gravity helped explain the nature of Earth, the sun, and the moon, eventually leading to the development of physics and chemistry as distinct fields. Life sciences also intersect with ESS, as Earth is the only known biologically active planet, and fossils in rocks are of interest to both biologists and geologists. Most ESS research is interdisciplinary, spanning astrophysics, geophysics, geochemistry, and geobiology, though traditional geology focused on identifying, analyzing, and mapping rocks remains foundational.

### ESS1: Earth’s Place in the Universe

**ESS1: Earth’s Place in the Universe** describes the universe as a whole and addresses its grand scale in both space and time. This idea includes the overall structure, composition, and history of the universe, the forces and processes by which the solar system operates, and Earth’s planetary history.

Core Idea	K–2	3–5	6–8	9–12
<b>ESS1.A: The Universe and Its Stars</b>	1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted.	5-ESS1-1. Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.	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. (ESS1.A, ESS1.B)	HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation. (ESS1.A, PS3.D)
			MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (ESS1.A, ESS1.B)	HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. (ESS1.A, PS4.B)
				HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

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Core Idea	K–2	3–5	6–8	9–12
<b>ESS1.B: Earth and the Solar System</b>	1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.	5-ESS1-2. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.	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. (ESS1.A, ESS1.B)	HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.
			MS-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (ESS1.A, ESS1.B)	HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth’s systems result in changes in climate. (ESS1.B, ESS2.A, ESS2.D, <i>secondary to ESS1.B</i> )
<b>ESS1.C: The History of Planet Earth</b>	2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur quickly or slowly.	4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.	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.	HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. (ESS1.C, <i>secondary to ESS2.B and PS1.C</i> )
			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. (ESS1.C, ESS2.B)	HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history. (ESS1.C, <i>secondary to PS1.C</i> )

## ESS2: Earth's Systems

**ESS2: Earth's Systems** encompasses the processes that drive Earth's conditions and its continual evolution (i.e., change over time). It addresses the planet's large-scale structure and composition, describes its individual systems, and explains how they are interrelated. It also focuses on the mechanisms driving Earth's internal motions and on the vital role that water plays in all of the planet's systems and surface processes.

Core Idea	K-2	3-5	6-8	9-12
<b>ESS2.A: Earth Materials and Systems</b>	2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. (ESS2.A, secondary to ETS1.C)	4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. (ESS2.A, ESS2.E)	MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.	HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. (ESS2.A, ESS2.B)
		5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.	MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (ESS2.A, ESS2.C)	HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (ESS2.A, ESS2.D)
				HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (ESS2.A, ESS2.B, secondary to PS4.A)
				HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (ESS1.B, ESS2.A, ESS2.D, secondary to ESS1.B)

## ESS2: Earth's Systems

**ESS2: Earth's Systems** encompasses the processes that drive Earth's conditions and its continual evolution (i.e., change over time). It addresses the planet's large-scale structure and composition, describes its individual systems, and explains how they are interrelated. It also focuses on the mechanisms driving Earth's internal motions and on the vital role that water plays in all of the planet's systems and surface processes.

Core Idea	K-2	3-5	6-8	9-12
<b>ESS2.B: Plate Tectonics and Large Scale System Interactions</b>	2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area.	4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.	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. (ESS1.C, ESS2.B)	<p>HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. (ESS1.C, <i>secondary to ESS2.B and PS1.C</i>)</p> <p>HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. (ESS2.A, ESS2.B)</p> <p>HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. (ESS2.A, ESS2.B, <i>secondary to PS4.A</i>)</p>
	<b>ESS2.C: The Roles of Water in Earth's Surface Processes</b>	2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid.	5-ESS2-2. Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.	<p>MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (ESS2.A, ESS2.C)</p> <p>MS-ESS2-4. Develop a model to describe the cycling of water</p>

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Core Idea	K–2	3–5	6–8	9–12
			<p>through Earth's systems driven by energy from the sun and the force of gravity.</p> <p>MESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. (ESS2.C, ESS2.D)</p> <p>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. (ESS2.C, ESS2.D)</p>	
<b>ESS2.D: Weather and Climate</b>	<p>K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time.</p>	<p>3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.</p> <p>3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.</p>	<p>MS-ESS2-5. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. (ESS2.C, ESS2.D)</p> <p>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. (ESS2.C, ESS2.D)</p>	<p>HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. (ESS2.A, ESS2.D)</p> <p>HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. (ESS1.B, ESS2.A, ESS2.D, <i>secondary to ESS1.B</i>)</p>

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Core Idea	K-2	3-5	6-8	9-12
				<p>HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.</p> <p>HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (ESS2.D, ESS2.E)</p> <p>HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change). (ESS2.D, ESS3.D)</p>
<b>ESS2.E: Biogeology</b>	Intentionally left blank	4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. (ESS2.A, ESS2.E)	Intentionally left blank	HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. (ESS2.D, ESS2.E)

## ESS3: Earth and Human Activity

**ESS3: Earth and Human Activity** addresses society’s interactions with the planet. Connecting the ESS to the scale of human life, this idea explains how Earth’s processes affect people through natural resources and natural hazards, and it describes some of the ways in which humanity affects Earth’s systems.

Core Idea	K–2	3–5	6–8	9–12
<b>ESS3.A: Natural Resources</b>	K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.	4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	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.	HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity. (ESS3.A, ESS3.B)  HS-ESS3-2. Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits. (ESS3.A, secondary to ETS1.B)
	<b>ESS3.B: Natural Hazards</b>	K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. (ESS3.B, secondary to ETS1.A)	3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of weather-related hazard.  4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes and climate change have on humans. (ESS3.B, secondary to ETS1.B)	MS-ESS3-2. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.  HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and climate change have influenced human activity. (ESS3.A, ESS3.B)

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Core Idea	K–2	3–5	6–8	9–12
<b>ESS3.C: Human Impacts on Earth Systems</b>	K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. (ESS2.E, ESS3.C)	5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources, environment and address climate change issues.	MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.  MS-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.  HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems. (ESS3.C, <i>secondary to ETS1.B</i> )
			MS-ESS3–5. Ask questions to clarify evidence of the factors that have caused climate change over the past century.	HS-ESS3–5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.  HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity (i.e., climate change). (ESS2.D, ESS3.D)
<b>ESS3.D: Global Climate Change</b>	Intentionally left blank	Intentionally left blank		

## Engineering, Technology, and the Application of Science

The fields of science and engineering are mutually supportive. New technologies expand the reach of science, allowing the study of realms previously inaccessible to investigation; scientists depend on the work of engineers to produce the instruments and computational tools they need to conduct research. Engineers in turn depend on the work of scientists to understand how different technologies work so they can be improved; scientific discoveries are exploited to create new technologies in the first place. Scientists and engineers often work together in teams, especially in new fields, such as nanotechnology or synthetic biology that blur the lines between science and engineering. Students should come to understand these interactions and at increasing levels of sophistication as they mature. Their appreciation of the interface of science, engineering, and society should give them deeper insights into local, national, and global issues.

### ETS1: Engineering Design

**ETS1: Engineering Design** is the iterative cycle of design that offers the greatest potential for applying science knowledge in the classroom and engaging in engineering practices. The components of this core idea include understanding how engineering problems are defined and delimited, how models can be used to develop and refine possible solutions to a design problem, and what methods can be employed to optimize a design.

Core Idea	K–2	3–5	6–8	9–12
<b>ETS1.A: Defining and Delimiting an Engineering Problem</b>	<p>K–2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.</p> <p>K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. (PS2.A, <i>secondary to ETS1.A</i>)</p> <p>K-ESS3-2. Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather. (ESS3.B, <i>secondary to ETS1.A</i>)</p>	<p>3–5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.</p> <p>4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (PS3.B, PS3.D, <i>secondary to ETS1.A</i>)</p>	<p>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.</p> <p>MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. (PS3.A, PS3.B, <i>secondary to ETS1.A and ETS1.B</i>)</p>	<p>HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.</p> <p>HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. (PS2.A, <i>secondary to ETS1.A and ETS1.C</i>)</p> <p>HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy. (PS3.A, PS3.D, <i>secondary to ETS1.A</i>)</p>

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Core Idea	K-2	3-5	6-8	9-12
<b>ETS1.B: Developing Possible Solutions</b>	<p>K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.</p> <p>K-ESS3-3. Communicate solutions that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment. (ESS3.C, <i>secondary to ETS1.B</i>)</p> <p>2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. (LS2.A, <i>secondary to ETS1.B</i>)</p>	<p>3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.</p> <p>3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (ETS1B, ETS1.C)</p> <p>4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes and climate change have on humans. (ESS3.B, <i>secondary to ETS1.B</i>)</p>	<p>MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</p> <p>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. (ETS1.B, ETS1.C)</p> <p>MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (ETS1.B, ETS1.C)</p> <p>MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. (PS1.B, <i>secondary to ETS1.B and ETS1.C</i>)</p> <p>MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal</p>	<p>HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</p> <p>HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.</p> <p>HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. (LS2.C, LS4.D, <i>secondary to ETS1.B</i>)</p> <p>HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. (LS4.C, LS4.D, <i>secondary to ETS1.B</i>)</p>

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Core Idea	K-2	3-5	6-8	9-12
			energy transfer. (PS3.A, PS3.B, <i>secondary to ETS1.A and ETS1.B</i> ) MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services. (LS2.C, LS4.D, <i>secondary to ETS1.B</i> )	HS-ESS3-2. Evaluate competing design solutions for developing, conserving, managing, and utilizing energy and mineral resources based on the associated economic, social, environmental, and geopolitical costs and risks, as well as benefits. (ESS3.A, <i>secondary to ETS1.B</i> ) HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other natural systems. (ESS3.C, <i>secondary to ETS1.B</i> )
<b>ETS1.C: Optimizing the Design Solution</b>	K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. 2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. (ESS2.A, <i>secondary to ETS1.C</i> )	3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. (ETS1B, ETS1.C) 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information. (PS4.C, <i>secondary to ETS1.C</i> )	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. (ETS1.B, ETS1.C) MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (ETS1.B, ETS1.C)	HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. (PS1.B, <i>secondary to ETS1.C</i> )

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Core Idea	K-2	3-5	6-8	9-12
			MS-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. (PS1.B, secondary to ETS1.B and ETS1.C)	HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision. (PS2.A, secondary to ETS1.A and ETS1.C)