

# Indiana Academic Standards Science



## Grade 7

## K-12 Science Indiana Academic Standards Overview

The K-12 Science Indiana Academic Standards are based on *A Framework for K-12 Science Education* (NRC, 2012) and the Next Generation Science Standards (NGSS Lead States, 2013). They are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The K-12 Science Indiana Academic Standards:

- Reflect science as it is practiced and experienced in the real world;
- Build logically from kindergarten through grade 12;
- Focus on deeper understanding as well as application of content; and
- Integrate practices, crosscutting concepts, and core ideas.

The K-12 Science Indiana Academic Standards outline the knowledge, science, and engineering practices that all students should learn by the end of high school. The standards are three-dimensional because each student performance expectation engages students at the nexus of the following three dimensions:

- Dimension 1 describes scientific and engineering practices.
- Dimension 2 describes crosscutting concepts, overarching science concepts that apply across science disciplines.
- Dimension 3 describes core ideas in the science disciplines.

### Science and Engineering Practices (*as found in NGSS*)

The eight practices describe what scientists use to investigate and build models and theories of the world around them or that engineers use as they build and design systems. The practices are essential for all students to learn and are as follows:

1. Asking questions (for science) and defining problems (for engineering);
2. Developing and using models;
3. Planning and carrying out investigations;
4. Analyzing and interpreting data;
5. Using mathematics and computational thinking;
6. Constructing explanations for science and designing solutions for engineering;
7. Engaging in argument from evidence; and
8. Obtaining, evaluating, and communicating information.

### Crosscutting Concepts (*as found in NGSS*)

The seven crosscutting concepts bridge disciplinary boundaries and unit core ideas throughout the fields of science and engineering. Their purpose is to help students deepen their understanding of the disciplinary core ideas, and develop a coherent, and scientifically based view of the world. The seven crosscutting concepts are as follows:

1. *Patterns*. Observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them.
2. *Cause and Effect: Mechanism and Explanation*. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated.

Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

3. *Scale, Proportion, and Quantity*. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. *Systems and System Models*. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. *Energy and Matter: Flows, Cycles, and Conservation*. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. *Structure and Function*. The way in which an object or living thing is shaped and its substructure determines many of its properties and functions.
7. *Stability and Change*. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

### **Disciplinary Core Ideas** (as found in NGSS)

The disciplinary core ideas describe the content that occurs at each grade or course. The K-12 Science Indiana Academic Standards focus on a limited number of core ideas in science and engineering both within and across the disciplines and are built on the notion of learning as a developmental progression. The Disciplinary Core Ideas are grouped into the following domains:

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

The K-12 Science Indiana Academic Standards are not intended to be used as curriculum. Instead, the standards are the minimum that students should know and be able to do. Therefore, teachers should continue to differentiate for the needs of their students by adding depth and additional rigor.

### **References:**

- National Research Council. 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/13165>.
- NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

## How to Read the Revised Science Indiana Academic Standards

Standard Number	Title
<p>The title for a set of performance expectations is not necessarily unique and may be reused at several different grade levels.</p>	
<p>Students who demonstrate understanding can:</p>	
<p><b>Standard Number</b></p>	<p><b>Performance Expectation: A statement that combines practices, core ideas, and crosscutting concepts together to describe how students can show what they have learned. [Clarification Statement: A statement that supplies examples or additional clarification to the performance expectation.]</b></p>
<p><b>Science and Engineering Practices</b></p> <p>Science and Engineering Practices are activities that scientists and engineers engage in to either understand the world or solve the problem.</p> <p>There are 8 practices. These are integrated into each standard. They were previously found at the beginning of each grade level content standard and known as SEPs.</p> <p><b>Connections to the Nature of Science</b></p> <p>Connections are listed in either practices or the crosscutting concepts section.</p>	<p><b>Disciplinary Core Ideas</b></p> <p>Disciplinary Core Ideas are concepts in science and engineering that have broad importance within and across disciplines as well as relevance in people’s lives.</p> <p>To be considered core, the ideas should meet at least two of the following criteria and ideally all four:</p> <ul style="list-style-type: none"> <li>● Have broad importance across multiple sciences or engineering disciplines or be a key organizing concept of a single discipline;</li> <li>● Provide a key tool for understanding or investigating more complex ideas and solving problems;</li> <li>● Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge;</li> <li>● Be teachable and learnable over multiple grades at increasing levels of depth and sophistication.</li> </ul> <p>Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology, and applications of science.</p> <p><b>Crosscutting Concepts</b></p> <p>Crosscutting concepts are seven ideas such as Patterns and Cause and Effect, which are not specific to any one discipline but cut across them all.</p> <p>Crosscutting concepts have value because they provide students with connections and intellectual tools that are related across the differing areas of disciplinary content and can enrich their application of practices and their understanding of core ideas.</p> <p><b>Connections to Engineering, Technology and Applications of Science</b></p> <p>These connections are drawn from either the Disciplinary Core Ideas or Science and Engineering Practices.</p>

<b>MS-PS2-1 Motion and Stability: Forces and Interactions</b>	
<p>Students who demonstrate understanding can:</p> <p><b>MS-PS2-1. Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.</b> [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.]</p>	
<p style="background-color: #000080; color: white; padding: 2px;"><b>Science and Engineering Practices</b></p> <p><b>SEP.6: Constructing Explanations and Designing Solutions</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>Apply scientific ideas or principles to design an object, tool, process, or system.</li> </ul>	<p style="background-color: #ff8c00; color: white; padding: 2px;"><b>Disciplinary Core Ideas</b></p> <p><b>PS2.A: Forces and Motion</b></p> <ul style="list-style-type: none"> <li>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).</li> </ul>
	<p style="background-color: #76b82a; color: white; padding: 2px;"><b>Crosscutting Concepts</b></p> <p><b>CC.4: Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p style="text-align: center;"><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.</li> </ul>

**MS-PS2-2 Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

**MS-PS2-2. Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton’s First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton’s Second Law), frame of reference, and specification of units.]

<p style="text-align: center;"><b>Science and Engineering Practices</b></p> <p><b>SEP.3: Planning and Carrying Out Investigations</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><i>Connections to Nature of Science</i></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p style="text-align: center;"><b>Disciplinary Core Ideas</b></p> <p><b>PS2.A: Forces and Motion</b></p> <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> </ul> <p style="text-align: center;"><b>Crosscutting Concepts</b></p> <p><b>CC.7: Stability and Change</b></p> <ul style="list-style-type: none"> <li>Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.</li> </ul>
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**MS-PS2-3 Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

**MS-PS2-3. Ask questions and design a plan 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.]

**Science and Engineering Practices**

**SEP.1: 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.

**Disciplinary Core Ideas**

**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.

**Crosscutting Concepts**

**CC.2: Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**MS-PS2-4 Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

**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.]

<p style="text-align: center;"><b>Science and Engineering Practices</b></p> <p><b>SEP.7: Engaging in Argument from Evidence</b></p> <p>Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.</p> <ul style="list-style-type: none"> <li>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.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p style="text-align: center;"><b>Disciplinary Core Ideas</b></p> <p><b>PS2.B: Types of Interactions</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul> <hr/> <p style="text-align: center;"><b>Crosscutting Concepts</b></p> <p><b>CC.4: Systems and System Models</b></p> <ul style="list-style-type: none"> <li>Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems.</li> </ul>
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**MS-PS2-5 Motion and Stability: Forces and Interactions**

Students who demonstrate understanding can:

**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.]

**Science and Engineering Practices****SEP.3: 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.

**Disciplinary Core Ideas****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).

**Crosscutting Concepts****CC.2: Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**MS-PS3-1 Energy**

Students who demonstrate understanding can:

**MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.** [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a whiffle ball versus a tennis ball.]

**Science and Engineering Practices****SEP.4: Analyzing and Interpreting Data**

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

- Construct and interpret graphical displays of data to identify linear and nonlinear relationships.

**Disciplinary Core Ideas****PS3.A: Definitions of Energy**

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

**Crosscutting Concepts****CC.3: Scale, Proportion, and Quantity**

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

**MS-PS3-2 Energy**

Students who demonstrate understanding can:

- MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.** [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.]

**Science and Engineering Practices****SEP.2: Developing and Using Models**

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

- Develop a model to describe unobservable mechanisms.

**Disciplinary Core Ideas****PS3.A: Definitions of Energy**

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

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

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

**Crosscutting Concepts****CC.4: Systems and System Models**

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

**MS-PS3-3 Energy**

Students who demonstrate understanding can:

**MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.** [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.]

**Science and Engineering Practices****SEP.6: Constructing Explanations and Designing Solutions**

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

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

**Disciplinary Core Ideas****PS3.A: Definitions of Energy**

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

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

- Energy is spontaneously transferred out of hotter regions or objects and into colder ones.

**ETS1.A: Defining and Delimiting an Engineering Problem**

- 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. (*secondary*)

**ETS1.B: Developing Possible Solutions**

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (*secondary*)

**Crosscutting Concepts****CC.5: Energy and Matter**

- The transfer of energy can be tracked as energy flows through a designed or natural system.

<b>MS-PS3-4 Energy</b>	
<p>Students who demonstrate understanding can:</p> <p><b>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.</b> [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.]</p>	
<p style="background-color: #4b0082; color: white; text-align: center; padding: 2px;"><b>Science and Engineering Practices</b></p> <p><b>SEP.3: Planning and Carrying Out Investigations</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>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 much data is needed to support a claim.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p style="background-color: #ff8c00; color: white; text-align: center; padding: 2px;"><b>Disciplinary Core Ideas</b></p> <p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.</li> </ul>
	<p style="background-color: #76c73a; color: white; text-align: center; padding: 2px;"><b>Crosscutting Concepts</b></p> <p><b>CC.3: Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.</li> </ul>

<b>MS-PS3-5 Energy</b>	
<p>Students who demonstrate understanding can:</p> <p><b>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.</b> [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.]</p>	
<p><b>Science and Engineering Practices</b></p>	<p><b>Disciplinary Core Ideas</b></p>
<p><b>SEP.7: Engaging in Argument from Evidence</b></p> <p>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 worlds.</p> <ul style="list-style-type: none"> <li>Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p style="text-align: center;">Scientific Knowledge is Based on Empirical Evidence</p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations.</li> </ul>	<p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>When the motion energy of an object changes, there is inevitably some other change in energy at the same time.</li> </ul>
	<p><b>Crosscutting Concepts</b></p>
	<p><b>CC.5: Energy and Matter</b></p> <ul style="list-style-type: none"> <li>Energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).</li> </ul>

<b>MS-LS1-1 From Molecules to Organisms: Structures and Processes</b>	
<p>Students who demonstrate understanding can:</p> <p><b>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.</b> [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.]</p>	
<p style="text-align: center;"><b>Science and Engineering Practices</b></p> <p><b>SEP.3: Planning and Carrying Out Investigations</b></p> <p>Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.</p> <ul style="list-style-type: none"> <li>Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.</li> </ul>	<p style="text-align: center;"><b>Disciplinary Core Ideas</b></p> <p><b>LS1.A: Structure and Function</b></p> <ul style="list-style-type: none"> <li>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).</li> </ul>
	<p style="text-align: center;"><b>Crosscutting Concepts</b></p> <p><b>CC.3: Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>Phenomena that can be observed at one scale may not be observable at another scale.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Engineering, Technology and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.</li> </ul>

**MS-LS1-2 From Molecules to Organisms: Structures and Processes**

Students who demonstrate understanding can:

**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.]

**Science and Engineering Practices**

**SEP.2: 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.

**Disciplinary Core Ideas**

**LS1.A: Structure and Function**

- Within cells, special structures are responsible for functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.

**Crosscutting Concepts**

**CC.6: 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-LS1-3 From Molecules to Organisms: Structures and Processes**

Students who demonstrate understanding can:

**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.]

**Science and Engineering Practices**

**SEP.7: 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.

**Disciplinary Core Ideas**

**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.

**Crosscutting Concepts**

**CC.4: Systems and System Models**

- Systems may interact with other systems; they may have subsystems and be a part of larger complex systems.

**Connections to Nature of Science  
Science is a Human Endeavor**

- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

**MS-LS1-7 From Molecules to Organisms: Structures and Processes**

Students who demonstrate understanding can:

- 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.]

**Science and Engineering Practices****SEP.2: 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.

**Disciplinary Core Ideas****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.

**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. (*secondary*)

**Crosscutting Concepts****CC.5: Energy and Matter**

- Matter is conserved because atoms are conserved in physical and chemical processes.

**MS-LS1-8 From Molecules to Organisms: Structures and Processes**

Students who demonstrate understanding can:

- 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.**

**Science and Engineering Practices****SEP.8: 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.

**Disciplinary Core Ideas****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.

**Crosscutting Concepts****CC.2: Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural systems.

**MS-ESS1-4 Earth's Place in the Universe**

Students who demonstrate understanding can:

**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.]

**Science and Engineering Practices**

**SEP.2: 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.

**Disciplinary Core Ideas**

**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.

**Crosscutting Concepts**

**CC.3: 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.

<b>MS-ESS2-1 Earth's Systems</b>	
<p>Students who demonstrate understanding can:</p> <p><b>MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.</b> [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.]</p>	
<p style="background-color: #333399; color: white; padding: 2px;"><b>Science and Engineering Practices</b></p> <p><b>SEP.2: Developing and Using Models</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena.</li> </ul>	<p style="background-color: #ff9933; color: white; padding: 2px;"><b>Disciplinary Core Ideas</b></p> <p><b>ESS2.A: Earth's Materials and Systems</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>
	<p style="background-color: #99cc66; color: white; padding: 2px;"><b>Crosscutting Concepts</b></p> <p><b>CC.7: Stability and Change</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>

**MS-ESS2-2 Earth's Systems**

Students who demonstrate understanding can:

**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.]

**Science and Engineering Practices**

**SEP.6: 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 nature operate today as they did in the past and will continue to do so in the future.

**Disciplinary Core Ideas**

**ESS2.A: Earth's 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.

**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.

**Crosscutting Concepts**

**CC.3: 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.

<b>MS-ESS2-3 Earth's Systems</b>	
<p>Students who demonstrate understanding can:</p> <p><b>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.</b> [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).]</p>	
<p style="text-align: center;"><b>Science and Engineering Practices</b></p> <p><b>SEP.4: Analyzing and Interpreting Data</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>Analyze and interpret data to provide evidence for phenomena.</li> </ul> <p style="text-align: center;">-----</p> <p style="text-align: center;"><b>Connections to Nature of Science</b></p> <p style="text-align: center;">Scientific Knowledge is Open to Revision in Light of New Evidence</p> <ul style="list-style-type: none"> <li>Science findings are frequently revised and/or reinterpreted based on new evidence.</li> </ul>	<p style="text-align: center;"><b>Disciplinary Core Ideas</b></p> <p><b>ESS1.C: The History of Planet Earth</b></p> <ul style="list-style-type: none"> <li>Tectonic processes continually generate new ocean sea floor at ridges and destroy old seafloor at trenches. <i>(HS.ESS1.C GBE), (secondary)</i></li> </ul> <p><b>ESS2.B: Plate Tectonics and Large-Scale System Interactions</b></p> <ul style="list-style-type: none"> <li>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.</li> </ul>
	<p style="text-align: center;"><b>Crosscutting Concepts</b></p> <p><b>CC.1: Patterns</b></p> <ul style="list-style-type: none"> <li>Patterns in rates of change and other numerical relationships can provide information about natural systems.</li> </ul>

**MS-ESS3-1 Earth and Human Activity**

Students who demonstrate understanding can:

**MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.** [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

**Science and Engineering Practices**

**SEP.6: 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.

**Disciplinary Core Ideas**

**ESS3.A: Natural Resources**

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

**Crosscutting Concepts**

**CC.2: Cause and Effect**

- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

**Connections to Engineering, Technology, and Applications of Science**

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

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

**MS-ESS3-2 Earth and Human Activity**

Students who demonstrate understanding can:

**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.** [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

**Science and Engineering Practices**

**SEP.4: Analyzing and Interpreting Data**

Analyzing data in 6–8 builds on K–5 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.

**Disciplinary Core Ideas**

**ESS3.B: Natural Hazards**

- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.

**Crosscutting Concepts**

**CC.1: Patterns**

- Graphs, charts, and images can be used to identify patterns in data.

**Connections to Engineering, Technology, and Applications of Science**

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

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

<b>MS-ETS1-1 Engineering Design</b>	
<p>Students who demonstrate understanding can:</p> <p><b>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.</b></p>	
<p style="background-color: #4b0082; color: white; padding: 2px;"><b>Science and Engineering Practices</b></p> <p><b>SEP.1: Asking Questions and Defining Problems</b></p> <p>Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.</p> <ul style="list-style-type: none"> <li>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.</li> </ul>	<p style="background-color: #ff8c00; color: white; padding: 2px;"><b>Disciplinary Core Ideas</b></p> <p><b>ETS1.A: Defining and Delimiting Engineering Problems</b></p> <ul style="list-style-type: none"> <li>The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.</li> </ul>
	<p style="background-color: #76c73a; color: white; padding: 2px;"><b>Crosscutting Concepts</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.</li> <li>The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.</li> </ul>
<b>MS-ETS1-2 Engineering Design</b>	
<p>Students who demonstrate understanding can:</p> <p><b>MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.</b></p>	
<p style="background-color: #4b0082; color: white; padding: 2px;"><b>Science and Engineering Practices</b></p> <p><b>SEP.7: Engaging in Argument from Evidence</b></p> <p>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.</p> <ul style="list-style-type: none"> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.</li> </ul>	<p style="background-color: #ff8c00; color: white; padding: 2px;"><b>Disciplinary Core Ideas</b></p> <p><b>ETS1.B: Developing Possible Solutions</b></p> <ul style="list-style-type: none"> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.</li> </ul>

**MS-ETS1-3 Engineering Design**

Students who demonstrate understanding can:

**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.**

**Science and Engineering Practices****SEP.4: 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.

**Disciplinary Core Ideas****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.
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.

**ETS1.C: Optimizing the Design Solution**

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.

**MS-ETS1-4 Engineering Design**

Students who demonstrate understanding can:

**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.**

**Science and Engineering Practices****SEP.2: 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.

**Disciplinary Core Ideas****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.
- Models of all kinds are important for testing solutions.

**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.