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Introduction

Science uses observation and experimentation to explain natural phenomena. Science refers to an organized body of knowledge that includes core ideas from the disciplines of science and common themes that bridge the disciplines. The Oklahoma Academic Standards for Science include standards for kindergarten through grade twelve. The standards are arranged by grade levels at Grades K-8, and by course subject area at the high school level. The Oklahoma Academic Standards include the integration of scientific and engineering practices with core content from Physical Science, Life Science, and Earth/Space Science. This integrated approach will provide students with a coordinated and coherent understanding of the necessary skills and knowledge to be scientifically literate citizens.

Development and Review of the Standards

Executive Committee

An Executive Committee was comprised to assist in planning the process for the revision of the Oklahoma Academic Standards for Science and selecting representatives to comprise a Writing Committee and a Draft Committee. The Executive Committee also served on the Writing Committee.

The Oklahoma State Department of Education would like to extend a special thanks to the following members of the Executive Committee who gave their time, services and expertise to the revision process:

- Dr. Paul Risser (University of Oklahoma)
- Dr. Julie Angle (Oklahoma State University)
- Sarah Vann (Owasso Middle School)
- Missy Dominy (Gordon Cooper Technology Center)

Writing Committee

A Writing Committee was selected through an application process to revise the Oklahoma Academic Standards for Science. The committee met in person on six occasions and numerous times virtually. The committee was comprised of 37 representatives from K-12 education, higher education, career technology, scientists, engineers, parent and community members from across the state.

Draft Committee

A Draft Committee was selected through an application process to review draft standards developed by the Writing Committee and provide feedback. The committee was comprised of 21 representatives from K-12 education, higher education, career technology, scientists, engineers, parent and community members from across the state.

- Peggy Alexander (Owasso PS)
- William Bass (Berryhill PS)
- Tom Creider (Okla. Tourism & Recreation Dept.)
- Wendy Howard (Fredrick PS)
- Carol Huett (Moore PS)
- Amy Johnson (Deer Creek PS)
- Kristi Carlucci (Osteology Museum)
- Jennifer Koeninger (Mustang PS)
- Laura Lewis (Shawnee PS)
- Don Loving (Murray State College)
- Derrick Meador (Jennings PS)
- Debi Merkey (Cordell PS)
- Timothy Munson (OERB-Chairperson)
- Traci Richardson (Stillwater PS)
- Dr. Michael Soreghan (University of Oklahoma)
- Candy Schrack (Piedmont PS)
- Rebecca Sprink (Tulsa PS)
- Janis Slater (K20 Center—University of Okla.)
- Gaylen Urie (Glenpool PS)
- Dr. Laura Wilhelm (Oklahoma City University)
- Connie Ward (Piedmont PS)
Focus Groups
An additional level of review of the draft version of the Oklahoma Academics Standards for Science was conducted through Focus Groups. Over 500 educators and community members participated in meetings held in Bristow, Durant, Guymon, Hugo, Lawton, Oklahoma City, Ponca City, Tulsa, Woodward, and Vinita. Participants were able to review samples of the draft standards and provide feedback to the Writing Committee.

Oklahoma Academic Standards
The Oklahoma Academic Standards describe the specific areas of student learning that are considered the most important for proficiency in the discipline at a particular level and provide a basis for the development of local curricula and statewide assessments.

The Oklahoma Academic Standards in this document are not sequenced for instruction and do not prescribe classroom activities; materials; or instructional strategies, approaches, or practices. The Oklahoma Academic Standards are not a curriculum and they do not represent a scope, sequence, or curriculum guide. They provide a framework for schools and teachers to develop an aligned science curriculum. Such curriculum includes instructional units, lessons, and tasks; formative and summative assessments; opportunities for remediation and acceleration; and other selected activities, interventions, and strategies deemed appropriate and meaningful for the academic success of students.


Because each of the standards subsumes the knowledge and skills of the other standards, they are designed to be used as a whole. Although material can be added to the standards, using only a portion of the standards will leave gaps in the scientific understanding and practice of students.

Statewide Assessment
The Oklahoma Academic Standards for Science are defined as performance expectations and will be used as the basis for the development and/or refinement of questions on the Oklahoma State Testing Program. Although efforts to begin implementation of these Oklahoma Academic Standards will begin in the 2014-2015 school year, the Oklahoma School Testing Program will continue to assess standards and objectives found in the 2011 Oklahoma Academic Standards for Science through the 2015-2016 school year. The test blue prints will continue to align to the standards and objectives of the 2011 Oklahoma Academic Standards for Science through the 2015-2016 school year. In the 2016-2017 school year, the Oklahoma State Testing Program will begin measuring the performance expectations defined in the 2014 Oklahoma Academic Standards for Science for 5th grade, 8th grade, and Biology I.

Consistent with the current structure of the Oklahoma State Tests for science, questions will measure the practices and the core content at each grade level. In addition, most performance expectations may be assessed with items that utilize any of the science and engineering practices. For example, an assessment item for a performance expectation that requires students to construct explanations may also ask students to use other practices such as asking questions, using models, or analyzing data around the core content with a science and engineering practice.

Structure of this Document
Each Performance Expectation is displayed in a Standard Document that contains one Performance Expectation along with supporting structures intended to assist educators in understanding the expectation of the standard and the skills and knowledge associated with the standard. These components are explained on page 6. Also, see reference sample document on page 7.
Components of a Standard Document

1. **Performance Expectation**
   Performance Expectations represent the things students should know, understand, and be able to do to be proficient in science. Performance Expectations are the standards.
   Each Performance Expectation is built around A Framework for K-12 Science Education recommendation that science education in grades K-12 be built around three major dimensions:
   1. Science and Engineering Practices
   2. Crosscutting Concepts
   3. Disciplinary Core Ideas (NRC, 2012, p. 2)
   The additional components in the standard documents serve as support for instructors in providing clarity and further guidance for each Performance Expectation.

2. **Clarification Statement**
   Where needed, a Clarification Statement accompanies a Performance Expectation. The aim of a Clarification Statement is to provide further explanation or examples to better support educators in understanding the aim of the Performance Expectation.

3. **Assessment Boundary**
   Where applicable, an Assessment Boundary accompanies a Performance Expectation in order to provide additional support for educators in understanding the intent of the Performance Expectation and its relation to other Performance Expectations in the learning progression. While all teachers can utilize the Assessment Boundary as a tool for developing curriculum and local assessments, the Assessment Boundaries for 5th grade, 8th grade, and Biology will be utilized as a guide in the development of the Oklahoma Core Curriculum Tests.

4. **Science and Engineering Practices**
   The Science and Engineering Practices describe the major practices that scientists employ as they investigate and build models and theories about the world and a key set of engineering practices that engineers use as they design and build systems. The term “practice” is used instead of the term “process” to emphasize that scientists and engineers use skill and knowledge simultaneously, not in isolation. The eight science and engineering practices are:
   1. Ask questions and define problems
   2. Develop and use models
   3. Plan and conduct investigations
   4. Analyze and interpret data
   5. Use mathematical and computational thinking
   6. Construct explanations and design solutions
   7. Engage in scientific argument from evidence
   8. Obtain, evaluate, and communicate information
   Each Performance Expectation integrates one of the above Science and Engineering Practices with a Disciplinary Core Idea in science. The integration of Science and Engineering Practices with science content represents a shift from previous science standards in Oklahoma, giving the learning context and allowing students to utilize scientific reasoning and critical thinking to develop their understanding of science.

5. **Disciplinary Core Ideas**
   The Disciplinary Core Ideas represent a set of science and engineering ideas for K-12 science education that have broad importance across multiple sciences or engineering disciplines; provide a key tool for understanding or investigating more complex ideas and solving problems; relate to the interests and life experiences of students; be teachable and learnable over multiple grades at increasing levels of sophistication. (NRC, 2012, p. 31)
   Disciplinary Core Ideas are grouped into three domains:
   1. Physical Science (PS)
   2. Life Science (LS)
   3. Earth and Space Science (ESS)
   Each Performance Expectation integrates at least one Disciplinary Core Idea with a Science and Engineering Practice.

6. **Crosscutting Concepts**
   The Crosscutting Concepts represent common threads or themes that span across science disciplines (biology, chemistry, physics, environmental science, Earth/space science) and have value to both scientists and engineers because they identify universal properties and processes found in all disciplines. These crosscutting concepts are:
   1. Patterns
   2. Cause and Effect: Mechanisms and explanations
   3. Scale, Proportion, and Quantity
   4. Systems and System Models
   5. Energy and Matter: Flows, cycles, and conservation
   6. Structure and Function
   7. Stability and Change
   Where applicable each of the Performance Expectations includes one of the above Crosscutting Concepts, thereby ensuring that the concepts are not taught in isolation but reinforced in the context of instruction within the science content.

7. **Oklahoma Academic Standards Connections**
   Where applicable the Performance Expectations provide optional connections to the Oklahoma Academic Standards for English Language Arts/Literacy and Mathematics. The connections represent mathematics and literacy standards that could work in tandem with a Performance Expectation for science. The connections are not mandatory. Integration of a connecting English language arts or mathematics standards is determined by the instructor and carried out in the instruction.
### K-ESS3-1 Earth and Human Activity

#### Science & Engineering Practices

<table>
<thead>
<tr>
<th>Natural Resources:</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Living things need water, air, and resources from the land, and they live in places that have the things they need.</td>
<td>Use a model to represent the relationship between the needs of different plants, animals (including humans), and the places they live.</td>
<td>K-ESS3-1 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>• Humans use natural resources for everything they do.</td>
<td></td>
<td>Use a model to represent the relationship between the needs of different plants, animals (including humans), and the places they live.</td>
</tr>
</tbody>
</table>

#### Disciplinary Core Ideas

1. **K-ESS3-1**
   - Students who demonstrate understanding can:
     - Use a model to represent the relationship between the needs of different plants, animals (including humans), and the places they live.

#### Natural Resources:

- Living things need water, air, and resources from the land, and they live in places that have the things they need.
- Humans use natural resources for everything they do.

#### Crosscutting Concepts: Systems and System Models

- Systems in the natural and designed world have parts that work together.

#### Oklahoma Academic Standards Connections

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Literacy</strong> - 1.1 Interpret Meaning - The student will interpret and evaluate various ways visual image-makers including graphic artists, illustrators, and news photographers represent meaning.</td>
<td><strong>Data Analysis</strong> - 5.1 Data Analysis</td>
</tr>
</tbody>
</table>
K-5 Overview

The Kindergarten through 5th Grade Oklahoma Academic Standards for Science include the following Domains:

1. **Physical Science (PS)**
2. **Life Science (LS)**
3. **Earth & Space Science (ESS)**

Each Domain has a set of Topics in science that fit within that Domain:

1. **Physical Science (PS)**
   - Matter and Its Interactions (PS1)
   - Motion and Stability: Forces and Interactions (PS2)
   - Energy (PS3)
   - Waves and Their Application in Technologies for Information Transfer (PS4)

2. **Life Science (LS)**
   - From Molecules to Organisms: Structure and Processes (LS1)
   - Ecosystems: Interactions, Energy, and Dynamics (LS2)
   - Heredity: Inheritance and Variation of Traits (LS3)
   - Biological Unity and Diversity (LS4)

3. **Earth & Space Science (ESS)**
   - Earth’s Place in the Universe (ESS1)
   - Earth’s Systems (ESS2)
   - Earth and Human Activity (ESS3)

The abbreviations for the Domains and Topics are utilized in the naming system of each Performance Expectation found in the Oklahoma Academic Standards for Science.

For example, the Performance Expectation 4-PS3-1 represents the following:

**GRADE: 4**
**DOMAIN:** Physical Science
**TOPIC:** Energy
**STANDARD:** 1

Each grade level contains Performance Expectations from each Domain. However, to ensure students have a meaningful and focused experience with science in preparation of more advanced topics in Middle and High School, topics are not necessarily covered in each grade level. An example of the progression of topics in grade span 3-5 can be found in the table below. Physical Science Topic 2, “Motion and Stability: Forces and Interactions” (PS2) appears in grade 3 and 5 but not grade 4, is highlighted in green. In contrast, Life Science Topic 1, “From Molecule to Organisms: Structure and Function” (LS1), is highlighted in blue and occurs in each grade level.

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<thead>
<tr>
<th>Grade 3</th>
<th>Grade 4</th>
<th>Grade 5</th>
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</thead>
<tbody>
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<td>4-PS3-2</td>
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<tr>
<td>3-PS2-3</td>
<td>4-PS3-3</td>
<td>5-PS1-3</td>
</tr>
<tr>
<td>3-PS2-4</td>
<td>4-PS3-4</td>
<td>5-PS1-4</td>
</tr>
<tr>
<td>3-LS1-1</td>
<td>4-PS4-1</td>
<td>5-PS2-1</td>
</tr>
<tr>
<td>3-LS2-1</td>
<td>4-PS4-2</td>
<td>5-PS3-1</td>
</tr>
<tr>
<td>3-LS3-1</td>
<td>4-PS4-3</td>
<td>5-LS1-1</td>
</tr>
<tr>
<td>3-LS3-2</td>
<td>4-LS1-1</td>
<td>5-LS2-1</td>
</tr>
<tr>
<td>3-LS4-1</td>
<td>4-LS1-2</td>
<td>5-LS2-2</td>
</tr>
<tr>
<td>3-LS4-2</td>
<td>4-ESS1-1</td>
<td>5-ESS1-1</td>
</tr>
<tr>
<td>3-LS4-3</td>
<td>4-ESS2-1</td>
<td>5-ESS1-2</td>
</tr>
<tr>
<td>3-LS4-4</td>
<td>4-ESS2-2</td>
<td>5-ESS2-1</td>
</tr>
<tr>
<td>3-ESS2-2</td>
<td>4-ESS3-1</td>
<td>5-ESS2-2</td>
</tr>
<tr>
<td>3-ESS3-1</td>
<td>4-ESS3-2</td>
<td>5-ESS3-1</td>
</tr>
</tbody>
</table>
**K-PS2-1 Motion and Stability: Forces and Interactions**

<table>
<thead>
<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Forces and Motion: • Pushes and pulls can have different strengths and directions. • Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.</td>
<td>K-PS2-1 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2 Developing and using models</td>
<td>Types of Interactions: • When objects touch or collide, they push on one another and can change motion.</td>
<td>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.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
<td>Relationship Between Energy and Forces: • A bigger push or pull makes things speed up or slow down more quickly.</td>
<td>Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other (e.g. ramps such as blocks or wooden moldings with cars and balls; paper towel threaded on rope or string across the classroom).</td>
</tr>
<tr>
<td>4 With guidance, plan and conduct an investigation in collaboration with peers.</td>
<td></td>
<td>Assessment Boundary: Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.</td>
</tr>
<tr>
<td>5 Analyzing and interpreting data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Using mathematics and computational thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Engaging in argument from evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Obtaining, evaluating, and communicating information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Crosscutting Concepts: Cause and Effect**

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

**Oklahoma Academic Standards Connections**

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocabulary – 4.2. Use new vocabulary and language in own speech and writing.</td>
<td>Number Sense – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.</td>
</tr>
<tr>
<td>Writing – 1.3. Presents his or her own writing which may include pictures, attempts at letters, initial consonants, words, or phrases to the group, teacher and/or parent.</td>
<td>Measurement – 4.1. Linear Measurement</td>
</tr>
<tr>
<td>Modes/Forms of Writing – 2.2. Construct journal entries using illustrations and beginning writing skills.</td>
<td>a. Measure objects using nonstandard units of measurement (e.g., pencil, paper clip, block).</td>
</tr>
<tr>
<td>Listening – 1.3. Follow one- and two-step directions.</td>
<td>b. Compare objects according to observable attributes (e.g., long, longer; longest; short, shorter, shortest; big, bigger, biggest; small, smaller, smallest; small, medium, large).</td>
</tr>
<tr>
<td>Speaking – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.</td>
<td>c. Compare and order objects in graduated order (e.g., shortest to tallest, thinnest to thickest).</td>
</tr>
<tr>
<td></td>
<td>d. Identify the appropriate instrument used to measure length (ruler), weight (scale), time (clock: digital and analog; calendar: day, month, year, season), and temperature (thermometer).</td>
</tr>
</tbody>
</table>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
### K-PS2-2 Motion and Stability: Forces and Interactions

<table>
<thead>
<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| ① Asking questions (for science) and defining problems (for engineering) | **Forces and Motion:**  
- Pushes and pulls can have different strengths and directions.  
- Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.  
Defining Engineering Problems:  
(secondary to K-PS2-2)  
- A situation that people want to change or create can be approached as a problem to be solved through engineering.  
- Such problems may have many acceptable solutions. | **K-PS2-2**  
Students who demonstrate understanding can:  
**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.**  
**Clarification Statement:**  
Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn and using a rope or string to pull an object.  
**Assessment Boundary:**  
Assessment does not include friction as a mechanism for change in speed. |
| ② Developing and using models |  |  |
| ③ Planning and carrying out investigations |  |  |
| ④ Analyzing and interpreting data |  |  |
| Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.  
- Analyze data from tests of an object or tool to determine if it works as intended. |  |  |
| ⑤ Using mathematics and computational thinking |  |  |
| ⑥ Constructing explanations (for science) and designing solutions (for engineering) |  |  |
| ⑦ Engaging in argument from evidence |  |  |
| ⑧ Obtaining, evaluating, and communicating information |  |  |

### Crosscutting Concepts: Cause and Effect
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

### Oklahoma Academic Standards Connections

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
<th>Mathematics</th>
</tr>
</thead>
</table>
| **Vocabulary** – 4.2. Use new vocabulary and language in own speech and writing.  
**Speaking** – 2.1. Share information and ideas speaking in clear, complete, coherent sentences. | **Number Sense** – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.  
**Measurement** – 4.1. Linear Measurement  
a. Measure objects using nonstandard units of measurement (e.g., pencil, paper clip, block).  
b. Compare objects according to observable attributes (e.g., long, longer; longest; short, shorter; shortest; big, bigger, biggest; small, smaller, smallest; small, medium, large).  
c. Compare and order objects in graduated order (e.g., shortest to tallest, thinnest to thickest).  
d. Identify the appropriate instrument used to measure length (ruler), weight (scale), time (clock: digital and analog; calendar: day, month, year, season), and temperature (thermometer).  
**Data Analysis** – 5.1. Data Analysis  
b. Develops abilities to collect, describe, and record information through a variety of means including discussion, drawings, maps, charts, and graphs.  
c. Describes similarities and differences between objects.  
d. Collects and analyzes information about objects and events in the environment.  
**Data Analysis** – 5.2. Create and verbally explain a data display or graph (e.g., real object graph, pictorial graphs). |

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
### K-PS3-1 Energy

#### Science & Engineering Practices

<table>
<thead>
<tr>
<th>1</th>
<th>Asking questions (for science) and defining problems (for engineering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Developing and using models</td>
</tr>
<tr>
<td>3</td>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.</td>
</tr>
<tr>
<td>4</td>
<td>Make observations (firsthand or from media) to collect data that can be used to make comparisons.</td>
</tr>
<tr>
<td>5</td>
<td>Analyzing and interpreting data</td>
</tr>
<tr>
<td>6</td>
<td>Using mathematics and computational thinking</td>
</tr>
<tr>
<td>7</td>
<td>Constructing explanations (for science) and designing solutions (for engineering)</td>
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</tr>
<tr>
<td>9</td>
<td>Obtaining, evaluating, and communicating information</td>
</tr>
</tbody>
</table>

#### Disciplinary Core Ideas

**Conservation of Energy and Energy Transfer:**
- Sunlight warms Earth’s surface.

#### Performance Expectations

**K-PS3-1**

Students who demonstrate understanding can:

- **Make observations to determine the effect of sunlight on Earth’s surface.**

**Clarification Statement:**
Examples of Earth’s surface could include sand, soil, rocks, and water. Examples can extend beyond natural objects on Earth’s surface to include man-made objects such as plastics, asphalt, or concrete.

**Assessment Boundary:**
Assessment of temperature is limited to relative measures such as warmer/cooler.

---

### Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

**Vocabulary** – 4.2. Use new vocabulary and language in own speech and writing.
**Comprehension** – 6.3. Make predictions and confirm after reading or listening to text.
**Speaking** – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.

#### Mathematics

**Number Sense** – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.
**Data Analysis** – 5.1. Data Analysis
- Develops abilities to collect, describe, and record information through a variety of means including discussion, drawings, maps, charts, and graphs.

---

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
## K-PS3-2 Energy

### Science & Engineering Practices

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)
   - Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions.
   - Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem.
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td>Conservation of Energy and Energy Transfer:</td>
<td>K-PS3-2</td>
</tr>
<tr>
<td>• Sunlight warms Earth’s surface.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td></td>
<td><strong>Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.</strong></td>
</tr>
<tr>
<td></td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td></td>
<td>Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.</td>
</tr>
<tr>
<td></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
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</tbody>
</table>

### Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

### Oklahoma Academic Standards Connections

<table>
<thead>
<tr>
<th>ELA/Literacy</th>
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</thead>
<tbody>
<tr>
<td>Vocabulary – 4.2. Use new vocabulary and language in own speech and writing. Speaking – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.</td>
<td>Number Sense – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities. Data Analysis – 5.1. Data Analysis d. Collects and analyzes information about objects and events in the environment. Data Analysis – 5.2. Create and verbally explain a data display or graph (e.g., real object graph, pictorial graphs).</td>
</tr>
</tbody>
</table>

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
K-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

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

Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.

- Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.

Using mathematics and computational thinking

- Constructing explanations (for science) and designing solutions (for engineering)

Engaging in argument from evidence

Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Organization for Matter and Energy Flow in Organisms:

- All animals need food in order to live and grow.
- Animals obtain their food from plants or from other animals.
- Plants need water and light to live and grow.

Performance Expectations

K-LS1-1

Students who demonstrate understanding can:

Use observations to describe patterns of what plants and animals (including humans) need to survive.

Clarification Statement:

Examples of patterns could include that plants make their own food while animals do not; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water.

Assessment Boundary:

Students are not expected to understand the mechanisms of photosynthesis.

Crosscutting Concepts: Patterns

- Patterns in the natural and human designed world can be observed and used as evidence.

Oklahoma Academic Standards Connections

**ELA/Literacy**

Vocabulary – 4.2. Use new vocabulary and language in own speech and writing.

Speaking – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.

**Mathematics**

Number Sense – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.

Measurement – 4.1. Linear Measurement

b. Compare objects according to observable attributes (e.g., long, longer, longest; short, shorter, shortest; big, bigger, biggest; small, smaller, smallest; small, medium, large).

c. Compare and order objects in graduated order (e.g., shortest to tallest, thinnest to thickest).

Data Analysis – 5.1. Data Analysis

b. Develops abilities to collect, describe, and record information through a variety of means including discussion, drawings, maps, charts, and graphs.

c. Describes similarities and differences between objects.

d. Collects and analyzes information about objects and events in the environment.

Data Analysis – 5.2. Create and verbally explain a data display or graph (e.g., real object graph, pictorial graphs).

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
### Science & Engineering Practices

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

### Disciplinary Core Ideas

**Weather and Climate:**
- Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time.
- People measure these conditions to describe and record the weather and to notice patterns over time.

### Performance Expectations

**K-ESS2-1**

*Students who demonstrate understanding can:*

*Use and share observations of local weather conditions to describe patterns over time.*

**Clarification Statement:**
Examples of qualitative observations could include descriptions of the weather (such as sunny, cloudy, rainy, and warm); examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that it is usually cooler in the morning than in the afternoon and the number of sunny days versus cloudy days in different months.

**Assessment Boundary:**
Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.

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### Oklahoma Academic Standards Connections

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<td><strong>Vocabulary</strong> – 4.2. Use new vocabulary and language in own speech and writing.</td>
<td><strong>Number Sense</strong> – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.</td>
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<tr>
<td><strong>Speaking</strong> – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.</td>
<td>2.3. Count forward to twenty and backward from ten.</td>
</tr>
<tr>
<td><strong>Crosscutting Concepts:</strong> Patterns</td>
<td>2.4. Count objects in a set one-by-one from one through twenty.</td>
</tr>
<tr>
<td>• Patterns in the natural and human designed world can be observed and used as evidence.</td>
<td>2.5. Identify and create sets of objects zero through twenty.</td>
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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
### K-ESS2-2 Earth’s Systems

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<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Biogeology:  
- Plants and animals can change their environment. | K-ESS2-2  
Students who demonstrate understanding can:  
**Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs.**  
Clarification Statement:  
Examples of plants and animals changing their environment could include a squirrel digs in the ground to hide its food and tree roots can break concrete, or a dandelion spreading seeds to generate more dandelions.  
Assessment Boundary:  
Arguments should be based on qualitative not quantitative evidence. |
| 2. Developing and using models | Human Impacts on Earth Systems:  
- Things that people do to live comfortably can affect the world around them. |  |
| 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 in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).  
• Construct an argument with evidence to support a claim. |  |  |
| 8. Obtaining, evaluating, and communicating information |  |  |

### Crosscutting Concepts: Systems and System Models
- Systems in the natural and designed world have parts that work together.

### Oklahoma Academic Standards Connections

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</table>
| **Vocabulary** – 4.2. Use new vocabulary and language in own speech and writing.  
**Speaking** – 2.1. Share information and ideas speaking in clear, complete, coherent sentences.  
**Group Interaction** – 3.0. The student will use effective communication strategies in pair and small group context.  
1. Show respect and consideration for others in verbal communications.  
2. Show respect and consideration for others in physical communications.  
**Research and Information** – 8.1. Accessing Information - The student will select the best source for a given purpose. | **N/A** |

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
K-ESS3-1 Earth and Human Activity

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   - Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions.
   - Use a model to represent relationships in the natural world.
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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Natural Resources:**
- Living things need water, air, and resources from the land, and they live in places that have the things they need.
- Humans use natural resources for everything they do.

### Performance Expectations

**K-ESS3-1**

Students who demonstrate understanding can:

- **Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.**

**Clarification Statement:**

Examples of relationships could include that deer eat buds and leaves; therefore, they usually live in forested areas; and, grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.

**Assessment Boundary:**

N/A

### Crosscutting Concepts: Systems and System Models

- Systems in the natural and designed world have parts that work together.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

**Visual Literacy – 1.1 Interpret Meaning** - The student will interpret and evaluate various ways visual image-makers including graphic artists, illustrators, and news photographers represent meaning.

#### Mathematics

**Data Analysis – 5.1. Data Analysis**

b. Develops abilities to collect, describe, and record information through a variety of means including discussion, drawings, maps, charts, and graphs.

c. Describes similarities and differences between objects.

d. Collects and analyzes information about objects and events in the environment.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
### K-ESS3-2 Earth and Human Activity

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
   - Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.
   - Ask questions based on observations to find more information about the designed world.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

- **Natural Hazards:**
  - Some kinds of severe weather are more likely than others in a given region.
  - Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.

- **Defining and Delimiting an Engineering Problem:**
  - Asking questions, making observations, and gathering information are helpful in thinking about problems.

- **Interdependence of Science, Engineering, and Technology:**
  - People encounter questions about the natural world every day.

- **Influence of Engineering, Technology, and Science on Society and the Natural World:**
  - People depend on various technologies in their lives; human life would be very different without technology.

#### Performance Expectations

**K-ESS3-2**

Students who demonstrate understanding can:

**Ask questions to obtain information about the purpose of weather forecasting to prepare for, and respond to, severe weather.**

*Clarification Statement:*

Emphasis is on local forms of severe weather and safety precautions associated with that severe weather.

*Assessment Boundary:*

N/A

### Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

- **Comprehension** – 6.1.1. Use prereading skills (e.g., connecting prior knowledge to text, making predictions about text and using picture cues).
- 6.3. Make predictions and confirm after reading or listening to text.

#### Mathematics

- **Number Sense** – 2.1. Compare a group or set to another group, set, or numerical quantity and verbally explain which has more, less, or equivalent quantities.
- 2.3. Count forward to twenty and backward from ten.
- 2.4. Count objects in a set one-by-one from one through twenty.
- 2.5. Identify and create sets of objects zero through twenty.

- **Data Analysis** – 5.1. Data Analysis
  - Develops abilities to collect, describe, and record information through a variety of means including discussion, drawings, maps, charts, and graphs.
- Describes similarities and differences between objects.
- Collects and analyzes information about objects and events in the environment.

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*
### 1-PS4-1 Waves and Their Applications in Technologies for Information Transfer

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
   - Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Wave Properties:**
- Sound can make matter vibrate, and vibrating matter can make sound.

#### Performance Expectations

1-PS4-1

Students who demonstrate understanding can:

- **Plan and conduct investigations to provide evidence** that vibrating materials can make sound and that sound can make materials vibrate.

**Clarification Statement:**
Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.

**Assessment Boundary:**
N/A

### Crosscutting Concepts: Cause and Effect

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

### Oklahoma Academic Standards Connections

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</table>

### Connection to PASS Coming Soon
### 1-PS4-2 Waves and Their Applications in Technologies for Information Transfer

**Science & Engineering Practices**

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)

**Disciplinary Core Ideas**

**Electromagnetic Radiation:**
- Objects can be seen if light is available to illuminate them or if they give off their own light.

**Performance Expectations**

1-PS4-2

Students who demonstrate understanding can:

- **Make observations to construct an evidence-based account that objects can be seen only when illuminated.**

**Clarification Statement:**
Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light. This can be explored with light tables, 3-way mirrors, overhead projectors, and flashlights.

**Assessment Boundary:**
N/A

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**Crosscutting Concepts: Cause and Effect**

- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 1-PS4-3 Waves and Their Applications in Technologies for Information Transfer

#### Science & Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions.
   - Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas
**Electromagnetic Radiation:**
- Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach.
- Mirrors can be used to redirect a light beam. (Boundary: The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)

**Performance Expectations**

<table>
<thead>
<tr>
<th>K-2</th>
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<th>9-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-PS4-3</td>
<td>Students who demonstrate understanding can:</td>
<td>Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.</td>
<td>Clarification Statement: Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).</td>
</tr>
</tbody>
</table>

#### Crosscutting Concepts: Cause and Effect
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

#### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### 1-PS4-4 Waves and Their Applications in Technologies for Information Transfer

<table>
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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Information Technologies and Instrumentation: | 1-PS4-4  
Students who demonstrate understanding can:  
**Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.**  
*Connections to Engineering, Technology, and Application of Science*  
**Influence of Engineering, Technology, and Science, on Society and the Natural World:**  
• People depend on various technologies in their lives; human life would be very different without technology. | Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.* |
| 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) Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Use tools and materials provided to design a device that solves a specific problem. |  |  |
| 7 Engaging in argument from evidence |  |  |
| 8 Obtaining, evaluating, and communicating information |  |  |

### Crosscutting Concepts
- N/A

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
1-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

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)

Crosscutting Concepts: Structure and Function
• The shape and stability of structures of natural and designed objects are related to their function(s).

Disciplinary Core Ideas

Structure and Function:
• All organisms have external parts.
• Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air.
• Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow.

Information Processing:
• Animals have body parts that capture and convey different kinds of information needed for growth and survival.
• Animals respond to these inputs with behaviors that help them survive.
• Plants also respond to some external inputs.

Influence of Engineering, Technology, and Science, on Society and the Natural World:
• Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.

Performance Expectations

1-LS1-1
Students who demonstrate understanding can:

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.*

Clarification Statement:
Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.

Assessment Boundary:
N/A

Crosscutting Concepts: Structure and Function

• The shape and stability of structures of natural and designed objects are related to their function(s).

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### 1-LS1-2 From Molecules to Organisms: Structure and Processes

<table>
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<th>Disciplinary Core Ideas</th>
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</tr>
</thead>
</table>
| ✰ Asking questions (for science) and defining problems (for engineering) | Growth and Development of Organisms:  
- Adult plants and animals can have young.  
- In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive. | 1-LS1-2  
Students who demonstrate understanding can:  
Read text and use media to determine patterns in behavior of parents and offspring that help offspring survive.  
Clarification Statement:  
Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring).  
Information may be obtained through observations, media, or text.  
Assessment Boundary:  
N/A |
| ✰ Developing and using models | ✰ Planning and carrying out investigations | ✰ Analyzing and interpreting data |
| ✰ Using mathematics and computational thinking | ✰ Constructing explanations (for science) and designing solutions (for engineering) | ✰ Engaging in argument from evidence |
| ✰ Obtaining, evaluating, and communicating information | ✰ Obtaining, evaluating, and communicating information in K-2 builds on prior experiences and uses observations and texts to communicate new information. | ✰ Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world. |

**Crosscutting Concepts: Patterns**
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
1-LS3-1 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Inheritance of Traits:
- Young animals are very much, but not exactly like, their parents.
- Plants also are very much, but not exactly, like their parents.

Variation of Traits:
- Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.

Performance Expectations

1-LS3-1
Students who demonstrate understanding can:

**Make observations to construct an evidence-based account** that young plants and animals are like, but not exactly like, their parents.

Clarification Statement:
Examples of patterns could include features plants or animals share. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.

Assessment Boundary:
Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.

Crosscutting Concepts: Patterns

- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
1-ESS1-1 Earth’s Place in the Universe

Science & Engineering Practices

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
   Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations.
   • Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

The Universe and its Stars:
• Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.

Performance Expectations

1-ESS1-1
Students who demonstrate understanding can:

Use observations of the sun, moon, and stars to describe patterns that can be predicted.

Clarification Statement:
Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.

Assessment Boundary:
Assessment of star patterns is limited to stars being seen at night and not during the day.

Crosscutting Concepts: Patterns

• Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
1-ESS1-2 Earth’s Place in the Universe

Science & Engineering Practices | Disciplinary Core Ideas | Performance Expectations
---|---|---
1 Asking questions (for science) and defining problems (for engineering)  
2 Developing and using models  
3 Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, which provide data to support explanations or design solutions.  
4 Make observations (firsthand or from media) to collect data that can be used to make comparisons.  
5 Analyzing and interpreting data  
6 Using mathematics and computational thinking  
7 Constructing explanations (for science) and designing solutions (for engineering)  
8 Engaging in argument from evidence  
9 Obtaining, evaluating, and communicating information

Earth and the Solar System:  
- Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

1-ESS1-2  
Students who demonstrate understanding can:

Make observations at different times of year to relate the amount of daylight and relative temperature to the time of year.

Clarification Statement:  
Emphasis is on relative comparisons of the amount of daylight and temperature in the winter to the amount in the spring, fall or summer.

Assessment Boundary:  
Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.

Crosscutting Concepts: Patterns  
- Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
### 1-ESS3-1 Earth and Human Activity

#### Science & Engineering Practices
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

#### Disciplinary Core Ideas
- **Human Impacts on Earth Systems:**
  - Things that people do to live comfortably can affect the world around them. But, they can make choices that reduce their impacts on the land, water, air, and other living things.
- **Developing Possible Solutions:**
  - Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solutions to other people.

#### Performance Expectations
1. **1-ESS3-1**
   - Students who demonstrate understanding can:
     **Communicate solutions**
     that will reduce the impact of humans on the land, water, air, and/or other living things in the local environment.*

     **Clarification Statement:**
     Examples of human impact on the land could include cutting trees to produce paper and using resources to produce bottles. Examples of solutions could include reusing paper and recycling cans and bottles.

     **Assessment Boundary:**
     N/A

#### Crosscutting Concepts: Cause and Effect
- Events have causes that generate observable patterns.

#### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
## 2-PS1-1 Matter and Its Interactions

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, which provide data to support explanations or design solutions.

### Disciplinary Core Ideas

**Structure and Properties of Matter:**
- Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.
- Matter can be described and classified by its observable properties.
- Different properties are suited to different purposes.

### Performance Expectations

2-PS1-1

Students who demonstrate understanding can:

**Plan and conduct an investigation** to describe and classify different kinds of materials by their observable properties.

**Clarification Statement:**
Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share. Investigations could include ice and snow melting or frozen objects thawing.

**Assessment Boundary:**
N/A

### Crosscutting Concepts: Patterns

- Patterns in the natural and human designed world can be observed.

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### Connection to PASS Coming Soon
## 2-PS1-2 Matter and Its Interactions

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Structure and Properties of Matter:</strong> • Different properties are suited to different purposes. <em>Connections to Engineering, Technology, and Application of Science</em></td>
<td><strong>2-PS1-2</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td><strong>Influence of Engineering, Technology, and Science, on Society and the Natural World:</strong> • Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.</td>
<td><strong>Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.</strong></td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td><strong>Clarification Statement:</strong> Examples of properties could include, strength, flexibility, hardness, texture, and absorbency (e.g. paper towels could be utilized to measure absorbency and strength).</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td><strong>Assessment Boundary:</strong> Assessment of quantitative measurements is limited to length.</td>
</tr>
<tr>
<td>Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Analyze data from tests of an object or tool to determine if it works as intended.</td>
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</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
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</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Cause and Effect
- Simple tests can be designed to gather evidence to support or refute student ideas about causes.

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**Connection to PASS Coming Soon**
### 2-PS1-3 Matter and Its Interactions

**Science & Engineering Practices**

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)

**Disciplinary Core Ideas**

**Structure and Properties of Matter:**
- Different properties are suited to different purposes.
- A great variety of objects can be built up from a small set of pieces.

**Performance Expectations**

**2-PS1-3**

Students who demonstrate understanding can:

**Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.**

**Clarification Statement:**
Examples of pieces could include blocks, building bricks, or other assorted small objects. Provide students with the same number of objects to create a different object.

**Assessment Boundary:**
Do not introduce terminology associated with the Law of Conservation of Matter just concepts. Chemical change is outside of this performance expectation.

---

**Crosscutting Concepts: Energy and Matter**

- Objects may break into smaller pieces and be put together into larger pieces, or change shapes.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 2-PS1-4 Matter and Its Interactions

#### Science & Engineering Practices

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 in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s).
   - Construct an argument with evidence to support a claim.
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Chemical Reactions:**
- Heating or cooling a substance may cause changes that can be observed.
- Sometimes these changes are reversible, and sometimes they are not.

### Performance Expectations

**2-PS1-4**

Students who demonstrate understanding can:

**Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.**

**Clarification Statement:** Demonstrations of reversible changes could include materials such as water, butter or crayons at different temperatures. Demonstrations of irreversible changes could include cooking an egg, freezing a plant leaf, and heating paper.

**Assessment Boundary:**
N/A

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### Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

### Connection to PASS Coming Soon
### 2-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

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<th>Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Interdependent Relationships in Ecosystems:</td>
<td>2-LS2-1</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Plants depend on water and light to grow.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, which provide data to support explanations or design solutions.</td>
<td></td>
<td>Plan and conduct an investigation to determine if plants need sunlight and water to grow.</td>
</tr>
<tr>
<td>• Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.</td>
<td></td>
<td>Clarification Statement: Investigations should be limited to testing one variable at a time.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td>Assessment Boundary: Assessment is limited to testing one variable at a time.</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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**Crosscutting Concepts: Cause and Effect**

• Events have causes that generate observable patterns.

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**Connection to PASS Coming Soon**
### 2-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

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<th>Performance Expectations</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | **Interdependent Relationships in Ecosystems:**  
   - Plants depend on animals for pollination or to move their seeds around.  
   **Developing Possible Solutions:** (secondary to 2-LS2-2)  
   - Designs can be conveyed through sketches, drawings, or physical models.  
   - These representations are useful in communicating ideas for a problem’s solutions to other people. | **2-LS2-2**  
   Students who demonstrate understanding can:  
   **Develop a simple model** that mimics the function of an animal in dispersing seeds or pollinating plants.*  
   **Clarification Statement:**  
   Examples include: placing socks on the outside of students’ shoes and walking outside allows socks to gather seeds; plant sock(s) to see what grows; using an eyedropper to move liquids from one container to another emulating hummingbirds or bees pollinating plants.  
   **Assessment Boundary:**  
   N/A |
| 2. Developing and using models  
   Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions.  
   - Develop a simple model based on evidence to represent a proposed object or tool. | | |
| 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 | | |
| 8. Obtaining, evaluating, and communicating information | | |

**Crosscutting Concepts: Structure and Function**
- The shape and stability of structures of natural and designed objects are related to their function(s).

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
2-LS4-1 Biological Unity and Diversity

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, which provide data to support explanations or design solutions.
   - Make observations (firsthand or from media) to collect data which can be used to make comparisons.
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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Biodiversity and Humans:**
- There are many different kinds of living things in any area, and they exist in different places on land and in water.

### Performance Expectations

**2-LS4-1**

Students who demonstrate understanding can:

- **Make observations** of plants and animals to **compare the diversity of life in different habitats**.

**Clarification Statement:**

Emphasis is on the diversity of living things in each of a variety of different habitats. Students could explore different habitats around their school, aquariums, neighborhoods.

**Assessment Boundary:**

Assessment does not include specific animal and plant names in specific habitats.

### Crosscutting Concepts: N/A

- N/A

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
2-ESS1-1 Earth’s Place in the Universe

**Science & Engineering Practices**

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)

**Disciplinary Core Ideas**

The History of Planet Earth:
- Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.

**Performance Expectations**

2-ESS1-1
Students who demonstrate understanding can:

*Use information from several sources to provide evidence that Earth events can occur quickly or slowly.*

Clarification Statement:
Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.

Assessment Boundary:
Assessment does not include quantitative measurements of timescales.

**Crosscutting Concepts: Stability and Change**

- Things may change slowly or rapidly.

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**Connection to PASS Coming Soon**
### 2-ESS2-1 Earth’s Systems

#### Science & Engineering Practices

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)

#### Disciplinary Core Ideas

<table>
<thead>
<tr>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td>Earth Materials and Systems: • Wind and water can change the shape of the land.</td>
<td>2-ESS2-1 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>Optimizing the Design Solution: (secondary to 2-ESS2-1) • Because there is always more than one possible solution to a problem, it is useful to compare and test designs.</td>
<td></td>
</tr>
<tr>
<td>* Connections to Engineering, Technology, and Application of Science</td>
<td></td>
</tr>
<tr>
<td>Influence of Engineering, Technology, and Science on Society and the Natural World: • Developing and using technology has impacts on the natural world.</td>
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#### Crosscutting Concepts: Stability and Change

- Things may change slowly or rapidly.

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### Connection to PASS Coming Soon
## 2-ESS2-2 Earth’s Systems

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Plate Tectonics and Large-Scale System Interactions:</strong></td>
<td>2-ESS2-2</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Maps show where things are located.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions.</td>
<td>• One can map the shapes and kinds of land and water in any area.</td>
<td><strong>Develop a model to represent the shapes and kind of land and bodies of water in an area.</strong></td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td><strong>Clarification Statement:</strong></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td>See Disciplinary Core Ideas.</td>
<td>Assessment does not include quantitative scaling in models.</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td><strong>Assessment Boundary:</strong></td>
<td></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Patterns
- Patterns in the natural world can be observed.

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**Connection to PASS Coming Soon**
2-ESS2-3 Earth’s Systems

**Science & Engineering Practices**

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
8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

- **The Roles of Water in Earth’s Surface Processes:**
  - Water is found in the ocean, rivers, lakes, and ponds.
  - Water exists as solid ice and liquid form.

**Performance Expectations**

- **2-ESS2-3**
  - Students who demonstrate understanding can:
    - **Obtain information to identify** where water is found on Earth and that it can be solid or liquid.

**Clarification Statement:**
- See Disciplinary Core Ideas.

**Assessment Boundary:**
- N/A

**Crosscutting Concepts: Patterns**
- Patterns in the natural world can be observed.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
3-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

1 Asking questions (for science) and defining problems (for engineering)
2 Developing and using models
3 Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
4 Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.
5 Analyzing and interpreting data
6 Using mathematics and computational thinking
7 Constructing explanations (for science) and designing solutions (for engineering)
8 Engaging in argument from evidence
9 Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Forces and Motion:
• Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object’s speed or direction of motion. (Boundary: Qualitative and conceptual, but not quantitative addition of forces are used at this level.)

Types of Interactions:
• Objects in contact exert forces on each other.

Performance Expectations

3-PS2-1
Students who demonstrate understanding can:

Plan and conduct investigations on the effects of balanced and unbalanced forces on the motion of an object. (Connected to 3-PS2-2)

Clarification Statement:
Examples could include an unbalanced force on one side of a ball can make it start moving; and, balanced forces pushing on a box from opposite sides will not produce any motion at all.

Assessment Boundary:
Assessment is limited to one variable at a time: number, size, or direction of forces. Assessment does not include quantitative force size, only qualitative and relative. Assessment is limited to gravity being addressed as a force that pulls objects down.

Crosscutting Concepts: Cause and Effect
• Cause and effect relationships are routinely identified.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
### Science Standards: Forces and Interactions

#### 3-PS2-2 Motion and Stability: Forces and Interactions

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<th>Performance Expectations</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Forces and Motion: • The patterns of an object’s motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)</td>
<td>3-PS2-2 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td></td>
<td>Make observations and/or measurements of the object’s motion to provide evidence that a pattern can be used to predict future motion. (Connected to 3-PS2-1)</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. • Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.</td>
<td></td>
<td>Clariﬁcation Statement: Examples of motion with a predictable pattern could include a child swinging in a swing, a ball rolling back and forth in a bowl, and two children on a see-saw.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td>Assessment Boundary: Assessment does not include technical terms such as period and frequency.</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Patterns

- Patterns of change can be used to make predictions.

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### Connection to PASS Coming Soon
### 3-PS2-3 Motion and Stability: Forces and Interactions

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<th>Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td><strong>1</strong> Asking questions (for science) and defining problems (for engineering)</td>
<td>Types of Interactions:</td>
<td>3-PS2-3</td>
</tr>
<tr>
<td>Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.</td>
<td>• Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>• Ask questions that can be investigated based on patterns such as cause and effect relationships.</td>
<td><strong>Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.</strong></td>
<td><strong>Clarification Statement:</strong></td>
</tr>
<tr>
<td>2 Developing and using models</td>
<td></td>
<td>Examples of an electric force could include the force on hair from an electrically charged balloon and the electrical forces between a charged rod and pieces of paper; examples of a magnetic force could include the force between two permanent magnets, the force between an electromagnet and steel paperclips, and the force exerted by one magnet versus the force exerted by two magnets. Examples of cause and effect relationships could include how the distance between objects affects strength of the force and how the orientation of magnets affects the direction of the magnetic force.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations</td>
<td></td>
<td><strong>Assessment Boundary:</strong></td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td></td>
<td>Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td></td>
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<tr>
<td>7 Engaging in argument from evidence</td>
<td></td>
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<tr>
<td>8 Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Cause and Effect**

• Cause and effect relationships are routinely identified, tested, and used to explain change.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 3-PS2-4 Motion and Stability: Forces and Interactions

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Types of Interactions:  
  - Electric, and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. | 3-PS2-4  
Students who demonstrate understanding can:  
Define a simple design problem that can be solved by applying scientific ideas about magnets.*  

* Connections to Engineering, Technology, and Application of Science  
Interdependence of Science, Engineering, and Technology:  
- Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.  

| 2 Developing and using models |  
Planning and carrying out investigations |  
Analyzing and interpreting data |  
Using mathematics and computational thinking |  
Constructing explanations (for science) and designing solutions (for engineering) |  
Engaging in argument from evidence |  
Obtaining, evaluating, and communicating information |  

| Crosscutting Concepts: N/A |  

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<tr>
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**Connection to PASS Coming Soon**
## 3-LS1-1 From Molecules to Organisms: Structure and Processes

<table>
<thead>
<tr>
<th>Science &amp; Engineering Practices</th>
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<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Growth and Development of Organisms:  
- Reproduction is essential to the continued existence of every kind of organism.  
- Plants and animals have unique and diverse life cycles. | 3-LS1-1  
Students who demonstrate understanding can:  
**Develop models to describe** that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.  
**Clarification Statement:** Changes different organisms go through during their life form a pattern.  
**Assessment Boundary:** Assessment of plant life cycles is limited to those of flowering plants. Assessment does not include details of human reproduction or microscopic organisms. |
| 2 Developing and using models  
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.  
- Develop models to describe phenomena. | | |
| 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 | | |
| 8 Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Patterns
- Patterns of change can be used to make predictions.

### Oklahoma Academic Standards Connections

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### Connection to PASS
Coming Soon
### 3-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

#### Science & Engineering Practices

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

#### Disciplinary Core Ideas

Social Interactions and Group Behavior:
- Being part of a group helps animals obtain food, defend themselves, and cope with changes.
- Groups may serve different functions and vary dramatically in size.

#### Performance Expectations

3-LS2-1
Students who demonstrate understanding can:

**Construct an argument that some animals form groups that help members survive.**

Clarification Statement:
Arguments could include examples of group behavior such as division of labor in a bee colony, flocks of birds staying together to confuse or intimidate predators, or wolves hunting in packs to more efficiently catch and kill prey.

Assessment Boundary:
N/A

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**Crosscutting Concepts: Cause and Effect**
- Cause and effect relationships are routinely identified and used to explain change.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 3-LS3-1 Heredity: Inheritance and Variation of Traits

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Inheritance of Traits:</strong> • Many characteristics of organisms are inherited from their parents.</td>
<td><strong>3-LS3-1</strong></td>
</tr>
<tr>
<td>2 Developing and using models</td>
<td><strong>Variation of Traits:</strong> • Different organisms vary in how they look and function because they have different inherited information.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations</td>
<td></td>
<td><strong>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.</strong></td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td>Crosscutting Concepts: Patterns • Similarities and differences in patterns can be used to sort and classify natural phenomena.</td>
<td></td>
</tr>
<tr>
<td>Analyzing data in 3–5 builds on K–2 experiences and progresses to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Analyze and interpret data to make sense of phenomena using logical reasoning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using mathematics and computational thinking</td>
<td></td>
<td><strong>Clarification Statement:</strong> Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.</td>
</tr>
<tr>
<td>Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td><strong>Assessment Boundary:</strong> Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.</td>
</tr>
<tr>
<td>Engaging in argument from evidence</td>
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<tr>
<td>Obtaining, evaluating, and communicating information</td>
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<tbody>
<tr>
<td><strong>RI.3.1</strong></td>
<td><strong>MP .2</strong> Reason abstractly and quantitatively.</td>
</tr>
<tr>
<td><strong>RI.3.2</strong></td>
<td><strong>MP .4</strong> Model with mathematics.</td>
</tr>
<tr>
<td><strong>RI.3.3</strong></td>
<td>3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.</td>
</tr>
</tbody>
</table>

### Crosscutting Concepts: Patterns

- Similarities and differences in patterns can be used to sort and classify natural phenomena.

### Connection to PASS Coming Soon
### 3-LS3-2 Heredity: Inheritance and Variation of Traits

<table>
<thead>
<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Inheritance of Traits:  
- Other characteristics result from individuals’ interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. | 3-LS3-2  
Students who demonstrate understanding can:  
**Use evidence to support the explanation that traits can be influenced by the environment.**  
Clarification Statement:  
Examples of the environment affecting a trait could include normally tall plants grown with insufficient water are stunted; a pet dog that is given too much food and little exercise may become overweight; and animals who teach their offspring skills like hunting.  
Assessment Boundary: N/A |
| 2. Developing and using models | Variation of Traits:  
- The environment also affects the traits that an organism develops. |
| 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)  
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.  
- Use evidence (e.g., observations, patterns) to support an explanation. | | |
| 7. Engaging in argument from evidence | | |
| 8. Obtaining, evaluating, and communicating information | | |

#### Crosscutting Concepts: Cause and Effect
- Cause and effect relationships are routinely identified and used to explain change.

#### Oklahoma Academic Standards Connections

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**Connection to PASS** Coming Soon
### 3-LS4-1 Biological Unity and Diversity

<table>
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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Evidence of Common Ancestry and Diversity:</td>
<td>3-LS4-1</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Some kinds of plants and animals that once lived on Earth are no longer found anywhere.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.</td>
<td><strong>Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.</strong></td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td><strong>Clarification Statement:</strong></td>
</tr>
<tr>
<td>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</td>
<td></td>
<td>Examples of data could include type, size, and distributions of fossil organisms. Examples of fossils and environments could include marine fossils found on dry land, tropical plant fossils found in Arctic areas, and fossils of extinct organisms.</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
<td><strong>Assessment Boundary:</strong></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td>Assessment does not include identification of specific fossils or present plants and animals.</td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td></td>
<td>Assessment is limited to major fossil types and relative ages.</td>
</tr>
<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Scale, Proportion, and Quantity**
- Observable phenomena exist from very short to very long time periods.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**

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**SCIENCE STANDARDS • OKLAHOMA STATE DEPARTMENT OF EDUCATION**
## 3-LS4-2 Biological Unity and Diversity

### Science & Engineering Practices
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)

### Disciplinary Core Ideas

**Natural Selection:**
- Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.

### Performance Expectations

**3-LS4-2**
Students who demonstrate understanding can:

*Use evidence to construct an explanation for how the variations in characteristics among individuals of the same species may provide advantages in surviving and reproducing.*

**Clarification Statement:**
Examples of cause and effect relationships could be plants that have larger thorns than other plants may be less likely to be eaten by predators; and, animals that have better camouflage coloration than other animals may be more likely to survive and therefore more likely to leave offspring.

**Assessment Boundary:**
N/A

### Crosscutting Concepts: Scale, Proportion, and Quantity

- Observable phenomena exist from very short to very long time periods.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
3-LS4-3 Biological Unity and Diversity

Science & Engineering Practices

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

Crosscutting Concepts: Cause and Effect
- Cause and effect relationships are routinely identified and used to explain change.

Adaptation:
- For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.

Performance Expectations

3-LS4-3
Students who demonstrate understanding can:

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.

Clarification Statement:
Examples of evidence could include needs and characteristics of the organisms and habitats involved. The organisms and their habitat make up a system in which the parts depend on each other.

Assessment Boundary:
N/A

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### 3-LS4-4 Biological Unity and Diversity

#### Science & Engineering Practices
- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence

#### Disciplinary Core Ideas
- **Ecosystem Dynamics, Functioning, and Resilience:**
  - When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4)
- **Biodiversity and Humans:**
  - Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

#### Performance Expectations
- **3-LS4-4**
  - Students who demonstrate understanding can:
    - 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.*

*Clarification Statement: Examples of environmental changes could include changes in land characteristics, water distribution, temperature, food, and other organisms.

**Assessment Boundary:**
Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.

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**Crosscutting Concepts: Systems and System Models**
- A system can be described in terms of its components and their interactions.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 3rd Grade

#### 3-ESS2-1 Earth’s Systems

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</thead>
<tbody>
<tr>
<td><strong>1. Asking questions (for science) and defining problems (for engineering)</strong>&lt;br&gt;<strong>2. Developing and using models</strong>&lt;br&gt;<strong>3. Planning and carrying out investigations</strong>&lt;br&gt;<strong>4. Analyzing and interpreting data</strong>&lt;br&gt;<strong>Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.</strong>&lt;br&gt;<strong>• Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.</strong>&lt;br&gt;<strong>5. Using mathematics and computational thinking</strong>&lt;br&gt;<strong>6. Constructing explanations (for science) and designing solutions (for engineering)</strong>&lt;br&gt;<strong>7. Engaging in argument from evidence</strong>&lt;br&gt;<strong>8. Obtaining, evaluating, and communicating information</strong></td>
<td><strong>Weather and Climate:</strong>&lt;br&gt;• Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.</td>
<td><strong>3-ESS2-1</strong>&lt;br&gt;Students who demonstrate understanding can:&lt;br&gt;&lt;br&gt;&lt;br&gt;<strong>Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.</strong>&lt;br&gt;&lt;br&gt;&lt;br&gt;<strong>Clarification Statement:</strong>&lt;br&gt;Examples of data at this grade level could include average temperature, precipitation, and wind direction.&lt;br&gt;&lt;br&gt;&lt;br&gt;<strong>Assessment Boundary:</strong>&lt;br&gt;Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.</td>
</tr>
</tbody>
</table>

#### Crosscutting Concepts: Patterns
- Patterns of change can be used to make predictions.

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**Connection to PASS Coming Soon**
### 3-ESS2-2 Earth’s Systems

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</tr>
</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Weather and Climate: • Climate describes a range of an area’s typical weather conditions and the extent to which those conditions vary over years.</td>
<td>3-ESS2-2 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td></td>
<td>Obtain and combine information to describe climates in different regions of the world.</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td>Clarification Statement: N/A</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td>Assessment Boundary: N/A</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. • Obtain and combine information from books and other reliable media to explain phenomena.</td>
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**Crosscutting Concepts: Patterns**
- Patterns of change can be used to make predictions.

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**Connection to PASS Coming Soon**
3-ESS3-1 Earth and Human Activity

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</tr>
</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Natural Hazards:</td>
<td>3-ESS3-1</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• A variety of natural hazards result from natural processes.</td>
<td>Make a claim about the</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• Humans cannot eliminate natural hazards but can take steps to reduce their impacts.</td>
<td>merit of a design solution</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td>(Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)</td>
<td>that reduces the impacts</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
<td>of a weather-related hazard.</td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td>Influence of Engineering, Technology, and Science on Society and the Natural World:</td>
<td></td>
</tr>
<tr>
<td>Engaging in argument from evidence in 3-5 builds on K–2 experiences and progresses to</td>
<td>• Engineers improve existing technologies or develop new ones to increase their</td>
<td></td>
</tr>
<tr>
<td>critiquing the scientific explanations or solutions proposed by peers by citing relevant</td>
<td>benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in</td>
<td></td>
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<tr>
<td>evidence about the natural and designed world(s).</td>
<td>cars), and meet societal demands (e.g., cell phones).</td>
<td></td>
</tr>
<tr>
<td>• Make a claim about the merit of a solution to a problem by citing relevant evidence about</td>
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<tr>
<td>how it meets the criteria and constraints of the problem.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Obtaining, evaluating, and communicating information</td>
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Crosscutting Concepts: Cause and Effect
• Cause and effect relationships are routinely identified, tested, and used to explain change.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
4-PS3-1 Energy

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<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Definitions of Energy: • The faster a given object is moving, the more energy it possesses.</td>
<td>4-PS3-1 Students who demonstrate understanding can: Use evidence to construct an explanation relating the speed of an object to the energy of that object.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td></td>
<td>Clarification Statement: Energy can be moved from place to place by moving objects or through sound, light, or electric currents. At this grade level, no attempt is made to give a precise or complete definition of energy.</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td>Assessment Boundary: Assessment does not include quantitative measures of changes in the speed of an object or on any precise or quantitative definition of energy.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. • Use evidence (e.g., measurements, observations, patterns) to construct an explanation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td></td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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Crosscutting Concepts: Energy and Matter
• Energy can be transferred in various ways and between objects.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon

Science Standards • Oklahoma State Department of Education
### 4-PS3-2 Energy

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
   - Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Definitions of Energy:**
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents.

**Conservation of Energy and Energy Transfer:**
- Energy is present whenever there are moving objects, sound, light, or heat.
- When objects collide, energy can be transferred from one object to another, thereby changing their motion.
- In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.
- Light also transfers energy from place to place.
- Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light.
- The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

**Performance Expectations**

4-PS3-2
Students who demonstrate understanding can:

- **Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.**

**Clarification Statement:**
When energy is transferred it can stay in the same form, change forms, or both. Examples of this can include a moving arm throwing a baseball, the light from the sun warming a window-pane, and two moving objects colliding and changing their motion.

**Assessment Boundary:**
Assessment does not include quantitative measurements of energy.

### Crosscutting Concepts: Energy and Matter

- Energy can be transferred in various ways and between objects.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.

#### Mathematics

MP.1 Make sense of problems and persevere in solving them.

4.MD.C.6 Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

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**Connection to PASS Coming Soon**
4-PS3-3 Energy

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering) Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. • Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.</td>
<td>Definitions of Energy: • Energy can be moved from place to place by moving objects or through sound, light, or electric currents. Conservation of Energy and Energy Transfer: • Energy is present whenever there are moving objects, sound, light, or heat. • When objects collide, energy can be transferred from one object to another, thereby changing their motion. • In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Relationship Between Energy and Forces: • When objects collide, the contact forces transfer energy so as to change the objects’ motions.</td>
<td>4-PS3-3 Students who demonstrate understanding can: Ask questions and predict outcomes about the changes in energy that occur when objects collide. Clarification Statement: Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact. Assessment Boundary: Assessment does not include quantitative measurements of energy.</td>
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Crosscutting Concepts: Energy and Matter

- Energy can be transferred in various ways and between objects.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### 4-PS3-4 Energy

#### Science & Engineering Practices

- 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)

#### Disciplinary Core Ideas

- **Conservation of Energy and Energy Transfer:**
  - Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.

- **Energy in Chemical Processes and Everyday Life:**
  - The expression “produce energy” typically refers to the conversion of stored energy into a desired form for practical use.

- **Defining Engineering Problems** (secondary to 4-PS3-4)
  - Possible solutions to a problem are limited by available materials and resources (constraints).
  - The success of a designed solution is determined by considering the desired features of a solution (criteria).
  - Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.

#### Performance Expectations

**4-PS3-4**

Students who demonstrate understanding can:

- Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*

**Clarification Statement:**

Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat, mousetrap cars, rubber band-powered vehicles. Examples of constraints could include the materials, cost, or time to design the device.

**Assessment Boundary:**

N/A

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**Crosscutting Concepts: Energy and Matter**

- Energy can be transferred in various ways and between objects.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 4-PS4-1 Waves and Their Applications in Technologies for Information Transfer

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Wave Properties:  
- Waves, which are regular patterns of motion, can be made in water by disturbing the surface.  
- When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach.  
- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). | **4-PS4-1**  
Students who demonstrate understanding can:  
**Develop a model** of waves to describe patterns in terms of amplitude and wavelength and to show that waves can cause objects to move. |
| 2. Developing and using models  
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.  
- Develop a model using an analogy, example, or abstract representation to describe a scientific principle. |  
| 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 |  
| 8. Obtaining, evaluating, and communicating information |  

**Crosscutting Concepts: Patterns**  
- Similarities and differences in patterns can be used to sort and classify natural phenomena.

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**Connection to PASS Coming Soon**
### 4-PS4-2 Waves and Their Applications in Technologies for Information Transfer

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</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Electromagnetic Radiation:  
- An object can be seen when light reflected from its surface enters the eyes. | 4-PS4-2  
Students who demonstrate understanding can: |
| 2 Developing and using models  
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.  
- Develop a model to describe phenomena. | | Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen. |
| 3 Planning and carrying out investigations | | Clarification Statement:  
N/A |
| 4 Analyzing and interpreting data | | Assessment Boundary:  
Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works. |
| 5 Using mathematics and computational thinking | | |
| 6 Constructing explanations (for science) and designing solutions (for engineering) | | |
| 7 Engaging in argument from evidence | | |
| 8 Obtaining, evaluating, and communicating information | | |

**Crosscutting Concepts: Cause and Effect**  
- Cause and effect relationships are routinely identified.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
4-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

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)

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Information Technologies and Instrumentation:
- Digitized information can be transmitted over long distances without significant degradation.
- High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.

Optimizing The Design Solution (secondary to 4-PS4-3)
- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Performance Expectations

4-PS4-3
Students who demonstrate understanding can:

Generate and compare multiple solutions that use patterns to transfer information.*

Clarification Statement:
Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, QR codes, barcodes, and using Morse code to send text.

Assessment Boundary:
N/A

Crosscutting Concepts: Patterns
- Similarities and differences in patterns can be used to sort and classify designed products.

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Connection to PASS Coming Soon
## 4TH GRADE

### 4-LS1-1 From Molecules to Organisms: Structure and Processes

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<th>Disciplinary Core Ideas</th>
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</table>
| 1 Asking questions (for science) and defining problems (for engineering) | **Structure and Function:**  
- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. | **4-LS1-1**  
Students who demonstrate understanding can:  
**Construct an argument**  
that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. |
| 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  
Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).  
- Construct an argument with evidence, data, and/or a model. | | |
| 8 Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Systems and System Models
- A system can be described in terms of its components and their interactions.

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**Connection to PASS Coming Soon**
### 4-LS1-2 From Molecules to Organisms: Structure and Processes

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<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Information Processing:  • Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain.  • Animals are able to use their perceptions and memories to guide their actions.</td>
<td>4-LS1-2  Students who demonstrate understanding can:  <strong>Use a model to describe</strong> that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.  <strong>Clarification Statement:</strong> Emphasis is on systems of information transfer. Examples of response to stimuli include animals running from predators and plant leaves turning toward the sun.  <strong>Assessment Boundary:</strong> Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.</td>
</tr>
<tr>
<td>2 Developing and using models  Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.  • Use a model to test interactions concerning the functioning of a natural system.</td>
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<tr>
<td>3 Planning and carrying out investigations</td>
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<tr>
<td>4 Analyzing and interpreting data</td>
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<tr>
<td>5 Using mathematics and computational thinking</td>
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<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7 Engaging in argument from evidence</td>
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<td>8 Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Systems and System Models**
• A system can be described in terms of its components and their interactions.

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**Connection to PASS Coming Soon**
**4-ESS1-1 Earth’s Place in the Universe**

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<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>The History of Planet Earth:</td>
<td>4-ESS1-1 Students who demonstrate understanding can:</td>
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<tr>
<td>2 Developing and using models</td>
<td>• Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes.</td>
<td>Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.</td>
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<tr>
<td>3 Planning and carrying out investigations</td>
<td>• The presence and location of certain fossil types indicate the order in which rock layers were formed.</td>
<td>Clarification Statement: Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.</td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td>Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</td>
<td>Assessment Boundary: Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
<td>• Identify the evidence that supports particular points in an explanation.</td>
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<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
<td>Engaging in argument from evidence</td>
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<tr>
<td>Constructing explanations and designing solutions in 3-5 builds on K-2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.</td>
<td>Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Patterns**

• Patterns can be used as evidence to support an explanation.

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**Connection to PASS Coming Soon**
### 4-ESS2-1 Earth’s Systems

#### Science & Engineering Practices

1. **Asking questions (for science) and defining problems (for engineering)**
2. **Developing and using models**
3. **Planning and carrying out investigations**
   - Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.
   - With guidance, plan and conduct an investigation with peers.
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**
8. **Obtaining, evaluating, and communicating information**

#### Disciplinary Core Ideas

**Earth Materials and Systems:**
- Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

#### Performance Expectations

**4-ESS2-1**
- Students who demonstrate understanding can:
  - **Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.**

**Clarification Statement:**
Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.

**Assessment Boundary:**
Assessment is limited to a single form of weathering or erosion.

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**Crosscutting Concepts: Cause and Effect**

- Cause and effect relationships are routinely identified, tested, and used to explain change.

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**Connection to PASS Coming Soon**
4-ESS2-2 Earth’s Systems

Science & Engineering Practices

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
   - Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used.
   - Analyze and interpret data to make sense of phenomena using logical reasoning.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Plate Tectonics and Large-Scale System Interactions:
- The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns.
- Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans.
- Major mountain chains form inside continents or near their edges.
- Maps can help locate the different land and water features areas of Earth.

Performance Expectations

4-ESS2-2
Students who demonstrate understanding can:

- Analyze and interpret data from maps to describe patterns of Earth's features.

Clarification Statement:
Maps can include topographic maps of Earth’s land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.

Assessment Boundary:
N/A

Crosscutting Concepts: Patterns
- Patterns can be used as evidence to support an explanation.

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Connection to PASS Coming Soon
4-ESS3-1 Earth and Human Activity

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<td>① Asking questions (for science) and defining problems (for engineering)</td>
<td>Natural Resources:</td>
<td>4-ESS3-1</td>
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<td>② Developing and using models</td>
<td>• Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways.</td>
<td>Students who demonstrate understanding can:</td>
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<tr>
<td>③ Planning and carrying out investigations</td>
<td>• Some resources are renewable over time, and others are not.</td>
<td>Obtain and combine information to describe that energy and fuels are derived from renewable and non-renewable resources and how their uses affect the environment.</td>
</tr>
<tr>
<td>④ Analyzing and interpreting data</td>
<td></td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td>⑤ Using mathematics and computational thinking</td>
<td></td>
<td>Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.</td>
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<tr>
<td>⑥ Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>Assessment Boundary:</td>
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<tr>
<td>⑦ Engaging in argument from evidence</td>
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<tr>
<td>⑧ Obtaining, evaluating, and communicating information</td>
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<td>Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods.</td>
<td>• Obtain and combine information from books and other reliable media to explain phenomena.</td>
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Crosscutting Concepts: Cause and Effect
• Cause and effect relationships are routinely identified and used to explain change.

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Connection to PASS Coming Soon
### 4-ESS3-2 Earth and Human Activity

**Science & Engineering Practices**

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)

**Disciplinary Core Ideas**

**Natural Hazards:**
- A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions).
- Humans cannot eliminate the hazards but can take steps to reduce their impacts.

**Designing Solutions to Engineering Problems:**
- Testing a solution involves investigating how well it performs under a range of likely conditions.

**Influence of Engineering, Technology, and Science on Society and the Natural World:**
- Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.

**Performance Expectations**

4-ESS3-2

Students who demonstrate understanding can:

- **Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.***

**Clarification Statement:**
Examples of solutions could include designing an earthquake resistant building and improving monitoring of volcanic activity.

**Assessment Boundary:**
Assessment is limited to earthquakes, floods, tsunamis, and volcanic eruptions.

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**Crosscutting Concepts: Cause and Effect**

- Cause and effect relationships are routinely identified and used to explain change.

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**Connection to PASS Coming Soon**
5-PS1-1 Matter and Its Interactions

Science & Engineering Practices

1 Asking questions (for science) and defining problems (for engineering)
2 Developing and using models
   Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena.
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
8 Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Properties of Matter:
- Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means.
- A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects.

Performance Expectations

5-PS1-1
Students who demonstrate understanding can:

Develop a model to describe that matter is made of particles too small to be seen.

Clarification Statement:
Examples of evidence that could be utilized in building models include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating salt water.

Assessment Boundary:
Assessment does not include atomic-scale mechanism of evaporation and condensation or defining the unseen particles.

Crosscutting Concepts: Scale, Proportion, and Quantity

- Natural objects exist from the very small to the immensely large.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### 5-PS1-2 Matter and Its Interactions

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| 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  
8. Obtaining, evaluating, and communicating information | Structure and Properties of Matter:  
• The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish.  
Chemical Reactions:  
• No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) | 5-PS1-2  
Students who demonstrate understanding can:  
**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.**  
Clarification Statement:  
Examples of reactions or changes could include phase changes, dissolving, and mixing that forms new substances.  
Assessment Boundary:  
Assessment does not include distinguishing mass and weight. |

### Crosscutting Concepts: Scale, Proportion, and Quantity

- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### 5-PS1-3 Matter and Its Interactions

<table>
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<tr>
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<th>Disciplinary Core Ideas</th>
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</thead>
</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Structure and Properties of Matter:  
• Measurements of a variety of properties can be used to identify materials.  
(Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) | 5-PS1-3  
Students who demonstrate understanding can:  
**Make observations and measurements** to identify materials based on their properties. |
| 2 Developing and using models |  | |
| 3 Planning and carrying out investigations |  | |
| Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.  
• Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. |  |  
**Clarification Statement:**  
Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.  
**Assessment Boundary:**  
Assessment does not include density or distinguishing mass and weight. |
| 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 |  | |
| 8 Obtaining, evaluating, and communicating information |  | |

**Crosscutting Concepts: Scale, Proportion, and Quantity**
- Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 5th Grade

#### 5-PS1-4 Matter and Its Interactions

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Chemical Reactions: • When two or more different substances are mixed, a new substance with different properties may be formed.</td>
<td>5-PS1-4 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td></td>
<td><strong>Conduct an investigation to determine</strong> whether the mixing of two or more substances results in new substances.</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td>Clarification Statement: Examples of interactions forming new substances can include mixing baking soda and vinegar. Examples of interactions not forming new substances can include mixing baking soda and water.</td>
</tr>
<tr>
<td></td>
<td>Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.</td>
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<tr>
<td></td>
<td>• Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Cause and Effect**
- Cause and effect relationships are routinely identified, tested, and used to explain change.

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**Connection to PASS Coming Soon**
### 5-PS2-1 Motion and Stability: Forces and Interactions

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<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Types of Interactions:  
- The gravitational force of Earth acting on an object near Earth’s surface pulls that object toward the planet's center. | 5-PS2-1  
Students who demonstrate understanding can:  
**Support an argument that the gravitational force exerted by the Earth is directed down.** |
| 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  
Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). | | |
| 8. Obtaining, evaluating, and communicating information | | |

**Clarification Statement:**  
“Down” is a local description of the direction that points toward the center of the spherical earth. Earth causes objects to have a force on them that point toward the center of the Earth, “down”. Support for arguments can be drawn from diagrams, evidence, and data that are provided.

**Assessment Boundary:**  
Mathematical representation of gravitational force is not assessed.

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### Crosscutting Concepts: Cause and Effect
- Cause and effect relationships are routinely identified, tested, and used to explain change.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### 5-PS3-1 Energy

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</thead>
<tbody>
<tr>
<td><strong>1.</strong> Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Energy in Chemical Processes and Everyday Life:</strong></td>
<td><strong>5-PS3-1</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td><strong>2.</strong> Developing and using models Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Use models to describe phenomena.</td>
<td>• The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water).</td>
<td><strong>Use models to describe that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.</strong></td>
</tr>
<tr>
<td><strong>3.</strong> Planning and carrying out investigations</td>
<td><strong>Organization of Matter and Energy Flow in Organisms:</strong></td>
<td><strong>Clarification Statement:</strong> Examples of models could include diagrams, and flow charts.</td>
</tr>
<tr>
<td><strong>4.</strong> Analyzing and interpreting data</td>
<td>• Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion.</td>
<td><strong>Assessment Boundary:</strong> Assessment does not include cellular mechanisms of digestive absorption.</td>
</tr>
<tr>
<td><strong>5.</strong> Using mathematics and computational thinking</td>
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<tr>
<td><strong>6.</strong> Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td><strong>7.</strong> Engaging in argument from evidence</td>
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**Crosscutting Concepts: Energy and Matter**
- Energy can be transferred in various ways and between objects.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 5-LS1-1 From Molecules to Organisms: Structure and Processes

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<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Organization for Matter and Energy Flow in Organisms:  
   - Plants acquire their material for growth chiefly from air and water. | 5-LS1-1  
   Students who demonstrate understanding can: |
| 2. Developing and using models |  
   Engaging in argument from evidence  
   Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world.  
   - Support an argument with evidence, data, or a model.  
   - Obtaining, evaluating, and communicating information | Support an argument that plants get the materials they need for growth chiefly from air and water. |
| 3. Planning and carrying out investigations |  
   Obtaining, evaluating, and communicating information | Clarification Statement:  
   Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil. |
| 4. Analyzing and interpreting data |  
   Using mathematics and computational thinking |  |
| 5. Constructing explanations (for science) and designing solutions (for engineering) |  
   Using mathematics and computational thinking |  |
| 6. Engaging in argument from evidence |  
   Engaging in argument from evidence in 3-5 builds on K-2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world.  
   - Support an argument with evidence, data, or a model.  
   - Obtaining, evaluating, and communicating information |  |
| 7. Obtaining, evaluating, and communicating information |  
   Using mathematics and computational thinking |  |

**Crosscutting Concepts: Energy and Matter**

- Matter is transported into, out of, and within systems.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 5-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

#### Science & Engineering Practices

1. **Asking questions (for science) and defining problems (for engineering)**
2. **Developing and using models**
   - Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.
   - Develop a model to describe phenomena.
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**
8. **Obtaining, evaluating, and communicating information**

#### Disciplinary Core Ideas

**Interdependent Relationships in Ecosystems:**
- The food of almost any kind of animal can be traced back to plants.
- Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants.
- Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.”
- Decomposition eventually restores (recycles) some materials back to the soil.
- Organisms can survive only in environments in which their particular needs are met.
- A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.
- Newly introduced species can damage the balance of an ecosystem.

**Cycles of Matter and Energy Transfer in Ecosystems:**
- Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die.
- Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.

#### Performance Expectations

**5-LS2-1**

Students who demonstrate understanding can:

- Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

**Clarification Statement:** Emphasis is on the idea that matter that is not food (air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.

**Assessment Boundaries:** Assessment does not include molecular explanations.

---

### Crosscutting Concepts: Systems and System Models

- A system can be described in terms of its components and their interactions.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

RI.5.7
- Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

SL.5.5
- Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

### Mathematics

MP.2
- Reason abstractly and quantitatively.

MP.4
- Model with mathematics.

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### Connection to PASS Coming Soon
## 5th Grade

### 5-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

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<tbody>
<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Interdependent Relationships in Ecosystems:</strong></td>
<td><strong>5-LS2-2</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2 Developing and using models Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Use models to describe phenomena.</td>
<td>Organisms can survive only in environments in which their particular needs are met.</td>
<td>Use models to explain factors that upset the stability of local ecosystems.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations</td>
<td>A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life.</td>
<td>Clarification Statement: Factors that upset an ecosystem’s stability includes: invasive species, drought, human development, and removal of predators. Models could include simulations, and representations, etc.</td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td>Newly introduced species can damage the balance of an ecosystem.</td>
<td>Assessment Boundaries: Assessment does not include molecular explanations.</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
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<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
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### Crosscutting Concepts: Systems and System Models

- A system can be described in terms of its components and their interactions.

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### Connection to PASS

Coming Soon
### 5-ESS1-1 Earth’s Place in the Universe

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>The Universe and Its Stars:</strong> • The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.</td>
<td><strong>5-ESS1-1</strong> Students who demonstrate understanding can: <strong>Support an argument that</strong> differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth. <strong>Assessment Boundary:</strong> Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).</td>
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<tr>
<td>2. Developing and using models</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td></td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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</tr>
<tr>
<td>Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). • Support an argument with evidence, data, or a model.</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Scale, Proportion and Quantity**

- Natural objects exist from the very small to the immensely large.

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**Connection to PASS Coming Soon**
## 5-ESS1-2 Earth’s Place in the Universe

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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Earth and the Solar System: • The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.</td>
<td>5-ESS1-2 Students who demonstrate understanding can: <strong>Represent data in graphical displays to reveal patterns</strong> of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<td><strong>Clarification Statement:</strong> Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td><strong>Assessment Boundary:</strong> Assessment does not include causes of seasons.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data Analyzing data in 3–5 builds on K–2 experiences and progress to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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### Crosscutting Concepts: Patterns
- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

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**Connection to PASS Coming Soon**
5-ESS2-1 Earth’s Systems

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</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Earth Materials and System:  
- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes.  
- The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate.  
- Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. | 5-ESS2-1  
Students who demonstrate understanding can:  
**Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.** |
| 2. Developing and using models  
Modeling in 3-5 builds on K-2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.  
- Develop a model using an example to describe phenomena. | | |
| 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 | | |
| 8. Obtaining, evaluating, and communicating information | | |

Crosscutting Concepts: System and System Models
- A system can be described in terms of its components and their interactions.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
5-ESS2-2 Earth’s Systems

**Science & Engineering Practices**

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

Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.

- Describe and graph quantities such as area and volume to address scientific questions.
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

The Roles of Water in Earth’s Surface Processes:

- Nearly all of Earth’s available water is in the ocean.
- Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

**Performance Expectations**

5-ESS2-2 Students who demonstrate understanding can:

*Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.*

Assessment Boundary:
Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere. Only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.

**Crosscutting Concepts: Scale, Proportion, and Quantity**

- Standard units are used to measure and describe physical quantities such as weight and volume.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### 5-ESS3-1 Earth and Human Activity

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</tr>
</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Human Impacts on Earth Systems:</strong> Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.</td>
<td><strong>5-ESS3-1</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<td><strong>Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.</strong></td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
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<td><strong>Clarification Statement:</strong> Examples of information might include the use of natural fertilizers or biological pest control by farmers, replanting trees after cutting them by the logging industry, and the institution of recycling programs in cities.</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<td><strong>Assessment Boundary:</strong> N/A</td>
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<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods.</td>
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<tr>
<td>• Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.</td>
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</table>

### Crosscutting Concepts: System and System Models
- A system can be described in terms of its components and their interactions.

### Oklahoma Academic Standards Connections

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<thead>
<tr>
<th>ELA/Literacy</th>
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### Connection to PASS Coming Soon
6-12 Overview

The 6th–12th Grade Oklahoma Academic Standards for Science include the following Domains:

1. Physical Science (PS)
2. Life Science (LS)
3. Earth & Space Science (ESS)

Each Domain has a set of Topics in science that fit within that Domain:

1. Physical Science (PS)
   - Matter and Its Interactions (PS1)
   - Motion and Stability: Forces and Interactions (PS2)
   - Energy (PS3)
   - Waves and Their Applications in Technologies for Information

2. Life Science (LS)
   - From Molecules to Organisms: Structure and Processes (LS1)
   - Ecosystems: Interactions, Energy, and Dynamics (LS2)
   - Heredity: Inheritance and Variation of Traits (LS3)
   - Biological Unity and Diversity (LS4)

3. Earth & Space Science (ESS)
   - Earth’s Place in the Universe (ESS1)
   - Earth’s Systems (ESS2)
   - Earth and Human Activity (ESS4)

The abbreviations for the Domains and Topics are utilized in the naming system of each Performance Expectation found in the Oklahoma Academic Standards for Science.

For example, the Performance Expectation MS-PS1-4 represents the following:

**GRADE:** Middle School  
**DOMAIN:** Physical Science  
**TOPIC:** Matter and its Interactions  
**STANDARD:** 4

Each grade level contains Performance Expectations from each Domain. The progressions are unique from other grade spans in that Performance Expectations for a particular Topic are distributed across the 6th-8th grade. Performance Expectations for Physical Science Topic 1, “Matter and its Interactions,” are highlighted in green. The standards are unique to each grade and their distribution ensures students will have obtained a collection of experiences that assists them in fully understanding Topic 1 before they enter High School.

In 9th-12th grade, each course contains Performance Expectations that may appear in other courses and does not necessarily integrate Performance Expectations from each Domain. The Performance Expectations for Physical Science Topic 1, “Matter and its Interactions,” for high school are found in Physical Science, Chemistry, and Physics, and are highlighted in green in the table below. The Performance Expectations may be duplicated considering not every student will take all three courses. In some cases, the Performance Expectations appear in multiple courses with minor differences (see HS-PS4-1 in Physical Science, Chemistry, and Physics highlighted in blue) and sometimes the Performance Expectation is duplicated exactly (see HS-PS2-2 in Physical Science and Physics, highlighted in red). In some cases, Performance Expectations may only appear in one course (see HS-PS2-6 in Chemistry).

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<tr>
<th>Grade 6</th>
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<tr>
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</table>
MS-PS1-4 Matter and Its Interactions

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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 predict and/or describe phenomena.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Properties of Matter:
• Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
• The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

Definitions of Energy:
(secondary to MS-PS1-4)
• The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects.
• The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material.
• Temperature is not a direct measure of a system’s total thermal energy.
• The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.

Performance Expectations

MS-PS1-4
Students who demonstrate understanding can:

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Clarification Statement:
Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.

Assessment Boundary:
The use of mathematical formulas is not intended.

Crosscutting Concepts: Cause and Effect
• Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
MS-PS2-3 Motion and Stability: Forces and Interactions

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
   - 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.

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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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

Clarification Statement:
- Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.

Assessment Boundary:
- Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking. Assessment of Coulomb’s Law is not intended.

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

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
## MS-PS2-5 Motion and Stability: Forces and Interactions

**Science & Engineering Practices**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
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.
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
8. Obtaining, evaluating, and communicating information

<table>
<thead>
<tr>
<th>Types of Interactions:</th>
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<tbody>
<tr>
<td>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).</td>
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<tr>
<th>Disciplinary Core Ideas</th>
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<td>MS-PS2-5</td>
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**Performance Expectations**

- Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

**Clarification Statement:**
- Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.

**Assessment Boundary:**
- Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.

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### Crosscutting Concepts: Cause and Effect

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

### Oklahoma Academic Standards Connections

<table>
<thead>
<tr>
<th>6TH GRADE</th>
<th>9-12</th>
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<tr>
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**Connection to PASS Coming Soon**
### MS-PS3-1 Energy

**Science & Engineering Practices**

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
   - 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.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

**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.

**Performance Expectations**

**MS-PS3-1**
Students who demonstrate understanding can:

- **Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.**

**Clarification Statement:**
Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.

**Assessment Boundary:**
Does not include mathematical calculations of kinetic energy.

### Crosscutting Concepts: 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.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### MS-PS3-2 Energy

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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 predict and/or describe phenomena.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

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

**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.

#### Performance Expectations

**MS-PS3-2**
Students who demonstrate understanding can:

- **Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**

**Clarification Statement:**
Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate’s hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.

**Assessment Boundary:**
Assessment is limited to two objects and electric, magnetic, and gravitational interactions.

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**Crosscutting Concepts: Systems and System Models**
- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### MS-PS3-3 Energy

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Definitions of Energy: | MS-PS3-3

- 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.

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

Defining and Delimiting an Engineering Problem: (secondary to MS-PS3-3)
- 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.

Developing Possible Solutions: (secondary to MS-PS3-3)
- 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.

| 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) 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. |
| 7. Engaging in argument from evidence |
| 8. Obtaining, evaluating, and communicating information |

### Crosscutting Concepts: Energy and Matter

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

### Oklahoma Academic Standards Connections

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<th>ELA/Literacy</th>
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### Connection to PASS Coming Soon
### MS-PS3-4 Energy

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
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.

- 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.

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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**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.

**Conservation of Energy and Energy Transfer:**
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.

#### Performance Expectations

**MS-PS3-4**

Students who demonstrate understanding can:

**Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**

**Clarification Statement:**
Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.

**Assessment Boundary:** Assessment does not include calculating the total amount of thermal energy transferred.

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### Crosscutting Concepts: 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.

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**Connection to PASS** Coming Soon
### MS-LS1-1 From Molecules to Organisms: Structure and Processes

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Structure and Function:</td>
<td>MS-LS1-1 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• All living things are made up of cells, which is the smallest unit that can be said to be alive.</td>
<td><strong>Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.</strong></td>
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<tr>
<td>3. Planning and carrying out investigations</td>
<td>• An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).</td>
<td><strong>Clarification Statement:</strong> Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells.</td>
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<tr>
<td>Planning and carrying out investigations in K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.</td>
<td>• Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.</td>
<td><strong>Assessment Boundary:</strong> Assessments should provide evidence of students’ abilities to identify evidence that living things are made of cells and distinguish between living and nonliving cells.</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
<td>• Using mathematics and computational thinking</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<td>6. Engaging in argument from evidence</td>
<td>• Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Scale, Proportion, and Quantity

- Phenomena that can be observed at one scale may not be observable at another scale.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### MS-LS1-2 From Molecules to Organisms: Structure and Processes

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<th>Performance Expectations</th>
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<tbody>
<tr>
<td><strong>1.</strong> Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Structure and Function:</strong></td>
<td><strong>MS-LS1-2</strong></td>
</tr>
<tr>
<td><strong>2.</strong> Developing and using models</td>
<td>• Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>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.</td>
<td><strong>Develop and use a model to describe</strong> the function of a cell as a whole and ways parts of cells contribute to the function.</td>
<td><strong>Develop and use a model to describe</strong> the function of a cell as a whole and ways parts of cells contribute to the function.</td>
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<tr>
<td>• Develop and use a model to describe phenomena.</td>
<td><strong>Clarification Statement:</strong></td>
<td><strong>Clarification Statement:</strong></td>
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<tr>
<td><strong>3.</strong> Planning and carrying out investigations</td>
<td>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. Other organelles should be introduced while covering this concept.</td>
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<tr>
<td><strong>4.</strong> Analyzing and interpreting data</td>
<td><strong>Assessment Boundary:</strong></td>
<td><strong>Assessment Boundary:</strong></td>
</tr>
<tr>
<td><strong>5.</strong> Using mathematics and computational thinking</td>
<td>Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.</td>
<td>Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.</td>
</tr>
<tr>
<td><strong>6.</strong> Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td><strong>7.</strong> Engaging in argument from evidence</td>
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<tr>
<td><strong>8.</strong> Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Structure and Function
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

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### Connection to PASS Coming Soon
### MS-LS1-3 From Molecules to Organisms: Structure and Processes

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Structure and Function:</strong></td>
<td><strong>MS-LS1-3</strong></td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• 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.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td></td>
<td><strong>Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.</strong></td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td></td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td>7. Engaging in argument from evidence</td>
<td></td>
<td>Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.</td>
</tr>
<tr>
<td>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).</td>
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<tr>
<td>• Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Systems and System Models
- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.

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**Connection to PASS Coming Soon**
## MS-LS1-6 From Molecules to Organisms: Structure and Processes

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Organization for Matter and Energy Flow in Organisms:  
• Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. | MS-LS1-6  
Students who demonstrate understanding can:  
**Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.**  
Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.  
Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis. |
| 2. Developing and using models | Energy in Chemical Processes and Everyday Life:  
(secondary to MS-LS1-6):  
• The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur.  
• In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. |  |
| 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) |  |  |
| 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 knowledge, 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. |  |  |
| 7. Engaging in argument from evidence |  |  |
| 8. Obtaining, evaluating, and communicating information |  |  |

### Crosscutting Concepts: Energy and Matter
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

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### Connection to PASS Coming Soon
## 6TH GRADE

### MS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

#### Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Interdependent Relationships in Ecosystems:**
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- Growth of organisms and population increases are limited by access to resources.

#### Performance Expectations

**MS-LS2-1**

Students who demonstrate understanding can:

- **Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.**

**Clarification Statement:** Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.

**Assessment Boundary:** The model should focus on organisms’ needs and how resources in the ecosystem meet those needs. Determining the carrying capacity of ecosystems is beyond the intent.

### Crosscutting Concepts: Cause and Effect

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

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### Connection to PASS Coming Soon
### MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

#### Science & Engineering Practices
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)
   - Constructing explanations and designing solutions in grades 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
   - Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas
- **Interdependent Relationships in Ecosystems:**
  - Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.

#### Performance Expectations
- **MS-LS2-2**
  - Students who demonstrate understanding can:
    - Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

  **Clarification Statement:**
  Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial (e.g., competition, predation, parasitism, commensalism, mutualism).

  **Assessment Boundary:**
  Assessment should provide evidence that students can explain the consistency for the interactions of organisms with other organisms and/or the environment across different ecosystems (e.g., ocean, forests, wetlands, deserts, terrariums, cities).

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### Crosscutting Concepts: Patterns
- Patterns can be used to identify cause and effect relationships.

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**Connection to PASS Coming Soon**
### MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

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<tbody>
<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Cycle of Matter and Energy Transfer in Ecosystems:</td>
<td>MS-LS2-3</td>
</tr>
<tr>
<td>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.</td>
<td>• Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>• Develop a model to describe phenomena.</td>
<td>• Transfers of matter into and out of the physical environment occur at every level.</td>
<td>Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations</td>
<td>• Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments.</td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td>• The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.</td>
<td>Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
<td></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td>Assessment does not include the use of chemical reactions to describe the processes.</td>
</tr>
<tr>
<td>7 Engaging in argument from evidence</td>
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<tr>
<td>8 Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Energy and Matter**

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

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**Connection to PASS Coming Soon**
### MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

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<tr>
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<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
</table>
| ① Asking questions (for science) and defining problems (for engineering) | **Ecosystem Dynamics, Functioning, and Resilience:**  
  - Ecosystems are dynamic in nature; their characteristics can vary over time.  
  - Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. | **MS-LS2-4**  
  Students who demonstrate understanding can:  
  * Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.  
  **Clarification Statement:** Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.  
  **Assessment Boundary:** N/A |
| 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 | | |
| Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).  
  - Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. | | |
| ⑨ Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Stability and Change
- Small changes in one part of a system might cause large changes in another part.

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**Connection to PASS Coming Soon**
## MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

### Science & Engineering Practices

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

### Disciplinary Core Ideas

**Ecosystem Dynamics, Functioning, and Resilience**:
- Biodiversity describes the variety of species found in Earth’s terrestrial and oceanic ecosystems.
- The completeness or integrity of an ecosystem’s biodiversity is often used as a measure of its health.

**Biodiversity and Humans**:
- Changes in biodiversity can influence humans’ resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.

### Performance Expectations

**MS-LS2-5**

Students who demonstrate understanding can:

- Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

**Clarification Statement:**
Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.

**Assessment Boundary:**
N/A

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### Crosscutting Concepts: Stability and Change

- Small changes in one part of a system might cause large changes in another part.

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### Connection to PASS Coming Soon
### 6TH GRADE

#### MS-ESS2-4 Earth’s Systems

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>The Roles of Water in Earth’s Surface Processes: • Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity.</td>
<td>MS-ESS2-4 Students who demonstrate understanding can: Develop a model to describe the cycling of water through Earth’s systems driven by energy from the sun and the force of gravity. Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical. Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.</td>
</tr>
<tr>
<td>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.</td>
<td></td>
<td></td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<td></td>
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<tr>
<td>4. Analyzing and interpreting data</td>
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<td>5. Using mathematics and computational thinking</td>
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<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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#### Crosscutting Concepts: Energy and Matter
- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

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<td><strong>Disciplinary Core Ideas</strong></td>
<td><strong>Performance Expectations</strong></td>
</tr>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Human Impacts on Earth Systems:</strong></td>
<td><strong>MS-ESS3-3</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth’s environments can have different impacts (negative and positive) for different living things.</td>
<td><strong>Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.</strong></td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.</td>
<td><strong>Clarification Statement:</strong> Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td><em>Connections to Engineering, Technology, and Application of Science</em></td>
<td>Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td><strong>Influence of Engineering, Technology, and Science on Society and the Natural World:</strong></td>
<td></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td>• The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.</td>
<td></td>
</tr>
<tr>
<td>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.</td>
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<tr>
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**Crosscutting Concepts: Cause and Effect**
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

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**Connection to PASS Coming Soon**
## MS-PS1-1 Matter and Its Interactions

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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 predict and/or describe phenomena.
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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Structure and Properties of Matter:**
- Substances are made from different types of atoms, which combine with one another in various ways.
- Atoms form molecules that range in size from two to thousands of atoms.
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

### Performance Expectations

**MS-PS1-1**

Students who demonstrate understanding can:

- **Develop models to describe the atomic composition of simple molecules and extended structures.**

**Clarification Statement:**
- Emphasis is on developing models of molecules that vary in complexity.
- Examples of simple molecules could include ammonia and methanol.
- Examples of extended structures could include sodium chloride or diamonds.
- Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.

**Assessment Boundary:**
- Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.

### Crosscutting Concepts: Scale, Proportion, and Quantity

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

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**Connection to PASS Coming Soon**
# MS-PS1-2 Matter and Its Interactions

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</table>
| 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  
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.  
5. Using mathematics and computational thinking  
6. Constructing explanations (for science) and designing solutions (for engineering)  
7. Engaging in argument from evidence  
8. Obtaining, evaluating, and communicating information | Structure and Properties of Matter:  
• Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.  
Chemical Reactions:  
• Substances react chemically in characteristic ways.  
• In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. | MS-PS1-2  
Students who demonstrate understanding can:  
**Analyze and interpret data** on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. |

## Crosscutting Concepts: Patterns
• Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

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### Connection to PASS Coming Soon
MS-PS2-4 Motion and Stability: Forces and Interactions

Science & Engineering Practices

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
   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.
   • 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.
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Types of Interactions:
• Gravitational forces are always attractive.
• There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.

Performance Expectations

MS-PS2-4
Students who demonstrate understanding can:

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Clarification Statement:
Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.

Assessment Boundary:
Assessment does not include Newton’s Law of Gravitation or Kepler’s Laws.

Crosscutting Concepts: Systems and System Models

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

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### MS-PS3-6 Energy

#### Science & Engineering Practices

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

#### Disciplinary Core Ideas

**Conservation of Energy and Energy Transfer:**
- When the motion energy of an object changes, there is inevitably some other change in energy at the same time.

#### Performance Expectations

**MS-PS3-6**
- Students who demonstrate understanding can:

  **Construct, use, and present arguments to support the claim**
  that when the kinetic energy of an object changes, energy is transferred to or from the object.

  **Clarification Statement:**
  Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.

  **Assessment Boundary:**
  Assessment does not include calculations of energy.

#### Crosscutting Concepts: Energy and Matter

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

#### Oklahoma Academic Standards Connections

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#### Connection to PASS Coming Soon
MS-LS1-4 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

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

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).

6. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Growth and Development of Organisms:
- Animals engage in characteristic behaviors that increase the odds of reproduction.
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

Performance Expectations

MS-LS1-4
Students who demonstrate understanding can:

Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

Clarification Statement:
Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.

Assessment Boundary: N/A

Crosscutting Concepts: Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Oklahoma Academic Standards Connections

ELA/Literacy

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.

Mathematics

6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution, which can be described by its center, spread, and overall shape.

6.SP.B.4 Summarize numerical data sets in relation to their context.

Connection to PASS Coming Soon
### MS-LS1-5 From Molecules to Organisms: Structure and Processes

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<tr>
<td>&quot;Asking questions (for science) and defining problems (for engineering)&quot;</td>
<td>Growth and Development of Organisms:</td>
<td>MS-LS1-5</td>
</tr>
<tr>
<td>&quot;Developing and using models&quot;</td>
<td>• Genetic factors as well as local conditions affect the growth of the adult plant.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>&quot;Planning and carrying out investigations&quot;</td>
<td></td>
<td><strong>Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.</strong></td>
</tr>
<tr>
<td>&quot;Analyzing and interpreting data&quot;</td>
<td></td>
<td><strong>Clarification Statement:</strong> Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.</td>
</tr>
<tr>
<td>&quot;Using mathematics and computational thinking&quot;</td>
<td></td>
<td><strong>Assessment Boundary:</strong> Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.</td>
</tr>
<tr>
<td>&quot;Constructing explanations (for science) and designing solutions (for engineering)&quot;</td>
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<tr>
<td>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 knowledge, 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.</td>
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<tr>
<td>&quot;Engaging in argument from evidence&quot;</td>
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<tr>
<td>&quot;Obtaining, evaluating, and communicating information&quot;</td>
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**Crosscutting Concepts: Cause and Effect**

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
**MS-LS1-8 From Molecules to Organisms: Structure and Processes**

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<tbody>
<tr>
<td><strong>1 Asks questions (for science) and defining problems (for engineering)</strong></td>
<td>Information Processing:</td>
<td><strong>MS-LS1-8</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td><strong>2 Developing and using models</strong></td>
<td>• 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.</td>
<td><strong>Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.</strong></td>
</tr>
<tr>
<td><strong>3 Planning and carrying out investigations</strong></td>
<td></td>
<td><strong>Clarification Statement:</strong> N/A</td>
</tr>
<tr>
<td><strong>4 Analyzing and interpreting data</strong></td>
<td></td>
<td><strong>Assessment Boundary:</strong> The assessment should provide evidence of students’ abilities to provide a basic and conceptual explanation that sensory cells respond to stimuli in the environment and send electrical impulses to the brain where they are processed as either response or memory. Assessment does not include mechanisms for the transmission of this information.</td>
</tr>
<tr>
<td><strong>5 Using mathematics and computational thinking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>6 Constructing explanations (for science) and designing solutions (for engineering)</strong></td>
<td></td>
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<tr>
<td><strong>7 Engaging in argument from evidence</strong></td>
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<tr>
<td><strong>8 Obtaining, evaluating, and communicating information</strong></td>
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<tr>
<td>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.</td>
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<tr>
<td>• 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.</td>
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</table>

**Crosscutting Concepts: Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural systems.

**Oklahoma Academic Standards Connections**

**ELA/Literacy**

**Mathematics**

**Connection to PASS Coming Soon**
### MS-LS3-1 Heredity: Inheritance and Variation of Traits

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<tr>
<td><strong>1. Asking questions (for science) and defining problems (for engineering)</strong></td>
<td><strong>Inheritance of Traits:</strong></td>
<td><strong>MS-LS3-1</strong></td>
</tr>
<tr>
<td><strong>2. Developing and using models</strong></td>
<td>• Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td><strong>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.</strong></td>
<td>• Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.</td>
<td><strong>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.</strong></td>
</tr>
<tr>
<td><strong>3. Planning and carrying out investigations</strong></td>
<td><strong>Variation of Traits:</strong></td>
<td><strong>Clarification Statement:</strong></td>
</tr>
<tr>
<td><strong>4. Analyzing and interpreting data</strong></td>
<td>• In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations.</td>
<td>Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins. Examples: Radiation treated plants, genetically modified organisms (e.g. roundup resistant crops, bioluminescence), mutations both harmful and beneficial.</td>
</tr>
<tr>
<td><strong>5. Using mathematics and computational thinking</strong></td>
<td>• Though rare, mutations may result in changes to the structure and function of proteins.</td>
<td><strong>Assessment Boundary:</strong></td>
</tr>
<tr>
<td><strong>6. Constructing explanations (for science) and designing solutions (for engineering)</strong></td>
<td>• Some changes are beneficial, others harmful, and some neutral to the organism.</td>
<td>Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.</td>
</tr>
<tr>
<td><strong>7. Engaging in argument from evidence</strong></td>
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<tr>
<td><strong>8. Obtaining, evaluating, and communicating information</strong></td>
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**Crosscutting Concepts: Structure and Function**
- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
MS-LS3-2 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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 and use a model to describe phenomena.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Growth and Development of Organisms:
(secondary to MS-LS3-2)
• Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring

Inheritance of Traits:
• Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

Variation of Traits:
• In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.

Performance Expectations

MS-LS3-2
Students who demonstrate understanding can:

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Clarification Statement:
Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Assessment Boundary:
The assessment should measure the students’ abilities to explain the general outcomes of sexual versus asexual reproduction in terms of variation seen in the offspring.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
### MS-LS4-3 Biological Unity and Diversity

#### Science & Engineering Practices

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
   - Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
   - Analyze displays of data to identify linear and nonlinear relationships.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Evidence of Common Ancestry and Diversity:**
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.

#### Performance Expectations

**MS-LS4-3**
- Students who demonstrate understanding can:
  - Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

**Clarification Statement:**
- Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.

**Assessment Boundary:**
- Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.

#### Crosscutting Concepts: Patterns

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

#### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### MS-LS4-4 Biological Unity and Diversity

#### Science & Engineering Practices

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)
   - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
   - Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
9. Developing and using models
10. Planning and carrying out investigations
11. Analyzing and interpreting data
12. Planning and carrying out investigations
13. Using mathematics and computational thinking
14. Constructing explanations (for science) and designing solutions (for engineering)
   - Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.
   - Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.

#### Disciplinary Core Ideas

**Natural Selection:**
- Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

#### Performance Expectations

**MS-LS4-4**
Students who demonstrate understanding can:

- Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals’ probability of surviving and reproducing in a specific environment.

**Clarification Statement:**
Emphasis is on using simple probability statements and proportional reasoning to construct explanations.

**Assessment Boundary:**
The assessment should provide evidence of students’ abilities to explain why some traits are suppressed and other traits become more prevalent for those individuals better at finding food, shelter, or avoiding predators.

#### Crosscutting Concepts: Cause and Effect

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
MS-LS4-5 Biological Unity and Diversity

Science & Engineering Practices

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

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

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

Interdependence of Science, Engineering, and Technology:
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

Performance Expectations

MS-LS4-5
Students who demonstrate understanding can:

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

Clarification Statement:
Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.

Assessment Boundary:
The assessment should provide evidence of students’ abilities to understand and communicate how technology affects both individuals and society.

Crosscutting Concepts: Cause and Effect
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Oklahoma Academic Standards Connections

ELA/Literacy

Connection to PASS Coming Soon
### MS-LS4-6 Biological Unity and Diversity

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<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Adaptation:</td>
<td>MS-LS4-6</td>
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<tr>
<td>2. Developing and using models</td>
<td>• Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• Traits that support successful survival and reproduction in the new environment become more common; those that do not, become less common. Thus, the distribution of traits in a population changes.</td>
<td>Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.</td>
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<tr>
<td>• Use mathematical representations to support scientific conclusions and design solutions.</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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**Crosscutting Concepts: Cause and Effect**

- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

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**Connection to PASS Coming Soon**
### MS-ESS1-1 Earth’s Place in the Universe

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<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</table>
| 1 Asking questions (for science) and defining problems (for engineering) | The Universe and Its Stars:  
- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. | MS-ESS1-1  
Students who demonstrate understanding can:  
**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.** |
| 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. | Earth and the Solar System:  
- The model of the solar system can explain eclipses of the sun and the moon.  
- Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun.  
- The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. |  |
| 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 |  |
| 8 Obtaining, evaluating, and communicating information |  |

#### Crosscutting Concepts: Patterns
- Patterns can be used to identify cause-and-effect relationships.

#### Oklahoma Academic Standards Connections

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#### Connection to PASS Coming Soon
MS-ESS1-2 Earth’s Place in the Universe

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
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.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

The Universe and Its Stars:
• Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

Earth and the Solar System:
• The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
• The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Performance Expectations

MS-ESS1-2
Students who demonstrate understanding can:

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

Clarification Statement:
Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as their school or state).

Assessment Boundary:
Assessment does not include Kepler’s Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.

Crosscutting Concepts: Systems and System Models

• Models can be used to represent systems and their interactions.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
**Science & Engineering Practices**

| 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 |
| 8 | Obtaining, evaluating, and communicating information |

**Disciplinary Core Ideas**

**Earth and the Solar System:**
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

* Connections to Engineering, Technology, and Application of Science

**Interdependence of Science, Engineering, and Technology:**
- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.

**Performance Expectations**

**MS-ESS1-3**
- Students who demonstrate understanding can:
  - Analyze and interpret data to determine scale properties of objects in the solar system.*

**Clarification Statement:**
- Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.

**Assessment Boundary:**
- Assessment does not include recalling facts about properties of the planets and other solar system bodies.

**Crosscutting Concepts: Scale, Proportion, and Quantity**
- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
## MS-ESS2-5 Earth’s Systems

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<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Weather and Climate: • Because these patterns are so complex, weather can only be predicted probabilistically.</td>
<td>MS-ESS2-5 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2 Developing and using models</td>
<td></td>
<td>Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations 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. • Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.</td>
<td></td>
<td>Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).</td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td></td>
<td>Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
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<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7 Engaging in argument from evidence</td>
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<tr>
<td>8 Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

### Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
**MS-ESS2-6 Earth’s Systems**

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
</table>
| **1. Asking questions (for science) and defining problems (for engineering)** | **The Roles of Water in Earth’s Surface Processes:**  
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. | **MS-ESS2-6**  
Students who demonstrate understanding can:  
**Develop and use a model to describe how unequal heating and rotation of the Earth causes patterns of atmospheric and oceanic circulation that determine regional climates.** |
| **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. | **Weather and Climate:**  
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.  
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. |  |
| **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** |  |  |
| **8. Obtaining, evaluating, and communicating information** |  |  |

**Crosscutting Concepts: Systems and System Models**
- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Structure and Properties of Matter:**
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.

**Chemical Reactions:**
- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.

### Performance Expectations

**MS-PS1-3**

Students who demonstrate understanding can:

_Gather and make sense of information to describe that synthetic materials come from natural resources and impact society._*

**Clarification Statement:** Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.

**Assessment Boundary:** Not assessed at state level*.

### Crosscutting Concepts: Structure and Function

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

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### MS-PS1-5 Matter and Its Interactions

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Chemical Reactions:  
- Substances react chemically in characteristic ways.  
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.  
- The total number of each type of atom is conserved, and thus the mass does not change. | MS-PS1-5  
Students who demonstrate understanding can:  
**Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.** |
| 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. | | |
| 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) | Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena:  
- Laws are regularities or mathematical descriptions of natural phenomena. | |
| 7. Engaging in argument from evidence | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Energy and Matter

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

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**Connection to PASS Coming Soon**
### Science & Engineering Practices

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)

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 knowledge, principles, and theories.

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

#### Chemical Reactions:
- Some chemical reactions release energy, others store energy.

#### Developing Possible Solutions:
(secondary to MS-PS1-6)
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it.

#### Optimizing the Design Solution:
(secondary to MS-PS1-6)
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design.
- 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.

### Performance Expectations

**MS-PS1-6**

Students who demonstrate understanding can:

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

**Clarification Statement:**

Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.

**Assessment Boundary:**

Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.

### Crosscutting Concepts: Energy and Matter

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

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
### Science & Engineering Practices

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)

### Disciplinary Core Ideas

**Forces and Motion:**
- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law).

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

**Interdependence 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.

### Performance Expectations

**MS-PS2-1**
Students who demonstrate understanding can:

- **Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.**

*Clarification Statement:*
Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.

*Assessment Boundary:*
Assessment is limited to vertical or horizontal interactions in one dimension.

### Crosscutting Concepts: Systems and System Models

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

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**Note:** The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
### MS-PS2-2 Motion and Stability: Forces and Interactions

#### Science & Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
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.
   - 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.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas
- **Forces and Motion:**
  - The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change.
  - The greater the mass of the object, the greater the force needed to achieve the same change in motion.
  - For any given object, a larger force causes a larger change in motion.

#### Performance Expectations
- **MS-PS2-2**
  - Students who demonstrate understanding can:
    - 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.

#### Assessment Boundary:
- Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time.
- Assessment does not include the use of trigonometry.

### Crosscutting Concepts: Stability and Change
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

#### Mathematics

### Connection to PASS Coming Soon
### Science & Engineering Practices

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

Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to describe and/or support scientific conclusions and design solutions.

6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Waves Properties:**
- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.

### Performance Expectations

**MS-PS4-1**
Students who demonstrate understanding can:

**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.**

**Clarification Statement:**
Emphasis is on describing waves with both qualitative and quantitative thinking.

**Assessment Boundary:**
Assessment does not include electromagnetic waves and is limited to standard repeating waves.

### Crosscutting Concepts: Patterns

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

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### Connection to PASS Coming Soon
### MS-PS4-2 Waves and Their Applications in Technologies for Information Transfer

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Waves Properties:  
• A sound wave needs a medium through which it is transmitted. | **MS-PS4-2**  
Students who demonstrate understanding can:  
**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** |
| 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. | Electromagnetic Radiation:  
• When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object’s material and the frequency (color) of the light.  
• The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.  
• A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves. |  |
| 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 | |  |
| 8 Obtaining, evaluating, and communicating information | |  |

**Crosscutting Concepts: Structure and Function**

• Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

**Oklahoma Academic Standards Connections**

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**Connection to PASS** Coming Soon
MS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td>• Asking questions (for science) and defining problems (for engineering)</td>
<td>Information Technologies and Instrumentation: • Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.</td>
<td>MS-PS4-3 Students who demonstrate understanding can: Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.*</td>
</tr>
<tr>
<td>• Developing and using models</td>
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<tr>
<td>• Planning and carrying out investigations</td>
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<td>• Analyzing and interpreting data</td>
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<td>• Obtaining, evaluating, and communicating information</td>
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<td>Obtaining, evaluating, and communicating information in 6-8 builds on K-5 and progresses to evaluating the merit and validity of ideas and methods. • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.</td>
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Crosscutting Concepts: Structure and Function
• Structures can be designed to serve particular functions.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### MS-LS1-7 From Molecules to Organisms: Structure and Processes

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| **1. Asking questions (for science) and defining problems (for engineering)** | **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.  
   - **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. |
| **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. | **Performance Expectations** |
| **3. Planning and carrying out investigations** | **MS-LS1-7**  
   - Students who demonstrate understanding can:  
     - Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.  
     - **Clarification Statement:** Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.  
     - **Assessment Boundary:** Assessment does not include details of the chemical reactions for photosynthesis or respiration. |
| **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** | |
| **8. Obtaining, evaluating, and communicating information** | |

#### Crosscutting Concepts: Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes.

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**Connection to PASS** Coming Soon
### MS-LS4-1 Biological Unity and Diversity

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
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</thead>
<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Evidence of Common Ancestry and Diversity: * The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.</td>
<td>MS-LS4-1 Students who demonstrate understanding can: * 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.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
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<td>An 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.</td>
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### Crosscutting Concepts: Patterns
- Graphs, charts, and images can be used to identify patterns in data.

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### Connection to PASS Coming Soon
### MS-LS4-2 Biological Unity and Diversity

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| 1 Asking questions (for science) and defining problems (for engineering) | Evidence of Common Ancestry and Diversity:  
• The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. | MS-LS4-2  
Students who demonstrate understanding can:  
**Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.**  
Clarification Statement:  
Emphasis is on explanations of the ancestral relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.  
Assessment Boundary:  
N/A |
| 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)  
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.  
• Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. | | |
| 7 Engaging in argument from evidence | | |
| 8 Obtaining, evaluating, and communicating information | | |

#### Crosscutting Concepts: Patterns

- Patterns can be used to identify cause and effect relationships.

#### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### MS-ESS1-4 Earth’s Place in the Universe

#### Science & Engineering Practices

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<td>6</td>
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#### Disciplinary Core Ideas

**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.

#### Performance Expectations

**MS-ESS1-4**
Students who demonstrate understanding can:

**Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth’s geologic history.**

**Clarification Statement:**
Emphasis is on analyses of rock formations and fossils they contain to establish relative ages of major events in Earth’s history. Major events could include the formation of mountain chains and ocean basins, adaptation and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and the development of watersheds and rivers through glaciation and water erosion. The events in Earth’s history happened in the past continue today. Scientific explanations can include models.

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

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#### Crosscutting Concepts: Scale, Proportion, and Quantity

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

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#### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
MS-ESS2-1 Earth’s Systems

Science & Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
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.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas
Earth’s Materials and Systems:
- All Earth processes are the result of energy flowing and matter cycling within and among the planet’s systems. This energy is derived from the sun and Earth’s hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.

Performance Expectations
MS-ESS2-1
Students who demonstrate understanding can:
- Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.

Clarification Statement:
Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth’s materials.

Assessment Boundary:
Assessment does not include the identification and naming of minerals.

Crosscutting Concepts: Stability and Change
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
MS-ESS2-2 Earth’s Systems

Science & Engineering Practices

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)

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.

- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth’s Materials and Systems:
- The planet’s systems interact over scales that range from microscopic to global in size. These interactions have shaped Earth’s history and will determine its future.

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.

Performance Expectations

MS-ESS2-2
Students who demonstrate understanding can:

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 a large mountain ranges) or small (such as rapid landslides on microscopic geochemical reactions), and how many geoscience processes usually behave gradually but are punctuated by catastrophic events (such as earthquakes, volcanoes, and meteor impacts). 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.

Crosscutting Concepts: Scale, Proportion, and Quantity

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

Oklahoma Academic Standards Connections

ELA/Literacy

<table>
<thead>
<tr>
<th>MS-ESS2-2</th>
<th>Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.</th>
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</thead>
</table>

Mathematics

Connection to PASS Coming Soon
# MS-ESS2-3 Earth’s Systems

## Science & Engineering Practices

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
   - Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
   - Analyze and interpret data to provide evidence for phenomena.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

## Disciplinary Core Ideas

### The History of Planet Earth: (Secondary to 8-ESS2-3)
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches.

### Plate Tectonics and Large-Scale System Interactions:
- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth’s plates have moved great distances, collided, and spread apart.

### Performance Expectations

**MS-ESS2-3**

Students who demonstrate understanding can:

- **Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.**

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

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

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## Crosscutting Concepts: Patterns

- Patterns in rates of change and other numerical relationships can provide information about natural systems.

## Oklahoma Academic Standards Connections

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## Connection to PASS Coming Soon
## Science & Engineering Practices

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)

### Disciplinary Core Ideas

**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.

### Performance Expectations

**MS-ESS3-1**
Students who demonstrate understanding can:

**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).

**Crosscutting Concepts: Cause and Effect**
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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**Connection to PASS Coming Soon**
MS-ESS3-2 Earth and Human Activity

Science & Engineering Practices

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
   Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
   • Analyze and interpret data to provide evidence for phenomena.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

MS-ESS3-2
Students who demonstrate understanding can:

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).

Crosscutting Concepts: Patterns
• Graphs, charts, and images can be used to identify patterns in data.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### MS-ESS3-4 Earth and Human Activity

**Science & Engineering Practices**

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

**Disciplinary Core Ideas**

- **Human Impacts on Earth Systems:**
  - Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.

**Performance Expectations**

- **MS-ESS3-4**
  - Students who demonstrate understanding can:
    - Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth’s systems.

**Clarification Statement:**
Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.

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### Crosscutting Concepts: Cause and Effect

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

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
HS-PS1-1 Matter and Its Interactions

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   • Use a model to predict the relationships between systems or between components of a system.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Properties of Matter:
• Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
• The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.

Performance Expectations

HS-PS1-1
Students who demonstrate understanding can:

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.

Clarification Statement:
Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.

Assessment Boundary:
Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.

Crosscutting Concepts: Patterns
• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
# HS-PS1-2 Matter and Its Interactions

## Science & Engineering Practices

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)

**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.**

- **Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.**

7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

## Disciplinary Core Ideas

### Structure and Properties of Matter:
- The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.

### Chemical Reactions:
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

## Performance Expectations

**HS-PS1-2**

Students who demonstrate understanding can:

**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, knowledge of the patterns of chemical properties, and formation of compounds.**

**Clarification Statement:**
Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis/combustion, decomposition, single displacement, double displacement).

**Assessment Boundary:**
Assessment is limited to chemical reactions involving main group elements and combustion reactions.

## Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

## Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
## HS-PS1-5 Matter and Its Interactions

### Science & Engineering Practices

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)
   - Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
   - Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

- **Chemical Reactions:**
  - Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.

### Performance Expectations

- **HS-PS1-5**
  - Students who demonstrate understanding can:
    - 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.

### Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
HS-PS1-7 Matter and Its Interactions

Science & Engineering Practices

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

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

a. Use mathematical representations of phenomena to support claims.

Disciplinary Core Ideas

Chemical Reactions:
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Performance Expectations

HS-PS1-7
Students who demonstrate understanding can:

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Clarification Statement:
Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale (e.g. Law of Conservation of Mass). Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.

Assessment Boundary:
Assessment does not include complex chemical reactions.

Crosscutting Concepts: Energy and Matter
- The total amount of energy and matter in closed systems is conserved.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
HS-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

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
   Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
   - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Forces and Motion:
- Newton’s second law accurately predicts changes in the motion of macroscopic objects.

Performance Expectations

HS-PS2-1
Students who demonstrate understanding can:

- Analyze data and use it 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.

Clarification Statement:
Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.

Assessment Boundary:
Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.

Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics (continued)

Connection to PASS Coming Soon
**Science & Engineering Practices**

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

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena to describe explanations.

6. Constructing explanations (for science) and designing solutions (for engineering)

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

- **Forces and Motion:**
  - Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.
  - If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.

**Performance Expectations**

**HS-PS2-2**

Students who demonstrate understanding can:

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.

Clarification Statement:

Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.

Assessment Boundary:

Assessment is limited to systems of two macroscopic bodies moving in one dimension.

**Oklahoma Academic Standards Connections**

**ELA/Literacy**

**Mathematics**

**Connection to PASS Coming Soon**
### HS-PS2-3 Motion and Stability: Forces and Interactions

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Forces and Motion:  
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. | HS-PS2-3  
Students who demonstrate understanding can: |
| 2. Developing and using models | Defining and Delimiting Engineering Problems:  
(secondary to HS-PS2-3)  
- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. | Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.* |
| 3. Planning and carrying out investigations |  | Clarification Statement:  
Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute. |
| 4. Analyzing and interpreting data |  | Assessment Boundary:  
Assessment is limited to qualitative evaluations and/or algebraic manipulations. |
| 5. Using mathematics and computational thinking |  |  |
| 6. Constructing explanations (for science) and designing solutions (for engineering)  
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  
- Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. |  |  |
| 7. Engaging in argument from evidence |  |  |
| 8. Obtaining, evaluating, and communicating information |  |  |

Crosscutting Concepts: Cause and Effect
- Systems can be designed to cause a desired effect.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### HS-PS2-5 Motion and Stability: Forces and Interactions

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| 1. Asking questions (for science) and defining problems (for engineering) | Types of Interactions:  
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space.  
- Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.  
Definitions of Energy:  
(secondary to HS-PS2-4)  
- “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. | HS-PS2-5  
Students who demonstrate understanding can:  
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.  
Clarification Statement:  
N/A  
Assessment Boundary:  
Assessment is limited to designing and conducting investigations with provided materials and tools. |
| 2. Developing and using models | | |
| 3. Planning and carrying out investigations | | |
| Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.  
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. | | |
| 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 | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Cause and Effect
- Systems can be designed to cause a desired effect.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
HS-PS3-1 Energy

Science & Engineering Practices

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
   - Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
   - • Create a computational model or simulation of a phenomenon, designed device, process, or system.
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Definitions of Energy:
• Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.

Conservation of Energy and Energy Transfer:
• Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
• Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
• Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g. relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
• The availability of energy limits what can occur in any system.

Performance Expectations

HS-PS3-1
Students who demonstrate understanding can:

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.

Clarification Statement:
Emphasis is on explaining the meaning of mathematical expressions used in the model.

Assessment Boundary:
Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, and potential energy.

Crosscutting Concepts: Systems and System Models
• Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
Crosscutting Concepts: Energy and Matter

- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

### Definitions of Energy:
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

### HS-PS3-2 Energy

**Science & Engineering Practices**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   - Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   - Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.
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
8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

**Definitions of Energy:**
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

**Performance Expectations**

**HS-PS3-2**

Students who demonstrate understanding can:

- Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.

**Clarification Statement:**

Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

**Assessment Boundary:**

Assessment does not include quantitative calculations.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**

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**SCIENCE STANDARDS • OKLAHOMA STATE DEPARTMENT OF EDUCATION**

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### HS-PS3-3 Energy

#### Science & Engineering Practices

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)

#### Disciplinary Core Ideas

- **Definitions of Energy:**
  - At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

- **Defining and Delimiting Engineering Problems:**
  - Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

#### Performance Expectations

- **HS-PS3-3**
  - Students who demonstrate understanding can:
    - **Design, build, and refine a device** that works within given constraints to convert one form of energy into another form of energy.*

  **Clarification Statement:**
  - Emphasis is on both qualitative and quantitative evaluations of devices.
  - Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators.
  - Examples of constraints could include use of renewable energy forms and efficiency.

  **Assessment Boundary:**
  - Assessment for quantitative evaluations is limited to total output for a given input.
  - Assessment is limited to devices constructed with materials provided to students.

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### Crosscutting Concepts: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
## HS-PS3-4 Energy

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations

### Disciplinary Core Ideas

**Conservation of Energy and Energy Transfer:**
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

### Performance Expectations

**HS-PS3-4**

Students who demonstrate understanding can:

- **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).

**Clarification Statement:**

Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

**Assessment Boundary:**

Assessment is limited to investigations based on materials and tools provided to students.

### Crosscutting Concepts: System and System Models

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

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**SCIENCE STANDARDS • OKLAHOMA STATE DEPARTMENT OF EDUCATION**

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Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Wave Properties:
- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

Performance Expectations

HS-PS4-1
Students who demonstrate understanding can:

Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

Clarification Statement:
Examples of data could include electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, and seismic waves traveling through the Earth.

Assessment Boundary:
Assessment is limited to algebraic relationships and describing those relationships qualitatively.

Crosscutting Concepts: Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
## Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
   - Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.
   - Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.

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
8. Obtaining, evaluating, and communicating information

## Disciplinary Core Ideas

### Wave Properties:
- Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.

### Interdependence of Science, Engineering, and Technology:
- Modern civilization depends on major technological systems.
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

## Performance Expectations

**HS-PS4-2**

Students who demonstrate understanding can:

- **Evaluate questions about the advantages and disadvantages of using a digital transmission and storage of information.**

  * Connections to Engineering, Technology, and Application of Science

  **Clarification Statement:**
  Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.

**Assessment Boundary:**
N/A

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### Crosscutting Concepts: Stability and Changes

- Systems can be designed for greater or lesser stability.

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**Connection to PASS Coming Soon**
HS-PS4-4 Waves and Their Applications in Technologies for Information Transfer

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<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Electromagnetic Radiation:</td>
<td>HS-PS4-4 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat).</td>
<td>Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.</td>
<td>Clarification Statement: Emphasis is on the idea that different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td>• Photoelectric materials emit electrons when they absorb light of a high-enough frequency.</td>
<td>Assessment Boundary: Assessment is limited to qualitative descriptions.</td>
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<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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<tr>
<td>Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. • Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.</td>
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Crosscutting Concepts: Cause and Effect

• Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

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Connection to PASS Coming Soon
### Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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### Connection to PASS Coming Soon
## CHEMISTRY

### HS-PS1-2 Matter and Its Interactions

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| **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)  
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  
• Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.  
**7** Engaging in argument from evidence  
**8** Obtaining, evaluating, and communicating information | **Structure and Properties of Matter:**  
• The periodic table orders elements horizontally by the number of protons in the atom’s nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.  
**Chemical Reactions:**  
• The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. | **HS-PS1-2**  
Students who demonstrate understanding can:  
**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, knowledge of the patterns of chemical properties, and formation of compounds.**  
**Clarification Statement:**  
Examples of chemical reactions could include the reaction of sodium and chlorine, of carbon and oxygen, or of carbon and hydrogen. Reaction classification aids in the prediction of products (e.g. synthesis/combination decomposition, single displacement, double displacement, oxidation/reduction, acid/base).  
**Assessment Boundary:**  
Assessment is limited to chemical reactions involving main group elements and combustion reactions. |

### Crosscutting Concepts: Patterns

• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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### Connection to PASS Coming Soon
### HS-PS1-3 Matter and Its Interactions

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>• Structure and Properties of Matter: The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.</td>
<td>HS-PS1-3 Students who demonstrate understanding can:</td>
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<tr>
<td>2. Developing and using models</td>
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<td>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.</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<td>Clarification Statement: Emphasis is on understanding the strengths of forces between particles, not on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Examples of bulk properties of substances could include the melting point and boiling point, vapor pressure, and surface tension. The intent of the performance expectation is limited to evaluation of bulk scale properties and not micro scale properties.</td>
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**Assessment Boundary:** Assessment does not include Raoult’s law calculations of vapor pressure.

### Crosscutting Concepts: Patterns
- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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Connection to PASS Coming Soon
Crosscutting Concepts: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Oklahoma Academic Standards Connections

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Structure and Properties of Matter:  
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. | HS-PS1-4  
Students who demonstrate understanding can: |  
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. |
| 2. Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
- Develop a model based on evidence to illustrate the relationships between systems or between components of a system. | Chemical Reactions:  
- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. | |
| 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 | | |
| 8. Obtaining, evaluating, and communicating information | | |

Connection to PASS Coming Soon
Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### HS-PS1-6 Matter and Its Interactions

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<th>Performance Expectations</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Chemical Reactions:</strong> • In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.</td>
<td><strong>HS-PS1-6</strong> Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td><strong>Optimizing the Design Solution:</strong> • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain over others (trade-offs) may be needed.</td>
<td><strong>Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.</strong></td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.</td>
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<td>7. Engaging in argument from evidence</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

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### Connection to PASS Coming Soon
HS-PS1-7 Matter and Its Interactions

Science & Engineering Practices

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
   Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Chemical Reactions:
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Performance Expectations

HS-PS1-7
Students who demonstrate understanding can:

Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Clarification Statement:
Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale (i.e., Conservation of Mass and Stoichiometry). Emphasis is on assessing students’ use of mathematical thinking and not on memorization and rote application of problem-solving techniques.

Assessment Boundary:
Assessment does not include complex chemical reactions.

Crosscutting Concepts: Energy and Matter
- The total amount of energy and matter in closed systems is conserved.

Oklahoma Academic Standards Connections

ELA/Literacy | Mathematics
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Connection to PASS Coming Soon
### HS-PS1-8 Matter and Its Interactions

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<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Nuclear Processes: • Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy.</td>
<td>HS-PS1-8 Students who demonstrate understanding can: 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 radioactive decay.</td>
</tr>
<tr>
<td>2 Developing and using models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. • Develop a model based on evidence to illustrate the relationships between systems or between components of a system.</td>
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<td>Clarification Statement: Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.</td>
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<tr>
<td>3 Planning and carrying out investigations</td>
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<td>Assessment Boundary: Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.</td>
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<td>4 Analyzing and interpreting data</td>
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<tr>
<td>5 Using mathematics and computational thinking</td>
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<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7 Engaging in argument from evidence</td>
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<tr>
<td>8 Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Energy and Matter**
- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### Crosscutting Concepts: Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

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### HS-PS2-6 Motion and Stability: Forces and Interactions

#### Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

- Types of Interactions:
  - Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.

#### Performance Expectations

**HS-PS2-6**

Students who demonstrate understanding can:

- Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*

**Clarification Statement:**

Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.

**Assessment Boundary:**

Assessment is limited to provided molecular structures of specific designed materials.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.
Science & Engineering Practices

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)

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Definitions of Energy:
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

Defining and Delimiting Engineering Problems:
- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

* Connections to Engineering, Technology, and Application of Science

Interdependence of Science, Engineering, and Technology:
- Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

Performance Expectations

HS-PS3-3
Students who demonstrate understanding can:

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*

Clarification Statement:
Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.

Assessment Boundary:
Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.

Crosscutting Concepts: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
### HS-PS3-4 Energy

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations

**Planning and carrying out investigations**
- Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.
- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Conservation of Energy and Energy Transfer:**
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down).

#### Performance Expectations

**HS-PS3-4**

Students who demonstrate understanding can:

- **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).**

**Clarification Statement:**
Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.

**Assessment Boundary:**
Assessment is limited to investigations based on materials and tools provided to students.

---

**Crosscutting Concepts: System and System Models**

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
## HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

### Science & Engineering Practices

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
   - Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
   - Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Wave Properties:**
- The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing.

### Performance Expectations

**HS-PS4-1**

Students who demonstrate understanding can:

- **Use mathematical representations to describe relationships among the frequency, wavelength, and speed of waves.**

**Clarification Statement:**

Examples of data could include relationship to the electromagnetic spectrum.

**Assessment Boundary:**

Assessment is limited to algebraic relationships and describing those relationships qualitatively.

---

### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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**Connection to PASS Coming Soon**
**Crosscutting Concepts: Cause and Effect**

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

---

### Science & Engineering Practices

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

**Science & Engineering Practices**

- Asking questions (for science) and defining problems (for engineering)
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence

**Disciplinary Core Ideas**

**Wave Properties:**
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.
- Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.

**Electromagnetic Radiation:**
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

**Performance Expectations**

**HS-PS4-3**

Students who demonstrate understanding can:

- **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.**

**Clarification Statement:**

Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.

**Assessment Boundary:**

Assessment does not include using quantum theory.

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**Connection to PASS Coming Soon**
### HS-PS1-8 Matter and Its Interactions

#### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   - Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   - Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
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
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Nuclear Processes:**
- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.

#### Performance Expectations

**HS-PS1-8**

Students who demonstrate understanding can:

- **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 radioactive decay.

**Clarification Statement:**
- Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.

**Assessment Boundary:**
- Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.

### Crosscutting Concepts: Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

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### Connection to PASS Coming Soon
## HS-PS2-1 Motion and Stability: Forces and Interactions

### Science & Engineering Practices

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
   - Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
   - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

#### Forces and Motion:

- Newton’s second law accurately predicts changes in the motion of macroscopic objects.

### Performance Expectations

**HS-PS2-1**

Students who demonstrate understanding can:

- **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.**

**Clarification Statement:**

Examples of data could include tables or graphs of position or velocity as a function of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.

**Assessment Boundary:**

Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.

### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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### Connection to PASS Coming Soon
# HS-PS2-2 Motion and Stability: Forces and Interactions

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</table>
| **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  
Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.  
• Use mathematical representations of phenomena to describe explanations.  
**6.** Constructing explanations (for science) and designing solutions (for engineering)  
**7.** Engaging in argument from evidence  
**8.** Obtaining, evaluating, and communicating information | Forces and Motion:  
• Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object.  
• If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. | **HS-PS2-2**  
Students who demonstrate understanding can:  
**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.**  
**Clarification Statement:** Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.  
**Assessment Boundary:** Assessment is limited to systems of two macroscopic bodies moving in one dimension. |

## Crosscutting Concepts: Systems and System Models
- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

## Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
### HS-PS2-3 Motion and Stability: Forces and Interactions

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Forces and Motion:  
- If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. | HS-PS2-3  
Students who demonstrate understanding can:  
**Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.**  
Clarification Statement:  
Examples of evaluation and refinement could include determining the success of the device at protecting an object from damage and modifying the design to improve it. Examples of a device could include a football helmet or a parachute.  
Assessment Boundary:  
Assessment is limited to qualitative evaluations and/or algebraic manipulations. |
| 2. Developing and using models | Defining and Delimiting Engineering Problems:  
- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. |
| 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) | | |
| Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  
- Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. | | |
| 7. Engaging in argument from evidence | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Cause and Effect
- Systems can be designed to cause a desired effect.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
## HS-PS2-4 Motion and Stability: Forces and Interactions

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analysing and interpreting data
5. Using mathematics and computational thinking

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Use mathematical representations of phenomena to describe explanations.

### Disciplinary Core Ideas

#### Types of Interactions:

- Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.
- Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space.
- Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.

### Performance Expectations

**HS-PS2-4**

Students who demonstrate understanding can:

*Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.*

**Clarification Statement:**

Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.

**Assessment Boundary:**

Assessment is limited to systems with two objects.

### Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

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**Connection to PASS Coming Soon**
### HS-PS2-5 Motion and Stability: Forces and Interactions

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</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Types of Interactions:  
• Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space.  
• Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.  
Definitions of Energy: (secondary to HS-PS2-5).  
• “Electrical energy” may mean energy stored in a battery or energy transmitted by electric currents. | HS-PS2-5  
Students who demonstrate understanding can:  
**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.  
Clarification Statement:  
N/A  
Assessment Boundary:  
Assessment is limited to designing and conducting investigations with provided materials and tools. |
| 2 Developing and using models | | |
| 3 Planning and carrying out investigations  
Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.  
• Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. | | |
| 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 | | |
| 8 Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Cause and Effect

• Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
**Science & Engineering Practices**

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

Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create a computational model or simulation of a phenomenon, designed device, process, or system.

**Disciplinary Core Ideas**

**Definitions of Energy:**
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.

**Conservation of Energy and Energy Transfer:**
- Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.
- Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- Mathematical expressions, which quantify how the stored energy in a system depends on its configuration (e.g., relative positions of charged particles, compression of a spring) and how kinetic energy depends on mass and speed, allow the concept of conservation of energy to be used to predict and describe system behavior.
- The availability of energy limits what can occur in any system.

**Performance Expectations**

**HS-PS3-1**

Students who demonstrate understanding can:

- **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.

**Clarification Statement:**
Emphasis is on explaining the meaning of mathematical expressions used in the model.

**Assessment Boundary:**
Assessment is limited to basic algebraic expressions or computations; to systems of two or three components; and to thermal energy, kinetic energy, potential energy and/or the energies in gravitational, magnetic, or electric fields.

---

**Crosscutting Concepts: Systems and System Models**

- Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

**Oklahoma Academic Standards Connections**

**ELA/Literacy**

**Mathematics**

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**Connection to PASS Coming Soon**
### Crosscutting Concepts: Energy and Matter

- Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

### Definitions of Energy:
- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system’s total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.
- These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.

### Performance Expectations

**HS-PS3-2**

Students who demonstrate understanding can:

- **Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.**

**Clarification Statement:** Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the earth, and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.

**Assessment Boundary:** Assessment does not include quantitative calculations.
# HS-PS3-3 Energy

## Science & Engineering Practices

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)

**Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.**

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

## Disciplinary Core Ideas

**Definitions of Energy:**
- At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.

**Defining and Delimiting Engineering Problems:**
- Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them.

## Performance Expectations

**HS-PS3-3**

Students who demonstrate understanding can:

- **Design, build, and refine a device** that works within given constraints to convert one form of energy into another form of energy.*

**Clarification Statement:**
Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, and generators. Examples of constraints could include use of renewable energy forms and efficiency.

**Assessment Boundary:**
Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.

---

## Crosscutting Concepts: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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## Connection to PASS Coming Soon
Crosscutting Concepts: System and System Models
• When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

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Connection to PASS Coming Soon
Crosscutting Concepts: Energy and Matter

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

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### HS-PS3-5 Energy

**Science & Engineering Practices**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   - Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   - Develop a model based on evidence to illustrate the relationships between systems or between components of a system.
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
8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

**Relationship Between Energy and Forces:**
- When two objects interacting through a field change relative position, the energy stored in the field is changed.

**Performance Expectations**

- **HS-PS3-5**
  - Students who demonstrate understanding can:
    - 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.

  **Clarification Statement:**
  - Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other, including an explanation of how the change in energy of the objects is related to the change in energy of the field.

  **Assessment Boundary:**
  - Assessment is limited to systems containing two objects.

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**Oklahoma Academic Standards Connections**

### ELA/Literacy

- WHST.9-12.7: Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- WHST.11-12.8: Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of specific tasks, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source following a standard format for citation.
- WHST.9-12.9: Draw evidence from informational texts to support analysis, reflection, and research.

### Mathematics

- MP.2: Reason abstractly and quantitatively.
- MP.4: Model with mathematics.

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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### Connection to PASS Coming Soon
# HS-PS4-2 Waves and Their Applications in Technologies for Information Transfer

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<td>Wave Properties:</td>
<td>HS-PS4-2</td>
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<tr>
<td>Asking questions and defining problems in grades 9–12 builds on grades K–8 experiences and</td>
<td>• Information can be digitized (e.g., a picture stored as the values of an array of</td>
<td>Students who demonstrate understanding can:</td>
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<tr>
<td>progresses to formulating, refining, and evaluating empirically testable questions and design</td>
<td>pixels); in this form, it can be stored reliably in computer memory and sent over</td>
<td>Evaluate questions about the advantages and disadvantages of using a digital</td>
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<td>problems using models and simulations.</td>
<td>long distances as a series of wave pulses.</td>
<td>transmission and storage of information.*</td>
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<td>• Evaluate questions that challenge the premise(s) of an argument, the interpretation of a data</td>
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<td>set, or the suitability of a design.</td>
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<td>2. Developing and using models</td>
<td>Interdependence of Science, Engineering, and Technology:</td>
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<td>3. Planning and carrying out investigations</td>
<td>• Modern civilization depends on major technological systems.</td>
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<td>4. Analyzing and interpreting data</td>
<td>• Engineers continuously modify these technological systems by applying scientific</td>
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<td>5. Using mathematics and computational thinking</td>
<td>knowledge and engineering design practices to increase benefits while decreasing</td>
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<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td>costs and risks.</td>
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<td>7. Engaging in argument from evidence</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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* Connections to Engineering, Technology, and Application of Science

**Interdependence of Science, Engineering, and Technology:**

- Modern civilization depends on major technological systems.
- Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.

**Clarification Statement:**

Examples of advantages could include that digital information is stable because it can be stored reliably in computer memory, transferred easily, and copied and shared rapidly. Disadvantages could include issues of easy deletion, security, and theft.

**Assessment Boundary:**

N/A

---

**Crosscutting Concepts: Stability and Changes**

- Systems can be designed for greater or lesser stability.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
## HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

### Science & Engineering Practices

| 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. Engaging in argument from evidence |

### Disciplinary Core Ideas

**Wave Properties:**
- Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other.
- Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up.

**Electromagnetic Radiation:**
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons.
- The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.

### Performance Expectations

**HS-PS4-3**

Students who demonstrate understanding can:

- **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.**

**Clarification Statement:** Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photo-electric effect.

**Assessment Boundary:** Assessment does not include using quantum theory.

---

**Crosscutting Concepts: Cause and Effect**

- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Cause and Effect

- Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Connection to PASS Coming Soon
## HS-PS4-5 Waves and Their Applications in Technologies for Information Transfer

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<th>Disciplinary Core Ideas</th>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Energy in Chemical Processes: (secondary to HS-PS4-5)</td>
<td>HS-PS4-5 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Solar cells are human-made devices that likewise capture the sun’s energy and produce electrical energy.</td>
<td>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.*</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>Wave Properties:</td>
<td>Clarification Statement: Examples could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology.</td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
<td>• Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses.</td>
<td>Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory</td>
</tr>
<tr>
<td>5. Using mathematics and computational thinking</td>
<td>Electromagnetic Radiation:</td>
<td></td>
</tr>
<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
<td>• Photoelectric materials emit electrons when they absorb light of a high-enough frequency.</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
<td>Information Technologies and Instrumentation:</td>
<td></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information</td>
<td>• Multiple technologies based on the understanding of waves and their interactions with matter are part of every day experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.</td>
<td></td>
</tr>
<tr>
<td>Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs.</td>
<td>* Connections to Engineering, Technology, and Application of Science</td>
<td></td>
</tr>
<tr>
<td>• Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).</td>
<td>Interdependence of Science, Engineering, and Technology:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Modern civilization depends on major technological systems.</td>
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### Crosscutting Concepts: Cause and Effect
- Systems can be designed to cause a desired effect.

### Oklahoma Academic Standards Connections

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</table>
Crosscutting Concepts: Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

**ELA/Literacy**

RST.11-12.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

WHST.9-12.9 Draw evidence from informational texts to support analysis, reflection, and research.

**Mathematics**

Disciplinary Core Ideas

**Structure and Function:**
- Systems of specialized cells within organisms help them perform the essential functions of life.
- All cells contain genetic information in the form of DNA molecules.
- Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells.

**Performance Expectations**

**HS-LS1-1**

Students who demonstrate understanding can:

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.

Clarification Statement:
Emphasis is on the conceptual understanding that DNA sequences determine the amino acid sequence, and thus, protein structure. Students can produce scientific writings, oral presentations and or physical models that communicate constructed explanations.

Assessment Boundary:
Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### HS-LS1-2 From Molecules to Organisms: Structure and Processes

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<tbody>
<tr>
<td><strong>1.</strong> Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Structure and Function:</strong></td>
<td><strong>HS-LS1-2</strong></td>
</tr>
<tr>
<td><strong>2.</strong> Developing and using models</td>
<td>• Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td></td>
<td>Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.</td>
</tr>
<tr>
<td>• Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.</td>
<td></td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td><strong>3.</strong> Planning and carrying out investigations</td>
<td></td>
<td>Emphasis is on the levels of organization including cells, tissues, organs, and systems of an organism.</td>
</tr>
<tr>
<td><strong>4.</strong> Analyzing and interpreting data</td>
<td></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td><strong>5.</strong> Using mathematics and computational thinking</td>
<td></td>
<td>Assessment does not include interactions and functions at the molecular or chemical level.</td>
</tr>
<tr>
<td><strong>6.</strong> Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td><strong>7.</strong> Engaging in argument from evidence</td>
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<tr>
<td><strong>8.</strong> Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Systems and System Models**
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

**Oklahoma Academic Standards Connections**

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</table>
Crosscutting Concepts: Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

Oklahoma Academic Standards Connections

### Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
   Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical and empirical models.
   - Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.
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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Structure and Function:**
- Feedback mechanisms maintain a living system’s internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Outside that range (e.g., at a too high or too low external temperature, with too little food or water available) the organism cannot survive.

### Performance Expectations

**HS-LS1-3**

Students who demonstrate understanding can:

**Plan and conduct an investigation to provide evidence of the importance of maintaining homeostasis in living organisms.**

**Clarification Statement:**
A state of homeostasis must be maintained for organisms to remain alive and functional even as external conditions change within some range. Examples of investigations could include heart rate response to exercise, stomate response to moisture and temperature, root development in response to water levels, and cell response to hyper and hypotonic environments.

**Assessment Boundary:**
Assessment does not include the cellular processes involved in the feedback mechanism.

**Crosscutting Concepts: Stability and Change**

- Feedback (negative or positive) can stabilize or destabilize a system.
Crosscutting Concepts: Systems and System Models
- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Oklahoma Academic Standards Connections

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</tr>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Growth and Development of Organisms: • In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. • The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. • Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.</td>
<td>HS-LS1-4 Students who demonstrate understanding can: Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. Clarification Statement: Emphasis is on conceptual understanding that mitosis passes on genetically identical materials via replication, not on the details of each phase in mitosis. Assessment Boundary: Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<tr>
<td>Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td>• Use a model based on evidence to illustrate the relationships between systems or between components of a system.</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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</table>
## Crosscutting Concepts: Energy and Matter

- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

## Oklahoma Academic Standards Connections

### ELA/Literacy

### Mathematics

## Connection to PASS Coming Soon
HS-LS1-6 From Molecules to Organisms: Structure and Processes

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</table>
| ① Asking questions (for science) and defining problems (for engineering) | Organization for Matter and Energy Flow:  
- (Builds on HS-LS1-5) The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into large molecules that can be assembled into large molecules (such as proteins or DNA), used for example to form new cells.  
- As matter and energy flow through different organization levels of living systems, chemical elements are recombined in different ways to form different products. | HS-LS1-6  
Students who demonstrate understanding can:  
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.  
Clarification Statement:  
Emphasis is on students constructing explanations for how sugar molecules are formed through photosynthesis and the components of the reaction (i.e., carbon, hydrogen, oxygen). This hydrocarbon backbone is used to make amino acids and other carbon-based molecules that can be assembled (anabolism) into larger molecules (such as proteins or DNA).  
Assessment Boundary:  
Assessment does not include the details of the specific chemical reactions or identification of macromolecules. |
| 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)  
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  
- Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. |  |  |
| ⑦ Engaging in argument from evidence |  |  |
| ⑧ Obtaining, evaluating, and communicating information |  |  |

Crosscutting Concepts: Energy and Matter
- Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

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Connection to PASS Coming Soon
### HS-LS1-7 From Molecules to Organisms: Structure and Processes

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Organization for Matter and Energy Flow in Organisms: (Builds on HS-LS1-6) | HS-LS1-7
| 2. Developing and using models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. | • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. | Students who demonstrate understanding can:
| • Use a model based on evidence to illustrate the relationships between systems or between components of a system. | • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. | **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. |
| 3. Planning and carrying out investigations | • Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. | **Clarification Statement:** Emphasis is on the conceptual understanding of the inputs and outputs of the process of cellular respiration. Examples of models could include diagrams, chemical equations, conceptual models, and/or laboratory investigations. |
| 4. Analyzing and interpreting data | • Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. | **Assessment Boundary:** Assessment should not include identification of the steps or specific processes involved in cellular respiration (e.g. glycolysis and Kreb’s Cycle). |
| 5. Using mathematics and computational thinking | | |
| 6. Constructing explanations (for science) and designing solutions (for engineering) | | |
| 7. Engaging in argument from evidence | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Energy and Matter
- Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

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**Connection to PASS Coming Soon**
### Crosscutting Concepts: Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

### Oklahoma Academic Standards Connections

### Connection to PASS Coming Soon
Crosscutting Concepts: Scale, Proportion, and Quantity

- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
### HS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Cycles of Matter and Energy Transfer in Ecosystems: | HS-LS2-3  
Students who demonstrate understanding can: |
| 2. Developing and using models | • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. | Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. |
| 3. Planning and carrying out investigations | | Clarification Statement: |
| 4. Analyzing and interpreting data | | Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments (e.g., chemosynthetic bacteria, yeast, and muscle cells). |
| 5. Using mathematics and computational thinking | | Assessment Boundary: |
| 6. Constructing explanations (for science) and designing solutions (for engineering) | | Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration. |
|  | Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. | |
|  | • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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. | |
|  | Engaging in argument from evidence | |
|  | Obtaining, evaluating, and communicating information | |

### Crosscutting Concepts: Energy and Matter
- Energy drives the cycling of matter within and between systems.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon
### Science & Engineering Practices

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
   - Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
   - Use mathematical representations of phenomena or design solutions to support claims.
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

- **Cycles of Matter and Energy Transfer in Ecosystems:**
  - Plants or algae form the lowest level of the food web.
  - At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level.
  - Given this inefficiency, there are generally fewer organisms at higher levels of a food web.
  - Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.
  - The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.
  - At each link in an ecosystem, matter and energy are conserved.

### Performance Expectations

- **HS-LS2-4**
  Students who demonstrate understanding can:

  **Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.**

  **Clarification Statement:** Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.

  **Assessment Boundary:** The assessment should provide evidence of students’ abilities to develop and use energy pyramids, food chains, food webs, and other models from data sets.

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**Crosscutting Concepts: Energy and Matter**

- Energy cannot be created or destroyed - it only moves between one place and another place, between objects and/or fields, or between systems.

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Systems and Models

• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

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Connection to PASS Coming Soon
Crosscutting Concepts: Stability and Change

• Much of science deals with constructing explanations of how things change and how they remain stable.

### HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics

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<tr>
<td><strong>1.</strong> Asking questions (for science) and defining problems (for engineering)</td>
<td><strong>Ecosystem Dynamics, Functioning, and Resilience:</strong></td>
<td><strong>HS-LS2-6</strong></td>
</tr>
<tr>
<td><strong>2.</strong> Developing and using models</td>
<td>• A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td><strong>3.</strong> Planning and carrying out investigations</td>
<td>• If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem.</td>
<td><strong>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.</strong></td>
</tr>
<tr>
<td><strong>4.</strong> Analyzing and interpreting data</td>
<td>• Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.</td>
<td><strong>Clarification Statement:</strong> Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.</td>
</tr>
<tr>
<td><strong>5.</strong> Using mathematics and computational thinking</td>
<td><strong>Assessment Boundary:</strong> The assessment should provide evidence of students’ abilities to derive trends from graphical representations of population trends. Assessments should focus on describing drivers of ecosystem stability and change, not on the organizational mechanisms of responses and interactions.</td>
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<tr>
<td><strong>6.</strong> Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td><strong>7.</strong> Engaging in argument from evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.</td>
<td>• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.</td>
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<td></td>
<td>• Obtaining, evaluating, and communicating information</td>
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## Oklahoma Academic Standards Connections

### ELA/Literacy

### Mathematics

### Connection to PASS Coming Soon
Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
**Crosscutting Concepts: Cause and Effect**

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### HS-LS3-2 Heredity: Inheritance and Variation of Traits

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | **Variation of Traits:**  
- In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation.  
- Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also cause mutations in genes, and variables mutations are inherited.  
- Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in the population. Thus the variation and distribution of traits observe depends on both genetic and environmental factors. | **HS-LS3-2**  
Students who demonstrate understanding can:  
**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. |
| 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  
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.  
- Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence. |  
| 8. Obtaining, evaluating, and communicating information |  |

**Crosscutting Concepts: Cause and Effect**
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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**Connection to PASS Coming Soon**
## HS-LS3-3 Heredity: Inheritance and Variation of Traits

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</tr>
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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Variance of Traits: • Environmental factors also affect expression of traits, and therefore affect the probability of occurrence of traits in the population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.</td>
<td>HS-LS3-3 Students who demonstrate understanding can: <strong>Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.</strong></td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<td></td>
</tr>
<tr>
<td>4. Analyzing and interpreting data</td>
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<tr>
<td>Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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**Crosscutting Concepts: Scale, Proportion and Quantity**

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
## Crosscutting Concepts: Patterns

- Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

## HS-LS4-1 Biological Unity and Diversity

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<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evidence of Common Ancestry and Diversity:</strong></td>
<td><strong>HS-LS4-1</strong> Students who demonstrate understanding can:</td>
<td><strong>Analyze and evaluate how evidence such as similarities in DNA sequences, anatomical structures, and order of appearance of structures during embryological development contribute to the scientific explanation of biological diversity.</strong></td>
</tr>
<tr>
<td>• Genetic information provides evidence of common ancestry and diversity. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence.</td>
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<tr>
<td><strong>Clarification Statement:</strong> Emphasis is on identifying sources of scientific evidence.</td>
<td><strong>Assessment Boundary:</strong> The assessment should provide evidence of students' abilities to evaluate and analyze evidence (e.g. cladograms, analogous/homologous structures, and fossil records).</td>
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## Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
## HS-LS4-2 Biological Unity and Diversity

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Natural Selection: • Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals.</td>
<td>HS-LS4-2 Students who demonstrate understanding can: <strong>Construct an explanation based on evidence that biological diversity is influenced by (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.</strong></td>
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<tr>
<td>2. Developing and using models</td>
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<td>3. Planning and carrying out investigations</td>
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<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.</td>
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<tr>
<td>• Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

## Oklahoma Academic Standards Connections

### ELA/Literacy

### Mathematics

## Connection to PASS Coming Soon
Crosscutting Concepts: Patterns
• Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations and phenomena.

Oklahoma Academic Standards Connections

Connection to PASS Coming Soon
## HS-LS4-4 Biological Unity and Diversity

### Science & Engineering Practices

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)

   Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

   - Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.

7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Adaptation:**

- Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment.
- That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.

### Performance Expectations

**HS-LS4-4**

Students who demonstrate understanding can:

**Construct an explanation based on evidence for how natural selection leads to adaptation of populations.**

**Clarification Statement:**

Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or adaptation of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations. One example could be that as climate became more arid, grasses replaced forests, which led to adaptation in mammals over time (e.g. Increase to tooth enamel and size of teeth in herbivores).

**Assessment Boundary:**

The assessment should measure students’ abilities to differentiate types of evidence used in explanations.

### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Science & Engineering Practices

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

ENGAGING IN ARGUMENT FROM EVIDENCE

Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

- Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.
- Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Adaptation:
- Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
- Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species’ adaptation over time is lost.

Performance Expectations

HS-LS4-5
Students who demonstrate understanding can:

Synthesize, communicate, and evaluate the information that describes how changes in environmental conditions can affect the distribution of traits in a population causing:
1) increases in the number of individuals of some species, 2) the emergence of new species over time, and 3) the extinction of other species.

Clarification Statement:
Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.

Assessment Boundary:
The assessment should provide evidence of students’ abilities to explain the cause and effect for how changes to the environment affect distribution or disappearance of traits in species.

Oklahoma Academic Standards Connections

ELA/Literacy

Mathematics

Connection to PASS Coming Soon
Crosscutting Concepts: Scale, Proportion, and Quantity
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

HS-ESS1-1 Earth’s Place in the Universe

Science & Engineering Practices
1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   • Develop a model based on evidence to illustrate the relationships between systems or components of a system.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas
The Universe and Its Stars:
• The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.

Energy in Chemical Processes and Everyday Life:
(secondary to HS-ESS1-1)
• Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.

Performance Expectations
HS-ESS1-1
Students who demonstrate understanding can:
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.

Clarification Statement:
Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun’s core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun’s radiation varies due to sudden solar flares (“space weather”), the 11-year sunspot cycle, and non-cyclic variations over centuries.

Assessment Boundary:
Assessment does not include details of the atomic and sub-atomic processes involved with the sun’s nuclear fusion.
HS-ESS1-2 Earth’s Place in the Universe

Science & Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
   - Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   - Develop a model based on evidence to illustrate the relationships between systems or components of a system.
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
8. Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth and the Solar System:
- The solar system consists of the sun and a collection of objects of varying sizes and conditions – including planets and their moons – that are held in orbit around the sun by its gravitational pull on them.

Performance Expectations

**HS-ESS1-2**
Students who demonstrate understanding can:

**Develop models to describe the sun’s place in relation to the Milky Way galaxy and the distribution of galaxies and galaxy clusters in the Universe.**

Clarification Statement:
Mathematical models can focus on the logarithmic powers-of-ten relationship among the sun, its solar system, the Milky Way galaxy, the local cluster of galaxies, and the universe, these relationships can also be investigated graphically, using 2D or 3D scaled models, or through computer programs, either pre-made or student-written.

Assessment Boundary:
Details about the mapped distribution of galaxies and clusters are not assessed.

Crosscutting Concepts: Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Oklahoma Academic Standards Connections

**ELA/Literacy**

**Mathematics**

Connection to PASS Coming Soon
Crosscutting Concepts: Energy and Matter

- In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

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Connection to PASS Coming Soon
Crosscutting Concepts: Scale, Proportion, and Quantity

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

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**Crosscutting Concepts: Stability and Change**

- Much of science deals with constructing explanations of how things change and how they remain stable.

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### HS-ESS1-5 Earth’s Place in the Universe

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<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Plate Tectonics and Large-Scale System Interactions:</td>
<td>HS-ESS1-5</td>
</tr>
<tr>
<td>2 Developing and using models</td>
<td>• Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth’s surface and provides a framework for understanding its geologic history.</td>
<td>Students who demonstrate understanding can:</td>
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<tr>
<td>3 Planning and carrying out investigations</td>
<td></td>
<td><strong>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.</strong></td>
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<tr>
<td>4 Analyzing and interpreting data</td>
<td></td>
<td><strong>Clarification Statement:</strong></td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
<td></td>
<td>Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core (a result of past plate interactions).</td>
</tr>
<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td><strong>Assessment Boundary:</strong></td>
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<tr>
<td>7 Engaging in argument from evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.</td>
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<td>8 Obtaining, evaluating, and communicating information</td>
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**Connection to PASS Coming Soon**
## EARTH & SPACE SCIENCE

### HS-ESS1-6 Earth’s Place in the Universe

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>History of Planet Earth: • Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over years. Studying these objects can provide information about Earth’s formation and early history.</td>
<td>HS-ESS1-6 Students who demonstrate understanding can: <strong>Apply scientific reasoning and evidence</strong> from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth’s formation and early history.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<tr>
<td>3. Planning and carrying out investigations</td>
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<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering) Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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### Crosscutting Concepts: Stability and Change

• Much of science deals with constructing explanations of how things change and how they remain stable.

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### Connection to PASS Coming Soon
## EARTH & SPACE SCIENCE

### HS-ESS2-1 Earth’s Systems

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<tbody>
<tr>
<td>1 Asking questions (for science) and defining problems (for engineering)</td>
<td>Earth Materials and Systems:</td>
<td>HS-ESS2-1</td>
</tr>
<tr>
<td>2 Developing and using models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.</td>
<td>• Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.</td>
<td>Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>* Develop a model based on evidence to illustrate the relationships between systems or components of a system.</td>
<td>Plate Tectonics and Large-Scale System Interactions:</td>
<td>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.</td>
</tr>
<tr>
<td>3 Planning and carrying out investigations</td>
<td>• Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth’s surface and provides a framework for understanding its geologic history.</td>
<td>Clarification Statement:</td>
</tr>
<tr>
<td>4 Analyzing and interpreting data</td>
<td>• Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust.</td>
<td>Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, erosion, and mass wasting).</td>
</tr>
<tr>
<td>5 Using mathematics and computational thinking</td>
<td></td>
<td>Assessment Boundary:</td>
</tr>
<tr>
<td>6 Constructing explanations (for science) and designing solutions (for engineering)</td>
<td></td>
<td>Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.</td>
</tr>
<tr>
<td>7 Engaging in argument from evidence</td>
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<tr>
<td>8 Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

### Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
## HS-ESS2-2 Earth’s Systems

### Science & Engineering Practices

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
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas

**Earth Materials and Systems:**
- Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

**Weather and Climate:**
- The foundation for Earth’s: global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space.

### Performance Expectations

**HS-ESS2-2**

Students who demonstrate understanding can:

**Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks and interactions that cause changes to other Earth’s systems.**

**Clarification Statement:**
Examples could be taken from system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion, which limits additional vegetation patterns; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent. Examples could also include climate feedbacks that increase surface temperatures through geologic time.

**Assessment Boundary:**
N/A

### Crosscutting Concepts: Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

### Oklahoma Academic Standards Connections

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### Connection to PASS Coming Soon

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**SCIENCE STANDARDS • OKLAHOMA STATE DEPARTMENT OF EDUCATION**

211
### Science Standards • Oklahoma State Department of Education

#### HS-ESS2-3 Earth’s Systems

<table>
<thead>
<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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<tbody>
<tr>
<td><strong>Earth Materials and Systems:</strong></td>
<td><strong>HS-ESS2-3</strong> Students who demonstrate understanding can:</td>
<td><strong>Clarification Statement:</strong></td>
</tr>
<tr>
<td>• Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth’s surface features, its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust.</td>
<td>Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.</td>
<td>Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of the Earth’s surface features as well as three-dimensional structure in the subsurface, obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and prediction of the composition of Earth’s layers from high-pressure laboratory experiments.</td>
</tr>
<tr>
<td>• Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth’s interior and gravitational movement of denser materials toward the interior.</td>
<td><strong>Assessment Boundary:</strong> N/A</td>
<td></td>
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<tr>
<td><strong>Plate Tectonics and Large-Scale System Interactions:</strong></td>
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<tr>
<td>• The radioactive decay of unstable isotopes continually generates new energy within Earth’s crust and mantle, providing the primary source of the heat that drives mantle convection.</td>
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<tr>
<td>• Plate tectonics can be viewed as the surface expression of mantle convection.</td>
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<tr>
<td><strong>Waves Properties:</strong></td>
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<tr>
<td>(secondary to HS-ESS2-3)</td>
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<tr>
<td>• Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.</td>
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#### Crosscutting Concepts: Energy and Matter

- Energy drives the cycling of matter within and between systems.

#### Oklahoma Academic Standards Connections

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#### Connection to PASS Coming Soon

212 Science Standards • Oklahoma State Department of Education
# HS-ESS2-4 Earth’s Systems

## Science & Engineering Practices

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
   - Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
   - Analyze data using computational models in order to make valid and reliable scientific claims.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

## Disciplinary Core Ideas

### Earth and the Solar System:
- (secondary to HS-ESS2-4)
  - Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other changes in climate.

### Earth Materials and Systems:
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles.

### Weather and Climate:
- The foundation for Earth’s global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space.

## Performance Expectations

**HS-ESS2-4**

Students who demonstrate understanding can:

- Analyze and interpret data to explore how variations in the flow of energy into and out of Earth’s systems result in changes in atmosphere and climate.

**Clarification Statement:**

Changes differ by timescale, from sudden (large volcanic eruption, ocean circulation); to intermediate (ocean circulation, solar output, human activity); and long-term (Earth’s orbit and the orientation of its axis and changes in atmospheric composition). Examples of human activities could include fossil fuel combustion, cement production, or agricultural activity and natural processes such as changes in incoming solar radiation or volcanic activity. Examples of data can include tables, graphs, maps of global and regional temperatures, and atmospheric levels of gases.

**Assessment Boundary:**

N/A

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### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Oklahoma Academic Standards Connections

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## Connection to PASS Coming Soon
Crosscutting Concepts: Structure and Function

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
# HS-ESS2-6 Earth’s Systems

## Crosscutting Concepts: Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

## Oklahoma Academic Standards Connections

### Disciplinary Core Ideas

**Biogeology:**
- Organisms ranging from bacteria to human beings are a major driver of the global carbon and they influence global climate by modifying the chemical makeup of the atmosphere.
- The abundance of carbon in the atmosphere is reduced through the ocean floor accumulation of marine sediments and the accumulation of plant biomass.

### Performance Expectations

**HS-ESS2-6**

Students who demonstrate understanding can:

- Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

**Clarification Statement:**
Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.

**Assessment Boundary:**
N/A

---

### Disciplinary Core Ideas

**HSN-Q.A.1**

Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

**HSN-Q.A.2**

Define appropriate quantities for the purpose of descriptive modeling.

**HSN-Q.A.3**

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

---

### Oklahoma Academic Standards Connections

### ELA/Literacy

### Mathematics

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**Connection to PASS Coming Soon**
### Crosscutting Concepts: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

### HS-ESS2-7 Earth’s Systems

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</table>
| - Asking questions (for science) and defining problems (for engineering) | **Weather and Climate:**  
  - Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. | **HS-ESS2-7**  
  Students who demonstrate understanding can:  
  **Construct an argument based on evidence about the simultaneous co-evolution of Earth’s systems and life on Earth.** |
| - Developing and using models | **Biogeology:**  
  - The many dynamic and delicate feedback mechanisms between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it. |  |
| - Planning and carrying out investigations |  |  |
| - Analyzing and interpreting data |  |  |
| - Using mathematics and computational thinking |  |  |
| - Constructing explanations (for science) and designing solutions (for engineering) |  |  |
| - Engaging in argument from evidence  
  Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.  
  - Construct an oral and written argument or counter-arguments based on data and evidence. |  |  |
| - Obtaining, evaluating, and communicating information |  |  |

**Clarification Statement:**  
Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors influence conditions for life, which in turn continuously alters Earth’s surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and affected animal life; how microbial life on land increased the formation of soil, which in turn allowed for the development of land plant species; or how the changes in coral species created reefs that altered patterns of erosion and deposition along coastlines and provided habitats to support biodiversity. Geologic timescale should be considered with the emphases above.

**Assessment Boundary:**  
Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth’s other systems.

### Oklahoma Academic Standards Connections

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**Connection to PASS Coming Soon**
HS-ESS3-1 Earth and Human Activities

### Science & Engineering Practices

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)

### Disciplinary Core Ideas

#### Natural Resources:
- Resource availability has guided the development of human society.

#### Natural Hazards:
- Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.

### Performance Expectations

**HS-ESS3-1**

Students who demonstrate understanding can:

*Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.*

**Clarification Statement:**

Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Natural hazards and other geologic events exhibit some non-random patterns of occurrence. Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.

**Assessment Boundary:**

N/A

### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

- RST.11-12.1

#### Mathematics

- HSN-Q.A.1
- HSN-Q.A.2
- HSN-Q.A.3

### Connection to PASS Coming Soon
Crosscutting Concepts: Cause and Effect

- N/A

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### HS-ESS3-5 Earth and Human Activities

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Natural Resources: • Most elements exist in Earth’s crust at concentrations too low to be extracted, but in some locations—where geological processes have concentrated them—extraction is economically viable.</td>
<td>HS-ESS3-5 Students who demonstrate understanding can: Construct a scientific explanation from evidence for how geological processes lead to uneven distribution of natural resources.</td>
</tr>
<tr>
<td>2. Developing and using models</td>
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<td>3. Planning and carrying out investigations</td>
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<td>4. Analyzing and interpreting data</td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. • Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students’ own investigations, models, theories, simulations, peer review) 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.</td>
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<tr>
<td>7. Engaging in argument from evidence</td>
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<tr>
<td>8. Obtaining, evaluating, and communicating information</td>
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#### Crosscutting Concepts: Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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Connection to PASS Coming Soon
## HS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

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<tbody>
<tr>
<td>1. Asking questions (for science) and defining problems (for engineering)</td>
<td>Interdependent Relationships in Ecosystems:</td>
<td>HS-LS2-1 Students who demonstrate understanding can:</td>
</tr>
<tr>
<td>2. Developing and using models</td>
<td>• Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.</td>
<td>Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.</td>
</tr>
<tr>
<td>3. Planning and carrying out investigations</td>
<td>• These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.</td>
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<tr>
<td>4. Analyzing and interpreting data</td>
<td>• Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.</td>
<td></td>
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<tr>
<td>5. Using mathematics and computational thinking</td>
<td>• This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.</td>
<td></td>
</tr>
<tr>
<td>Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical and/or computational representations of phenomena or design solutions to support explanations.</td>
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<tr>
<td>6. Constructing explanations (for science) and designing solutions (for engineering)</td>
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<td>7. Engaging in argument from evidence</td>
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<td>8. Obtaining, evaluating, and communicating information</td>
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### Crosscutting Concepts: Scale, Proportion, and Quantity
- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

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### Connection to PASS Coming Soon

**Oklahoma Academic Standards Connections**

**ELA/Literacy**

**Mathematics**
### Crosscutting Concepts: Scale, Proportion, and Quantity
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

#### Mathematics
### Crosscutting Concepts: Stability and Change

- Energy cannot be created or destroyed— it only moves between one place and another place, between objects and/or fields, or between systems.

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</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Cycles of Matter and Energy Transfer in Ecosystems:  
Plants or algae form the lowest level of the food web.  
At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level.  
Given this inefficiency, there are generally fewer organisms at higher levels of a food web.  
Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded.  
The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways.  
At each link in an ecosystem, matter and energy are conserved. | HS-LS2-4  
Students who demonstrate understanding can:  
Use a mathematical representation to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.  
Clarification Statement:  
Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on atoms and molecules such as carbon, oxygen, hydrogen and nitrogen being conserved as they move through an ecosystem.  
Assessment Boundary:  
The assessment should provide evidence of students’ abilities to develop and use energy pyramids, food chains, food webs, and other models from data sets. |
| 2. Developing and using models  
3. Planning and carrying out investigations  
4. Analyzing and interpreting data  
5. Using mathematics and computational thinking  
Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.  
Use mathematical representations of phenomena or design solutions to support claims.  
6. Constructing explanations (for science) and designing solutions (for engineering)  
7. Engaging in argument from evidence  
8. Obtaining, evaluating, and communicating information |  |  |

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Stability and Change
• Much of science deals with constructing explanations of how things change and how they remain stable.

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</table>
| 1 Asking questions (for science) and defining problems (for engineering) | Ecosystem Dynamics, Functioning, and Resilience:  
- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions.  
- If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem.  
- Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. | HS-LS2-6  
Students who demonstrate understanding can:  
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.  
Clarification Statement:  
Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.  
Assessment Boundary:  
The assessment should provide evidence of students’ abilities to derive trends from graphical representations of population trends. Assessments should focus on describing drivers of ecosystem stability and change, not on the organismal mechanisms of responses and interactions. |
| 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  
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.  
- Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.  
- Obtaining, evaluating, and communicating information |  |  |

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Connection to PASS Coming Soon
## HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics

### Science & Engineering Practices
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)
   - Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
   - Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

### Disciplinary Core Ideas
- **Ecosystem Dynamics, Functioning, and Resilience:**
  - Anthropogenic changes (induced by human activity) in the environment can disrupt an ecosystem and threaten the survival of some species.

- **Biodiversity and Humans:**
  - Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).
  - Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity.
  - Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth.
  - Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.

- **Developing Possible Solutions:**
  - When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts.

### Performance Expectations
**HS-LS2-7**
Students who demonstrate understanding can:

**Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment biodiversity.*

**Clarification Statement:**
Examples of human activities can include urbanization, building dams, and dissemination of invasive species.

**Assessment Boundary:**
N/A

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### Crosscutting Concepts: Stability and Change
- Much of science deals with constructing explanations of how things change and how they remain stable.

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### Oklahoma Academic Standards Connections

#### ELA/Literacy

#### Mathematics

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### Connection to PASS Coming Soon
### Crosscutting Concepts: Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

### Oklahoma Academic Standards Connections

#### ELA/Literacy

**SL.11-12.5**

Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

#### Mathematics

**HSN-Q.A.1**

Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

**HSN-Q.A.2**

Define appropriate quantities for the purpose of descriptive modeling.

**HSN-Q.A.3**

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

**HSF-IF.B.6**

Calculate and interpret the average rate of change of function (presented symbolically or as a table) over specified interval. Estimate the rate of change from a graph.

### HS-ESS2-1 Earth’s Systems

**Science & Engineering Practices**

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.
   - Develop a model based on evidence to illustrate the relationships between systems or components of a system.
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
8. Obtaining, evaluating, and communicating information

**Disciplinary Core Ideas**

- **Earth Materials and Systems:**
  - Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

- **Plate Tectonics and Large-Scale System Interactions:**
  - Plate tectonics is the unifying theory that explains the past and current movements of rocks at Earth’s surface and provides a framework for understanding its geologic history.
  - Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth’s crust.

**Performance Expectations**

**HS-ESS2-1**

Students who demonstrate understanding can:

**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.**

**Clarification Statement:**

Emphasis is on how the appearance of land features (such as mountains, valleys, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion).

**Assessment Boundary:**

Assessment does not include memorization of the details of the formation of specific geographic features of Earth’s surface.
### Crosscutting Concepts: Stability and Change
- Feedback (negative or positive) can stabilize or destabilize a system.

### HS-ESS2-2 Earth’s Systems

#### Science & Engineering Practices
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
   - Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.
   - Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas
- **Earth Materials and Systems:**
  - Earth’s systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

- **Weather and Climate:**
  - The foundation for Earth’s global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space.

#### Performance Expectations

**HS-ESS2-2**

Students who demonstrate understanding can:

- **Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks and interactions that cause changes to other Earth’s systems.**

**Clarification Statement:**
Examples could be taken from system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion, which limits additional vegetation patterns; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent. Examples could also include climate feedbacks that increase surface temperatures through geologic time.

**Assessment Boundary:**
N/A

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**Connection to PASS Coming Soon**
Crosscutting Concepts: Energy and Matter

- Energy drives the cycling of matter within and between systems.

Oklahoma Academic Standards Connections

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Connection to PASS Coming Soon
### HS-ESS2-4 Earth’s Systems

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Performance Expectations</th>
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</thead>
</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Earth and the Solar System: (secondary to HS-ESS2-4) | HS-ESS2-4  
Students who demonstrate understanding can:  
**Analyze and interpret data to explore how variations in the flow of energy into and out of Earth’s systems result in changes in atmosphere and climate.** |
| 2. Developing and using models |  
- Cyclical changes in the shape of Earth’s orbit around the sun, together with changes in the tilt of the planet’s axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the Earth. These phenomena cause a cycle of ice ages and other changes in climate. | |
| 3. Planning and carrying out investigations | Earth Materials and Systems:  
- The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun’s energy output or Earth’s orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to very long-term tectonic cycles. | |
| 4. Analyzing and interpreting data  
Analyzing data in 9–12 builds on K–8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.  
- Analyze data using computational models in order to make valid and reliable scientific claims. | Weather and Climate:  
- The foundation for Earth’s global climate system is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy’s re-radiation into space. | |
| 5. Using mathematics and computational thinking | | |
| 6. Constructing explanations (for science) and designing solutions (for engineering) | | |
| 7. Engaging in argument from evidence | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Cause and Effect
- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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**Connection to PASS Coming Soon**
**Crosscutting Concepts: Structure and Function**

- The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials.

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**Oklahoma Academic Standards Connections**

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**Connection to PASS Coming Soon**
### HS-ESS2-6 Earth’s Systems

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<tr>
<th>Science &amp; Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Biogeology:  
• Organisms ranging from bacteria to human beings are a major driver of the global carbon and they influence global climate by modifying the chemical makeup of the atmosphere.  
• The abundance of carbon in the atmosphere is reduced through the ocean floor accumulation of marine sediments and the accumulation of plant biomass. | **HS-ESS2-6**  
Students who demonstrate understanding can:  

**Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.**

Clarification Statement:  
Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms.  

Assessment Boundary:  
N/A |
| 2. Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. |  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 3. Planning and carrying out investigations |  
Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 4. Analyzing and interpreting data |  
Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 5. Using mathematics and computational thinking |  
Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 6. Constructing explanations (for science) and designing solutions (for engineering) |  
Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 7. Engaging in argument from evidence |  
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Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |
| 8. Obtaining, evaluating, and communicating information |  
Developing and using models  
Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.  
* Develop a model based on evidence to illustrate the relationships between systems or components of a system. | |

### Crosscutting Concepts: Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

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### Connection to PASS Coming Soon
## Crosscutting Concepts: Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable.

## HS-ESS2-7 Earth’s Systems

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<tbody>
<tr>
<td></td>
<td>Weather and Climate:</td>
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<tr>
<td></td>
<td>• Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.</td>
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<td>Biogeology:</td>
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<td>• The many dynamic and delicate feedback mechanisms between the biosphere and other Earth systems cause a continual co-evolution of Earth’s surface and the life that exists on it.</td>
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<tr>
<td>1) Asking questions (for science) and defining problems (for engineering)</td>
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<td>HS-ESS2-7</td>
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<tr>
<td>2) Developing and using models</td>
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<td>Students who demonstrate understanding can:</td>
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<td>3) Planning and carrying out investigations</td>
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<tr>
<td>4) Analyzing and interpreting data</td>
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<td>Construct an argument based on evidence about the simultaneous co-evolution of Earth’s systems and life on Earth.</td>
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<tr>
<td>5) Using mathematics and computational thinking</td>
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<tr>
<td>6) Constructing explanations (for science) and designing solutions (for engineering)</td>
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<tr>
<td>7) Engaging in argument from evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.</td>
<td></td>
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<td></td>
<td>• Construct an oral and written argument or counter-arguments based on data and evidence.</td>
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<td>8) Obtaining, evaluating, and communicating information</td>
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### Performance Expectations
- **HS-ESS2-7**: Students who demonstrate understanding can:
  - **Construct an argument based on evidence about the simultaneous co-evolution of Earth’s systems and life on Earth.**

#### Clarification Statement:
Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth’s other systems, whereby geoscience factors influence conditions for life, which in turn continuously alters Earth’s surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and affected animal life; how microbial life on land increased the formation of soil, which in turn allowed for the development of land plant species; or how the changes in coral species created reefs that altered patterns of erosion and deposition along coastlines and provided habitats to support biodiversity. Geologic timescale should be considered with the emphases above.

#### Assessment Boundary:
Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth’s other systems.

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### Connection to PASS Coming Soon
### Crosscutting Concepts:Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

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### Connection to PASS Coming Soon
## ENVIROMENTAL SCIENCE

### HS-ESS3-2 Earth and Human Activities

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Natural Resources:  
   - All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. | HS-ESS3-2  
   Students who demonstrate understanding can:  
   **Evaluate competing design solutions for developing, managing, and utilizing natural resources based on cost-benefit ratios.**  
   Clarification Statement:  
   Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas).  
   Assessment Boundary: N/A |
| 2. Developing and using models | Developing Possible Solutions:  
   (secondary to HS-ESS3-2)  
   - When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. |
| 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 Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.  
   - Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations). | | |
| 8. Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts:
- N/A

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### Connection to PASS Coming Soon
### Crosscutting Concepts: Stability and Change

- Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

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### HS-ESS3-3 Earth and Human Activities

#### Science & Engineering Practices

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
   Mathematical and computational thinking at the 9-12 level builds on K-8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.
   - Create a computational model or simulation of a phenomenon, device, process or system.
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

#### Disciplinary Core Ideas

**Human Impacts on Earth Systems:**
- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.

#### Performance Expectations

**HS-ESS3-3**

Students who demonstrate understanding can:

Create a computational simulation to illustrate the relationship among management of natural resources, the sustainability of human populations, and biodiversity.

**Clarification Statement:**
Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of consumption, and urban planning.

**Assessment Boundary:**
Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.

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**Connection to PASS Coming Soon**
### HS-ESS3-4 Earth and Human Activities

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</table>
| 1. Asking questions (for science) and defining problems (for engineering) | Human Impacts on Earth Systems:  
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. | HS-ESS3-4  
Students who demonstrate understanding can:  
**Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.*** |
| 2. Developing and using models | | **Clarification Statement:**  
Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use. Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions. |
| 3. Planning and carrying out investigations | | **Assessment Boundary:**  
N/A |
| 4. Analyzing and interpreting data | | |
| 5. Using mathematics and computational thinking | | |
| 6. Constructing explanations (for science) and designing solutions (for engineering)  
Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.  
- Design or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and tradeoff considerations.  
- Engaging in argument from evidence  
- Obtaining, evaluating, and communicating information | | |

### Crosscutting Concepts: Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

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**Connection to PASS Coming Soon**
SCIENCE