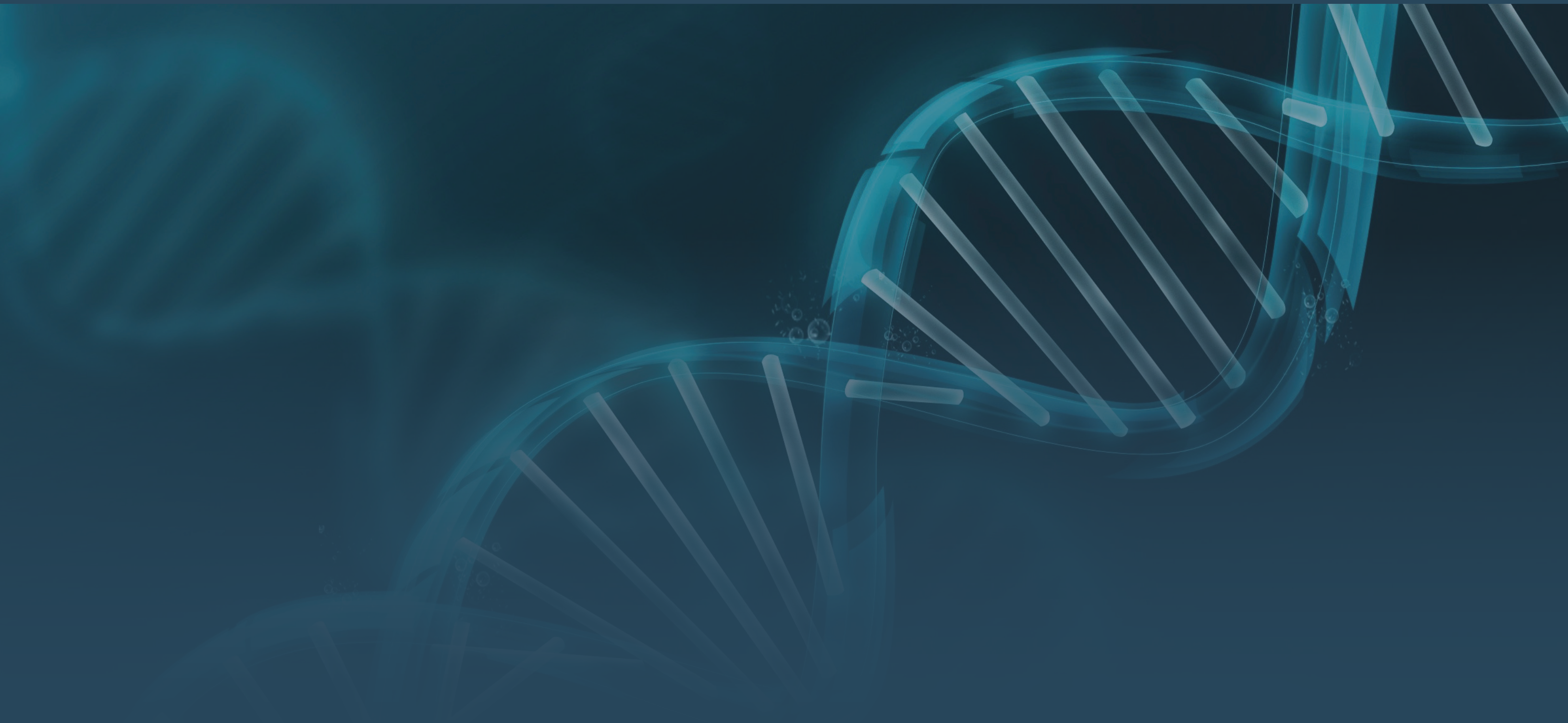

SCIENCE

OKLAHOMA STATE DEPARTMENT OF
EDUCATION

OKLAHOMA
ACADEMIC
STANDARDS

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SCIENCE

Table of Contents

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)
- Sarah Vann (Owasso Middle School)
- Dr. Julie Angle (Oklahoma State University)
- 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.

Janice Airhart (Broken Arrow PS)
Carrie Akins (Mid-Del Public Schools)
Dr. Julie Angle (Oklahoma State University)
Christa Askins (Bixby PS)
Theresa Balan (Moore PS)
Johana Benson (Bing)
Renee Bell (Mid Del PS)
Quentin Biddy (K20 Center– University of Okla.)
Jennifer Bobo (Stillwater PS)
Lori Chafee (Mustang PS)
Hal Clary (Noble Public Schools)
Deborah Coffman (Broken Arrow PS)
Richard Day (Union PS)
Wanda Dickenson (Wellston PS)
Chris Dobbins (Comanche PS)
Missy Dominy (Gordon Cooper Tech. Center)
Tina Fugate (Okla. State Career Technology)
Cora James (Putnam City PS)
Laura Johnston (Velma-Alma PS)
Teri Kimble (Hydro-Eakly PS)
Dr. Tim Laubach (University of Oklahoma)
Gaile Loving (Mustang PS)
Tanya Mantooth (Wayne PS)
Bob Melton (Putnam City PS)
Norma Neely (American Indian Institute – University of Oklahoma)
Jeffery Patterson (Norman PS)
Kendra Phillips (Muldrow PS)
Patrice Powdar (Moore PS)
Alisa Reimer (Cordell PS)
Dr. Paul Risser (University of Oklahoma)
Tina Rogers (Woodward Public Schools)
Georgia Smith (Bristow PS)
Amanda Smith (Moore PS)
Sara Snodgrass (Noble)
Sarah Vann (Owasso PS)
Dr. Dan Vincent (University of Central Okla.)
Cathy Walker (Stillwater PS)
Brandi Williams (Edmond Public Schools)
Craig Walker (OSDE)
Tiffany Neill (OSDE)

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 Carrluci (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 Spinks (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.

The Oklahoma Academic Standards in this document were informed by *A Framework for K-12 Science Education* (National Research Council, 2012), *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), *The Next Generation Science Standards* (2013) and the *Oklahoma Priority Academic Student Skills for Science* (Oklahoma State Department of Education, 2011).

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.

OKLAHOMA
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Components of a Standard Document

❶ 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.

❷ 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.

❸ 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.

❹ 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.

❺ 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.

❻ 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.

❼ 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

4

❶ Asking questions (for science) and defining problems (for engineering)

❷ **Developing and using models**
Modeling in K–2 builds on prior experiences and progresses to include using and developing s (i.e., diagram, drawing, l replica, diorama, ization, storyboard) that resent concrete events or design solutions.
- **Use a model to represent relationships in the natural world.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

5

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:

1

Use a model to repre the relationship bet needs of different p animals (including hum and the places they live.

2

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

3

Assessment Boundary:
N/A

6

utting Concepts: Systems and System Models
- ystems 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.

7

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.
Collects and analyze information about objects and events in environment.

K-5 Overview

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

❶ Physical Science (PS)
❷ Life Science (LS)
❸ Earth & Space Science (ESS)

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

❶ 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)

❷ 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)

❸ 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.

Grade 3	Grade 4	Grade 5
3-PS2-1	4-PS3-1	5-PS1-1
3-PS2-2	4-PS3-2	5-PS1-2
3-PS2-3	4-PS3-3	5-PS1-3
3-PS2-4	4-PS3-4	5-PS1-4
3-LS1-1	4-PS4-1	5-PS2-1
3-LS2-1	4-PS4-2	5-PS3-1
3-LS3-1	4-PS4-3	5-LS1-1
3-LS3-2	4-LS1-1	5-LS2-1
3-LS4-1	4-LS1-2	5-LS2-2
3-LS4-2	4-ESS1-1	5-ESS1-1
3-LS4-3	4-ESS2-1	5-ESS1-2
3-LS4-4	4-ESS2-2	5-ESS2-1
3-ESS2-2	4-ESS3-1	5-ESS2-2
3-ESS3-1	4-ESS3-2	5-ESS3-1

K-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**
- **With guidance, plan and conduct an investigation in collaboration with peers.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Types of Interactions:
- When objects touch or collide, they push on one another and can change motion.

Relationship Between Energy and Forces:
- A bigger push or pull makes things speed up or slow down more quickly.

Performance Expectations

K-PS2-1

Students who demonstrate understanding can:

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.

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).

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.

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

ELA/Literacy

Vocabulary – 4.2. Use new vocabulary and language in own speech and writing.
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.
Modes/Forms of Writing – 2.2. Construct journal entries using illustrations and beginning writing skills.
Listening – 1.3. Follow one- and two-step directions.
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
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 analyze 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-PS2-2 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

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

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
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 analyze 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.

KINDERGARTEN

K-PS3-1 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** • **Make observations (firsthand or from media) to collect data that an be used to make comparisons.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Conservation of Energy and Energy Transfer:** • Sunlight warms Earth's surface.	**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	Mathematics
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.	**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 b. 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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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

Performance Expectations

K-PS3-2
Students who demonstrate understanding can:

Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area.*

Clarification Statement:
Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.

Assessment Boundary:
N/A

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.
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
d. Collects and analyze 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.

KINDERGARTEN

K-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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 analyze 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-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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.
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.
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 analyze 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.

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K-ESS2-2 Earth's Systems

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ **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.** ❽ Obtaining, evaluating, and communicating information	**Biogeology:** • Plants and animals can change their environment. **Human Impacts on Earth Systems:** • Things that people do to live comfortably can affect the world around them.	**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.

Crosscutting Concepts: Systems and System Models

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics
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

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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 analyze 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

❶ 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.**

❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

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 clues).
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
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 analyze 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.

1-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Wave Properties:** • Sound can make matter vibrate, and vibrating matter can make sound.	**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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** **• Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Electromagnetic Radiation:** • Objects can be seen if light is available to illuminate them or if they give off their own light.	**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

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

1-PS4-3

Students who demonstrate understanding can:

Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.

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).

Assessment Boundary:
Assessment does not include the speed of light or assessment of descriptive words like transparent, translucent, opaque or reflective.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-PS4-4 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Information Technologies and Instrumentation:
- People also use a variety of devices to communicate (send and receive information) over long distances.

** 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.

Performance Expectations

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.*

Clarification Statement:
Examples of devices could include a light source to send signals, paper cup and string "telephones," and a pattern of drumbeats.

Assessment Boundary:
Assessment does not include technological details for how communication devices work.

Crosscutting Concepts

- N/A

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-LS1-2 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence **❽ 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.**	**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

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-LS3-1 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.
- **Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.**

❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ **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.** ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**The Universe and its Stars:** • Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.	**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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

1-ESS1-2 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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 that can be used to make comparisons.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ 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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **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.

- **Communicate solutions with others in oral and/or written forms using models and/or drawings that provide detail about scientific ideas.**

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-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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-PS1-1 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**
- **Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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 puposes.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-PS1-2 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Properties of Matter:
- Different properties are suited to different purposes.

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

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

2-PS1-2
Students who demonstrate understanding can:

Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*

Clarification Statement:
Examples of properties could include, strength, flexibility, hardness, texture, and absorbency (e.g. paper towels could be utilized to measure absorbency and strength).

Assessment Boundary:
Assessment of quantitative measurements is limited to length.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-PS1-3 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** **• Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-PS1-4 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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.** ❽ Obtaining, evaluating, and communicating information	**Chemical Reactions:** • Heating or cooling a substance may cause changes that can be observed. • Sometimes these changes are reversible, and sometimes they are not.	**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

Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** • **Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Interdependent Relationships in Ecosystems:** • Plants depend on water and light to grow.	**2-LS2-1** *Students who demonstrate understanding can:* **Plan and conduct an investigation to determine if plants need sunlight and water to grow.** **Clarification Statement:** Investigations should be limited to testing one variable at a time. **Assessment Boundary:** Assessment is limited to testing one variable at a time.

Crosscutting Concepts: Cause and Effect

- Events have causes that generate observable patterns.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) **❷ 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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-LS4-1 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** **• Make observations from several sources to construct an evidence-based account for natural phenomena.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**The History of Planet Earth:** • Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.	**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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.
- **Compare multiple solutions to a problem.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth Materials and Systems:
- Wind and water can change the shape of the land.

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.

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

Influence of Engineering, Technology, and Science on Society and the Natural World:
- Developing and using technology has impacts on the natural world.

Performance Expectations

2-ESS2-1

Students who demonstrate understanding can:

Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*

Clarification Statement:
Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land. Students could explore these ideas with sand tables or soil and water in large containers.

Assessment Boundary:
N/A

Crosscutting Concepts: Stability and Change

- Things may change slowly or rapidly.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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 model to represent patterns in the natural world.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Plate Tectonics and Large-Scale System Interactions:
- Maps show where things are located.
- One can map the shapes and kinds of land and water in any area.

Performance Expectations

2-ESS2-2
Students who demonstrate understanding can:

Develop a model to represent the shapes and kind of land and bodies of water in an area.

Clarification Statement:
See Disciplinary Core Ideas.

Assessment Boundary:
Assessment does not include quantitative scaling in models.

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

2-ESS2-3 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **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.

- **Obtain information using various texts, text features (e.g., headings, tables, contents, glossaries, electronic menus, icons, and other media that will be useful in answering scientific questions.**

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**
  - **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.)

Performance Expectations

3-PS2-2

Students who demonstrate understanding can:

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)

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.

Assessment Boundary:
Assessment does not include technical terms such as period and frequency.

Crosscutting Concepts: Patterns

- Patterns of change can be used to make predictions.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

- ❶ **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 based on patterns such as cause and effect relationships.**
- ❷ Developing and using models
- ❸ Planning and carrying out investigations
- ❹ Analyzing and interpreting data
- ❺ Using mathematics and computational thinking
- ❻ Constructing explanations (for science) and designing solutions (for engineering)
- ❼ Engaging in argument from evidence
- ❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

3-PS2-3

Students who demonstrate understanding can:

Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.

Clarification Statement:
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.

Assessment Boundary:
Assessment is limited to forces produced by objects that can be manipulated by students, and electrical interactions are limited to static electricity.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-PS2-4 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ **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.

- **Define a simple problem that can be solved through the development of a new or improved object or tool.**

❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

** 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.

Performance Expectations

3-PS2-4
Students who demonstrate understanding can:

Define a simple design problem that can be solved by applying scientific ideas about magnets.*

Clarification Statement:
Examples of problems could include constructing a latch to keep a door shut and creating a device to keep two moving objects from touching each other.

Assessment Boundary:
N/A

Crosscutting Concepts: N/A

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

3-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.

Crosscutting Concepts: Patterns

- Patterns of change can be used to make predictions.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

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

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS3-1 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Inheritance of Traits:
- Many characteristics of organisms are inherited from their parents.

Variation of Traits:
- Different organisms vary in how they look and function because they have different inherited information.

Performance Expectations

3-LS3-1

Students who demonstrate understanding can:

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.

Clarification Statement:
Patterns are the similarities and differences in traits shared between offspring and their parents, or among siblings. Emphasis is on organisms other than humans.

Assessment Boundary:
Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS3-2 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Variation of Traits:
- The environment also affects the traits that an organism develops.

Performance Expectations

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

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS4-1 Biological Unity and Diversity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ **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.** ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Evidence of Common Ancestry and Diversity:** • Some kinds of plants and animals that once lived on Earth are no longer found anywhere. • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**3-LS4-1** *Students who demonstrate understanding can:* **Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.** **Clarification Statement:** 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. **Assessment Boundary:** Assessment does not include identification of specific fossils or present plants and animals. Assessment is limited to major fossil types and relative ages.

Crosscutting Concepts: Scale, Proportion, and Quantity

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS4-2 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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 construct an explanation.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS4-3 Biological Unity and Diversity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ **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.** ❽ Obtaining, evaluating, and communicating information	**Adaptation:** • For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**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

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-LS4-4 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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).
- **Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.**

❽ Obtaining, evaluating, and communicating information

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.

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	Mathematics

Connection to *PASS* Coming Soon

3-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.
- **Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Weather and Climate:
- 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.

Performance Expectations

3-ESS2-1
Students who demonstrate understanding can:

Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.

Clarification Statement:
Examples of data at this grade level could include average temperature, precipitation, and wind direction.

Assessment Boundary:
Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3-ESS2-2 Earth's Systems

Science & Engineering Practices

- ❶ Asking questions (for science) and defining problems (for engineering)
- ❷ Developing and using models
- ❸ Planning and carrying out investigations
- ❹ Analyzing and interpreting data
- ❺ Using mathematics and computational thinking
- ❻ Constructing explanations (for science) and designing solutions (for engineering)
- ❼ Engaging in argument from evidence
- **❽ Obtaining, evaluating, and communicating information**
  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.**

Disciplinary Core Ideas

Weather and Climate:

- Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.

Performance Expectations

3-ESS2-2

Students who demonstrate understanding can:

Obtain and combine information to describe climates in different regions of the world.

Clarification Statement:
N/A

Assessment Boundary:
N/A

Crosscutting Concepts: Patterns

- Patterns of change can be used to make predictions.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

3RD GRADE

3-ESS3-1 Earth and Human Activity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ **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).** • **Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.** ❽ Obtaining, evaluating, and communicating information	**Natural Hazards:** • A variety of natural hazards result from natural processes. • Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.) ** Connections to Engineering, Technology, and Application of Science* **Influence of Engineering, Technology, and Science on Society and the Natural World:** • Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones).	**3-ESS3-1** *Students who demonstrate understanding can:* **Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.*** **Clarification Statement:** Examples of design solutions to weather-related hazards could include barriers to prevent flooding, wind resistant roofs, tornado shelters and lighting rods. **Assessment Boundary:** N/A

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS3-1 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ **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., measurements, observations, patterns) to construct an explanation.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Definitions of Energy:** • The faster a given object is moving, the more energy it possesses.	**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.** **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. **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.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS3-2 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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	Mathematics

Connection to *PASS* Coming Soon

4-PS3-3 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ 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.** ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS3-4 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.
- **Apply scientific ideas to solve design problems.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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

Influence of Engineering, Technology, and Science on Society and the Natural World:
- Engineers improve existing technologies or develop new ones.

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

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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).

Performance Expectations

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.

Clarification Statement:
Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves. Examples of wave patterns could include the vibrating patterns associated with sound; the vibrating patterns of seismic waves produced by earthquakes.

Assessment Boundary:
Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) **❷ 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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Electromagnetic Radiation:** • An object can be seen when light reflected from its surface enters the eyes.	**4-PS4-2** *Students who demonstrate understanding can:* **Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.** **Clarification Statement:** N/A **Assessment Boundary:** Assessment does not include knowledge of specific colors reflected and seen, the cellular mechanisms of vision, or how the retina works.

Crosscutting Concepts: Cause and Effect

- Cause and effect relationships are routinely identified.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Function:

- Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.

Performance Expectations

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.

Clarification Statement:
Examples of structures could include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin.

Assessment Boundary:
Assessment is limited to macroscopic structures within plant and animal systems.

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	Mathematics

Connection to *PASS* Coming Soon

4-LS1-2 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) **❷ 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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**4-LS1-2** *Students who demonstrate understanding can:* **Use a model to describe that animals' receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.** **Clarification Statement:** Emphasis is on systems of information transfer. Examples of response to stimuli include animals running from predators and plant leaves turning toward the sun. **Assessment Boundary:** Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.

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	Mathematics

Connection to *PASS* Coming Soon

4-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ **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.** - **Identify the evidence that supports particular points in an explanation.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**The History of Planet Earth:** - Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. - The presence and location of certain fossil types indicate the order in which rock layers were formed.	**4-ESS1-1** *Students who demonstrate understanding can:* **Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time.** **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. **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.

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-ESS3-1 Earth and Human Activity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence **❽ Obtaining, evaluating, and communicating information** **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.** **• Obtain and combine information from books and other reliable media to explain phenomena.**	**Natural Resources:** • Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. • Some resources are renewable over time, and others are not.	**4-ESS3-1** *Students who demonstrate understanding can:* **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.** **Clarification Statement:** 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. **Assessment Boundary:** N/A

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

4-ESS3-2 Earth and Human Activity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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. (secondary to 4-ESS3-2) ** Connections to Engineering, Technology, and Application of Science* **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.	**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.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS1-1 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS1-2 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.
- **Measure and graph quantities such as weight to address scientific and engineering questions and problems.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.)

Performance Expectations

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS1-3 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.)

Performance Expectations

5-PS1-3

Students who demonstrate understanding can:

Make observations and measurements to identify materials based on their properties.

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.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS1-4 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** • **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Chemical Reactions:** • When two or more different substances are mixed, a new substance with different properties may be formed.	**5-PS1-4** *Students who demonstrate understanding can:* **Conduct an investigation to determine whether the mixing of two or more substances results in new substances.** **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.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ **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).** ❽ Obtaining, evaluating, and communicating information	**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.** **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.

Crosscutting Concepts: Cause and Effect

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-PS3-1 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Energy in Chemical Processes and Everyday Life:
- 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).

Organization of Matter and Energy Flow in Organisms:
- 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.

Performance Expectations

5-PS3-1
Students who demonstrate understanding can:

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.

Clarification Statement:
Examples of models could include diagrams, and flow charts.

Assessment Boundary:
Assessment does not include cellular mechanisms of digestive absorption.

Crosscutting Concepts: Energy and Matter
- Energy can be transferred in various ways and between objects.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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.** ❽ Obtaining, evaluating, and communicating information	**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:* **Support an argument that plants get the materials they need for growth chiefly from air and water.** **Clarification Statement:** Emphasis is on the idea that plant matter comes mostly from air and water, not from the soil.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Interdependent Relationships in Ecosystems:** • 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.	**5-LS2-2** *Students who demonstrate understanding can:* **Use models to explain factors that upset the stability of local ecosystems.** **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. **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	Mathematics

Connection to *PASS* Coming Soon

5-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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).** **• Support an argument with evidence, data, or a model.** ❽ Obtaining, evaluating, and communicating information	**The Universe and Its Stars:** • 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.	**5-ESS1-1** *Students who demonstrate understanding can:* **Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.** **Assessment Boundary:** 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).

Crosscutting Concepts: Scale, Proportion and Quantity
- Natural objects exist from the very small to the immensely large.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-ESS1-2 Earth’s Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.
- **Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

5-ESS1-2

Students who demonstrate understanding can:

Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

Clarification Statement:
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.

Assessment Boundary:
Assessment does not include causes of seasons.

Crosscutting Concepts: Patterns
- Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

5TH GRADE

5-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Clarification Statement:
Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.

Assessment Boundary:
Assessment is limited to the interactions of two systems at a time.

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

5-ESS3-1 Earth and Human Activity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence **❽ Obtaining, evaluating, and communicating information** **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/or other reliable media to explain phenomena or solutions to a design problem.**	**Human Impacts on Earth Systems:** • 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.	**5-ESS3-1** *Students who demonstrate understanding can:* **Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.** **Clarification Statement:** 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. **Assessment Boundary:** N/A

Crosscutting Concepts: System and System Models

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

6-12 Overview

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

❶ Physical Science (PS)
❷ Life Science (LS)
❸ Earth & Space Science (ESS)

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

❶ 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

❷ 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)

❸ 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.

Grade 6	Grade 7	Grade 8
MS-PS1-4	MS-PS1-1	MS-PS1-3
MS-PS2-3	MS-PS1-2	MS-PS1-5
MS-PS2-5	MS-PS2-4	MS-PS1-6
MS-PS3-1	MS-PS3-6	MS-PS2-1
MS-PS3-2	MS-LS1-4	MS-PS2-2
MS-PS3-3	MS-LS1-5	MS-PS4-1
MS-PS3-4	MS-LS1-8	MS-PS4-2
MS-LS1-1	MS-LS3-1	MS-PS4-3
MS-LS1-2	MS-LS3-2	MS-LS1-7
MS-LS1-3	MS-LS4-3	MS-LS4-1
MS-LS1-6	MS-LS4-4	MS-LS4-2
MS-LS2-1	MS-LS4-5	MS-ESS1-4
MS-LS2-2	MS-LS4-6	MS-ESS2-1
MS-LS2-3	MS-ESS1-1	MS-ESS2-2
MS-LS2-4	MS-ESS1-2	MS-ESS2-3
MS-LS2-5	MS-ESS1-3	MS-ESS3-1
MS-ESS2-4	MS-ESS2-5	MS-ESS3-2
MS-ESS3-3	MS-ESS2-6	MS-ESS3-4

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).

Physical Science	Chemistry	Physics
HS-PS1-1	HS-PS1-1	HS-PS1-8
HS-PS1-2	HS-PS1-2	HS-PS2-1
HS-PS1-5	HS-PS1-3	HS-PS2-2
HS-PS1-7	HS-PS1-4	HS-PS2-3
HS-PS2-1	HS-PS1-5	HS-PS2-4
HS-PS2-2	HS-PS1-6	HS-PS2-5
HS-PS2-3	HS-PS1-7	HS-PS3-1
HS-PS2-5	HS-PS1-8	HS-PS3-2
HS-PS3-1	HS-PS2-6	HS-PS3-3
HS-PS3-2	HS-PS3-3	HS-PS3-4
HS-PS3-3	HS-PS3-4	HS-PS3-5
HS-PS3-4	HS-PS4-1	HS-PS4-1
HS-PS4-1	HS-PS4-3	HS-PS4-2
HS-PS4-2		HS-PS4-3
HS-PS4-4		HS-PS4-4
		HS-PS4-5

MS-PS1-4 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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	Disciplinary Core Ideas	Performance Expectations
❶ 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.** ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Types of Interactions:** • Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	**MS-PS2-3** *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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS2-5 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Types of Interactions:** • Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively).	**MS-PS2-5** *Students who demonstrate understanding can:* **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.

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-PS3-1 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

MS-PS3-2 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS3-3 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ 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:
- 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.

Performance Expectations

MS-PS3-3

Students who demonstrate understanding can:

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

Clarification Statement:
Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup. Care should be taken with devices that concentrate significant amounts of energy, e.g. conduction, convection, and/or radiation.

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

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS3-4 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models **❸ 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.** **• Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Structure and Function:** • All living things are made up of cells, which is the smallest unit that can be said to be alive. • An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular).	**MS-LS1-1** *Students who demonstrate understanding can:* **Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.** **Clarification Statement:** Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living cells, and understanding that living things may be made of one cell or many and varied cells. **Assessment Boundary:** Assessments should provide evidence of students' abilities to identify evidence that living things are made of cells and distinguish between living and nonliving cells.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-2 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Structure and Function:** • Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.	**MS-LS1-2** *Students who demonstrate understanding can:* **Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** **Clarification Statement:** Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall. Other organelles should be introduced while covering this concept. **Assessment Boundary:** Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-3 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **Engaging in argument from evidence**
Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).
- **Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Function:

- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Performance Expectations

MS-LS1-3

Students who demonstrate understanding can:

Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.

Clarification Statement:
Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.

Assessment Boundary:
Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-6 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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. **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.	**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.

Crosscutting Concepts: Energy and Matter

- Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ **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 predict phenomena.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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).

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **Developing and using models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.** • **Develop a model to describe phenomena.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Cycle of Matter and Energy Transfer in Ecosystems:** • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. • Transfers of matter into and out of the physical environment occur at every level. • Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. • The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	**MS-LS2-3** *Students who demonstrate understanding can:* **Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.** **Clarification Statement:** Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system. **Assessment Boundary:** Assessment does not include the use of chemical reactions to describe the processes.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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.** ❽ Obtaining, evaluating, and communicating information	**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

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **Engaging in argument from evidence**

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

- **Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.**

❽ Obtaining, evaluating, and communicating information

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:
(secondary to MS-LS2-5)

- 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.

Developing Possible Solutions:
(secondary to MS-LS2-5)

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

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

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

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

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

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS2-4 Earth's Systems

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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.

Crosscutting Concepts: Energy and Matter

- Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS3-3 Earth and Human Activity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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 principles to design an object, tool, process or system.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Human Impacts on Earth Systems:

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.
- 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.

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

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

- 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.

Performance Expectations

MS-ESS3-3

Students who demonstrate understanding can:

Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.*

Clarification Statement:
Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).

Crosscutting Concepts: Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS1-1 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

MS-PS1-2 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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-PS1-2
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.

Clarification Statement:
Analyze characteristic chemical and physical properties of pure substances. Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with HCl.

Assessment Boundary:
Assessment is limited to analysis of the following properties: color change, formation of a gas, temperature change, density, melting point, boiling point, solubility, flammability, and odor.

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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.** ❽ Obtaining, evaluating, and communicating information	**Types of Interactions:** • Gravitational forces are always attractive. • There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.	**MS-PS2-4** *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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS3-6 Energy

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ **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 worlds.** • **Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.** ❽ Obtaining, evaluating, and communicating information	**Conservation of Energy and Energy Transfer:** • When the motion energy of an object changes, there is inevitably some other change in energy at the same time.	**MS-PS3-6** *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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-4 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ Engaging in argument from evidence** **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).** **• Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.** ❽ Obtaining, evaluating, and communicating information	**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.	**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	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-5 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Growth and Development of Organisms:

- Genetic factors as well as local conditions affect the growth of the adult plant.

Performance Expectations

MS-LS1-5

Students who demonstrate understanding can:

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

Clarification Statement:
Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.

Assessment Boundary:
Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.

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	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-8 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **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

Information Processing:

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories.

Performance Expectations

MS-LS1-8

Students who demonstrate understanding can:

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Clarification Statement:
N/A

Assessment Boundary:
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.

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Inheritance of Traits:

- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual.
- Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.

Variation of Traits:

- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations.
- Though rare, mutations may result in changes to the structure and function of proteins.
- Some changes are beneficial, others harmful, and some neutral to the organism.

Performance Expectations

MS-LS3-1

Students who demonstrate understanding can:

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Clarification Statement:
Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins. Examples: Radiation treated plants, genetically modified organisms (e.g. roundup resistant crops, bioluminescence), mutations both harmful and beneficial.

Assessment Boundary:
Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.

Crosscutting Concepts: Structure and Function

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS3-2 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations **❹ 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.** ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Evidence of Common Ancestry and Diversity:** • Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.	**MS-LS4-3** *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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS4-4 Biological Unity and Diversity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Natural Selection:** • Natural selection leads to the predominance of certain traits in a population, and the suppression of others.	**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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS4-5 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **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.

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* *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-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	Mathematics

Connection to *PASS* Coming Soon

MS-LS4-6 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **Using mathematics and computational thinking**
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.
- **Use mathematical representations to support scientific conclusions and design solutions.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Adaptation:

- Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions.
- Traits that support successful survival and reproduction in the new environment become more common; those that do not, become less common. Thus, the distribution of traits in a population changes.

Performance Expectations

MS-LS4-6

Students who demonstrate understanding can:

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Clarification Statement:
Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.

Assessment Boundary:
The assessment should provide evidence of students' abilities to explain trends in data for the number of individuals with specific traits changing over time. Assessment does not include Hardy Weinberg calculations.

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	Mathematics

Connection to *PASS* Coming Soon

MS-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices

- ❶ Asking questions (for science) and defining problems (for engineering)
- ❷ **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.**
- ❸ Planning and carrying out investigations
- ❹ Analyzing and interpreting data
- ❺ Using mathematics and computational thinking
- ❻ Constructing explanations (for science) and designing solutions (for engineering)
- ❼ Engaging in argument from evidence
- ❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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.

Performance Expectations

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.

Clarification Statement:
Earth's rotation relative to the positions of the moon and sun describes the occurrence of tides; the revolution of Earth around the sun explains the annual cycle of the apparent movement of the constellations in the night sky; the moon's revolution around Earth explains the cycle of spring/neap tides and the occurrence of eclipses; the moon's elliptical orbit mostly explains the occurrence of total and annular eclipses. Examples of models can be physical, graphical, or conceptual.

Assessment Boundary:
N/A

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS1-2 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS1-3 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **Analyzing and interpreting data**
Analyzing data in 6–8 builds on K–5 experiences and progresses to e xtending 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS2-5 Earth's Systems

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Weather and Climate:** - Because these patterns are so complex, weather can only be predicted probabilistically.	**MS-ESS2-5** *Students who demonstrate understanding can:* **Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.** **Clarification Statement:** Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation). **Assessment Boundary:** Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.

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-ESS2-6 Earth’s Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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.

Performance Expectations

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.

Clarification Statement:
Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation (e.g. el niño/la niña) is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.

Assessment Boundary:
Assessment does not include the dynamics of the Coriolis effect.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS1-3 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **Obtaining, evaluating, and communicating information**

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 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

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.

** 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.

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-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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS1-5 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena:
- Laws are regularities or mathematical descriptions of natural phenomena.

Performance Expectations

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.

Clarification Statement:
Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.

Assessment Boundary:
Assessment does not include the use of atomic masses or intermolecular forces.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS1-6 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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 an object, tool, process or system.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

MS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Waves Properties:** • A sound wave needs a medium through which it is transmitted. **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.	**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.** **Clarification Statement:** Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions. **Assessment Boundary:** Assessment is limited to qualitative applications pertaining to light and mechanical waves.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

- ❶ Asking questions (for science) and defining problems (for engineering)
- ❷ Developing and using models
- ❸ Planning and carrying out investigations
- ❹ Analyzing and interpreting data
- ❺ Using mathematics and computational thinking
- ❻ Constructing explanations (for science) and designing solutions (for engineering)
- ❼ Engaging in argument from evidence
- ❽ **Obtaining, evaluating, and communicating information**

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.**

Disciplinary Core Ideas

Information Technologies and Instrumentation:

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

Performance Expectations

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.*

Clarification Statement:
Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.

Assessment Boundary:
Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.

Crosscutting Concepts: Structure and Function

- Structures can be designed to serve particular functions.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS1-7 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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:** (secondary to MS-LS1-7) • Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials.	**MS-LS1-7** *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.

Crosscutting Concepts: Energy and Matter

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-LS4-1 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **Analyzing and interpreting data**
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- **Analyze and interpret data to determine similarities and differences in findings.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Clarification Statement:
Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.

Assessment Boundary:
Assessment does not include the names of individual species or geological eras in the fossil record.

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
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MS-LS4-2 Biological Unity and Diversity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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	Mathematics

Connection to *PASS* Coming Soon

MS-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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	Mathematics

Connection to *PASS* Coming Soon

MS-ESS2-3 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Crosscutting Concepts: Patterns

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS3-1 Earth and Human Activity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

MS-ESS3-2 Earth and Human Activity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

MS-ESS3-4 Earth and Human Activity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **Engaging in argument from evidence**
Engaging in argument form 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 solution to a problem.**

❽ Obtaining, evaluating, and communicating information

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.

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

HS-PS1-1 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-5 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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.

Clarification Statement:
Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.

Assessment Boundary:
Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature and concentration.

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-PS1-7 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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 support claims.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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 (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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ **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.** ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Forces and Motion:** • Newton's second law accurately predicts changes in the motion of macroscopic objects.	**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

HS-PS2-2 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ **Using mathematical 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.** ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

HS-PS2-3 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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. **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.	**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.

Crosscutting Concepts: Cause and Effect

- Systems can be designed to cause a desired effect.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-5 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Crosscutting Concepts: Cause and Effect

- Systems can be designed to cause a desired effect.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

PHYSICAL SCIENCE

HS-PS3-1 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS3-2 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ 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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS3-3 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ **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.** ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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

HS-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ 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.**

❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

** 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-PS4-2

Students who demonstrate understanding can:

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

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-4 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ **Obtaining, evaluating, and communicating information** **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.**	**Electromagnetic Radiation:** • When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). • Shorter wavelength electromagnetic radiation (ultraviolet, X-ray s, gamma rays) can ionize atoms and cause damage to living cells. • Photoelectric materials emit electrons when they absorb light of a high-enough frequency.	**HS-PS4-4** *Students who demonstrate understanding can:* **Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.** **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. **Assessment Boundary:** Assessment is limited to qualitative descriptions.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-1 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) **❷ 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.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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/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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-3 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Structure and Properties of Matter:** • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.	**HS-PS1-3** *Students who demonstrate understanding can:* **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.** **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. **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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-4 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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-PS1-4

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.

Clarification Statement:
Emphasis is on the idea that a chemical reaction is a system that affects the energy change. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved.

Assessment Boundary:
N/A

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-PS1-5 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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.

Clarification Statement:
Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules.

Assessment Boundary:
Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.

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-PS1-6 Matter and Its Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** **• Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Chemical Reactions:** • 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. **Optimizing the Design Solution:** • 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.	**HS-PS1-6** *Students who demonstrate understanding can:* **Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*** **Clarification Statement:** Emphasis is on the application of Le Chatlier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants or removing products. **Assessment Boundary:** Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-7 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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 support claims.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

Connection to *PASS* Coming Soon

HS-PS1-8 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **Obtaining, evaluating, and communicating information**

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.

- **Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).**

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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS3-3 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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:
(secondary to HS-PS3-3)

- 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.

** 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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ 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.**

❽ Obtaining, evaluating, and communicating information

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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS1-8 Matter and Its Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-1 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-2 Motion and Stability: Forces and Interactions

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data **❺ 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.** ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-3 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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-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.

Crosscutting Concepts: Cause and Effect

- Systems can be designed to cause a desired effect.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-4 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **Using mathematical 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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS2-5 Motion and Stability: Forces and Interactions

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

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

HS-PS3-1 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

Connection to *PASS* Coming Soon

HS-PS3-2 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS3-3 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS3-5 Energy

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ 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.

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..

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-1 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ 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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

HS-PS4-2 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ 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.**

❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

** 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-PS4-2

Students who demonstrate understanding can:

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

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-3 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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 system at different scales.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-4 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence **❽ Obtaining, evaluating, and communicating information** **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.**	**Electromagnetic Radiation:** • When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). • Shorter wavelength electromagnetic radiation (ultraviolet, X-ray s, gamma rays) can ionize atoms and cause damage to living cells. • Photoelectric materials emit electrons when they absorb light of a high-enough frequency	**HS-PS4-4** *Students who demonstrate understanding can:* **Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electro-magnetic radiation have when absorbed by matter.** **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. **Assessment Boundary:** Assessment is limited to qualitative descriptions.

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 know n about smaller scale mechanisms within the system.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-PS4-5 Waves and Their Applications in Technologies for Information Transfer

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **Obtaining, evaluating, and communicating information**

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.

- **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).**

Disciplinary Core Ideas

Energy in Chemical Processes:
(secondary to HS-PS4-5)

- Solar cells are human-made devices that likewise capture the sun's energy and produce electrical energy.

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.

Electromagnetic Radiation:

- Photoelectric materials emit electrons when they absorb light of a high-enough frequency.

Information Technologies and Instrumentation:

- 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.

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

Interdependence of Science, Engineering, and Technology:

- Modern civilization depends on major technological systems.

Performance Expectations

HS-PS4-5

Students who demonstrate understanding can:

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.*

Clarification Statement: Examples could include solar cells capturing light and converting it to electricity; medical imaging; and communications technology.

Assessment Boundary: Assessments are limited to qualitative information. Assessments do not include band theory

Crosscutting Concepts: Cause and Effect

- Systems can be designed to cause a desired effect.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS1-1 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS1-2 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Function:

- 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.

Performance Expectations

HS-LS1-2

Students who demonstrate understanding can:

Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

Clarification Statement:
Emphasis is on the levels of organization including cells, tissues, organs, and systems of an organism.

Assessment Boundary:
Assessment does not include interactions and functions at the molecular or chemical level.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS1-3 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **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.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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 tool low external temperature, with too little food or water available) the organism cannot survive.	**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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS1-4 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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 based on evidence to illustrate the relationships between systems or between components of a system.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS1-5 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) **❷ 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 based on evidence to illustrate the relationships between systems or between components of a system.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Organization for Matter and Energy Flow in Organisms:** • The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**HS-LS1-5** *Students who demonstrate understanding can:* **Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.** **Clarification Statement:** Emphasis is on illustrating inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, conceptual models, and/or laboratory investigations. **Assessment Boundary:** The assessment should provide evidence of students' abilities to describe the inputs and outputs of photosynthesis, not the specific biochemical steps. (e.g. photosystems, electron transport, and Calvin cycle).

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

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

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-LS1-7 From Molecules to Organisms: Structure and Processes

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ **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 based on evidence to illustrate the relationships between systems or between components of a system.** ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Organization for Matter and Energy Flow in Organisms:** (Builds on HS-LS1-6) • As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. • As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. • 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. • Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment.	**HS-LS1-7** *Students who demonstrate understanding can:* **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.** **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. **Assessment Boundary:** Assessment should not include identification of the steps or specific processes involved in cellular respiration (e.g. glycolysis and Kreb's Cycle).

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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 and/or computational representations of phenomena or design solutions to support explanations.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Interdependent Relationships in Ecosystems:
- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Performance Expectations

HS-LS2-1

Students who demonstrate understanding can:

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Clarification Statement:
Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, or population changes gathered from simulations or historical data sets.

Assessment Boundary:
Assessment does not include deriving mathematical equations to make comparisons.

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

HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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 and revise explanations.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Interdependent Relationships in Ecosystems:
- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

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.

Performance Expectations

HS-LS2-2
Students who demonstrate understanding can:

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Clarification Statement:
Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary:
Assessment is limited to provided data.

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

Connection to *PASS* Coming Soon

HS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ **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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Cycles of Matter and Energy Transfer in Ecosystems:** • Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.	**HS-LS2-3** *Students who demonstrate understanding can:* **Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.** **Clarification Statement:** Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in different environments (e.g., chemosynthetic bacteria, yeast, and muscle cells). **Assessment Boundary:** Assessment does not include the specific chemical processes of either aerobic or anaerobic respiration.

Crosscutting Concepts: Energy and Matter
- Energy drives the cycling of matter within and between systems.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Cycles of Matter and Energy Transfer in Ecosystems:

- Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

Energy in Chemical Processes:
(secondary to HS-LS2-5)

- The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis.

Performance Expectations

HS-LS2-5

Students who demonstrate understanding can:

Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Clarification Statement:
Examples of models could include simulations and mathematical models (e.g., chemical equations that demonstrate the relationship between photosynthesis and cellular respiration.

Assessment Boundary:
Assessment does not include the specific chemical steps of photosynthesis and respiration.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-8 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ 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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Social Interactions and Group Behavior:

- Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.

Performance Expectations

HS-LS2-8

Students who demonstrate understanding can:

Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.

Clarification Statement:
Emphasis is on advantages of grouping behaviors (e.g., flocking, schooling, herding) and cooperative behaviors (e.g., hunting, migrating, swarming) on survival and reproduction.

Assessment Boundary:
The assessment should provide evidence of students' abilities to: (1) distinguish between group versus individual behavior, (2) identify evidence supporting the outcomes of group behavior, and (3) develop logical and reasonable arguments based on evidence.

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

HS-LS3-1 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ **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.
- **Ask question that arise from examining models or a theory to clarify relationships**

❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Structure and Function:
(secondary to HS-LS3-1)
- 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.

Inheritance of Traits:
- Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA.
- The instructions for forming species' characteristics are carried in DNA.
- All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways.
- Not all DNA codes for protein, some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known functions.

Performance Expectations

HS-LS3-1
Students who demonstrate understanding can:

Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Clarification Statement:
Emphasis should be on asking questions and making predictions to obtain reliable information about the role of DNA and chromosomes in coding the instructions for traits (e.g., pedigrees, karyotypes, genetic disorders, Punnett squares).

Assessment Boundary:
Assessments may include codominance, incomplete dominance, and sex-linked traits, but should not include dihybrid crosses.

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

HS-LS3-2 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Clarification Statement:
Emphasis is on using data to support arguments for the way variation occurs.

Assessment Boundary:
Assessment does not include the phases of meiosis or the biochemical mechanisms of specific steps in the process.

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

HS-LS3-3 Heredity: Inheritance and Variation of Traits

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations **❹ 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.** **• 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.** ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Variation of Traits:** • 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 observed depends on both genetic and environmental factors.	**HS-LS3-3** *Students who demonstrate understanding can:* **Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.** **Clarification Statement:** Emphasis is on distribution and variation of traits in a population and the use of mathematics (e.g., calculations of frequencies in Punnett squares, graphical representations) to describe the distribution. **Assessment Boundary:** The assessment should provide evidence of students' abilities to use mathematical reasoning to explain the variation observed in a population as a combination of genetic and environmental factors. Hardy-Weinberg calculations are beyond the intent.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS4-1 Biological Unity and Diversity

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ **Analyzing and interpreting data** **Analyzing data in 9-12 builds on K-8 experiences and progress to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.** • **Analyze and interpret data to determine similarities and differences in findings.** ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**Evidence of Common Ancestry and Diversity:** • 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.	**HS-LS4-1** *Students who demonstrate understanding can:* **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.** **Clarification Statement:** Emphasis is on identifying sources of scientific evidence. **Assessment Boundary:** The assessment should provide evidence of students' abilities to evaluate and analyze evidence (e.g. cladograms, analogous/homologous structures, and fossil records).

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-LS4-2 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

HS-LS4-2

Students who demonstrate understanding can:

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.

Clarification Statement:
Emphasis is on using evidence to explain the influence each of the four factors has on number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.

Assessment Boundary:
Assessment does not include genetic drift, gene flow through migration, and co-evolution.

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

HS-LS4-3 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.
- **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.
- The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population.

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.
- Adaptation also means that the distribution of traits in a population can change when conditions change.

Performance Expectations

HS-LS4-3

Students who demonstrate understanding can:

Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

Clarification Statement:
Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations for adaptations.

Assessment Boundary:
The assessment should provide evidence of students' abilities to analyze shifts in numerical distribution of traits as evidence to support explanations. Analysis is limited to basic statistical and graphical analysis, not gene frequency calculations.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS4-4 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS4-5 Biological Unity and Diversity

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ 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.**

❽ 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.

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

HS-ESS1-1 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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

HS-ESS1-2 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

HS-ESS1-3 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ **Obtaining, evaluating, and communicating information**

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.

- **Communicate scientific (e.g. about phenomena and/or the process of development and the design and performance of a proposed process of system) in multiple formats (including orally, graphically, textually, and mathematically).**

Disciplinary Core Ideas

The Universe and Its Stars:

- The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.
- Other than the hydrogen and helium, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy.
- Heavier elements are produced when certain massive stars achieve a supernova stage and explode.

Performance Expectations

HS-ESS1-3

Students who demonstrate understanding can:

Communicate scientific ideas about the way stars, over their life cycle, produce elements.

Clarification Statement:
Emphasis is on the way nucleosynthesis, and therefore the different elements created, depend on the mass of a star and the stage of its lifetime.

Assessment Boundary:
Details of the many different nucleosynthesis pathways for stars of differing masses are not assessed.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS1-4 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**
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 and revise 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

Earth and the Solar System:
- Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system.

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

Interdependence of Science, Engineering, and Technology:
- Science and engineering compliment each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

Performance Expectations

HS-ESS1-4

Students who demonstrate understanding can:

Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

Clarification Statement:
Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons. (e.g. graphical representations of orbits)

Assessment Boundary:
Mathematical representations for the gravitational attraction of bodies and Kepler's Laws of orbital motions should not deal with more than two bodies, nor involve calculus.

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

HS-ESS1-5 Earth's Place in the Universe

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.
- **Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Plate Tectonics and Large-Scale System Interactions:
- 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.

Performance Expectations

HS-ESS1-5

Students who demonstrate understanding can:

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.

Clarification Statement:
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).

Assessment Boundary:
N/A

Crosscutting Concepts: Stability and Change
- Much of science deals with constructing explanations of how things change and how they remain stable.

Oklahoma Academic Standards Connections

ELA/Literacy | **Mathematics**

Connection to *PASS* Coming Soon

HS-ESS1-6 Earth's Place in the Universe

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking **❻ 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.** ❼ Engaging in argument from evidence ❽ Obtaining, evaluating, and communicating information	**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.	**HS-ESS1-6** *Students who demonstrate understanding can:* **Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.** **Clarification Statement:** Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth. Examples of evidence include materials obtained through space exploration, radiometric dating of meteorites and Earth's oldest minerals, the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ 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, erosion, and mass wasting).

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

- 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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

HS-ESS2-3 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth Materials and Systems:
- 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.
- 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.

Plate Tectonics and Large-Scale System Interactions:
- 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.
- Plate tectonics can be viewed as the surface expression of mantle convection.

Waves Properties:
(secondary to HS-ESS2-3)
- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.

Performance Expectations

HS-ESS2-3

Students who demonstrate understanding can:

Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Clarification Statement:
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.

Assessment Boundary:
N/A

Crosscutting Concepts: Energy and Matter
- Energy drives the cycling of matter within and between systems.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-4 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

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

HS-ESS2-5 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **Planning and carrying out investigations**
Planning and carrying out investigations in 9-12 builds on 6-8 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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

The Role of Water in Earth's Surface Processes:
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

Performance Expectations

HS-ESS2-5

Students who demonstrate understanding can:

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Clarification Statement:
Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).

Assessment Boundary:
N/A

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-6 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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

Crosscutting Concepts: Energy and Matter

- The total amount of energy and matter in closed systems is conserved.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-7 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Weather and Climate:
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

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.

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.

Crosscutting Concepts: Stability and Change
- Much of science deals with constructing explanations of how things change and how they remain stable.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-1 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ 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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-2 Earth and Human Activities

Science & Engineering Practices	Disciplinary Core Ideas	Performance Expectations
❶ Asking questions (for science) and defining problems (for engineering) ❷ Developing and using models ❸ Planning and carrying out investigations ❹ Analyzing and interpreting data ❺ Using mathematics and computational thinking ❻ Constructing explanations (for science) and designing solutions (for engineering) **❼ 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).** ❽ Obtaining, evaluating, and communicating information	**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. **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.	**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, forestry, and mining. **Assessment Boundary:** N/A

Crosscutting Concepts: Cause and Effect

- N/A

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-5 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Clarification Statement:
Emphasis is on how geological processes have led to geological sedimentary basins that provide significant accumulations of crude oil and natural gas in some areas and not others and how geological processes lead to diverse soil profiles that support a diversity and range of agricultural crops and how plate-tectonics leads to concentrations of mineral deposits.

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	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-1 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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 and/or computational representations of phenomena or design solutions to support explanations.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Interdependent Relationships in Ecosystems:
- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.
- These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.
- This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

Performance Expectations

HS-LS2-1

Students who demonstrate understanding can:

Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

Clarification Statement:
Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate and competition. Examples of mathematical comparisons could include graphs, charts, histograms, or population changes gathered from simulations or historical data sets.

Assessment Boundary:
Assessment does not include deriving mathematical equations to make comparisons.

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

HS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

- ❶ Asking questions (for science) and defining problems (for engineering)
- ❷ Developing and using models
- ❸ Planning and carrying out investigations
- ❹ Analyzing and interpreting data
- ❺ **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 and revise explanations.**
- ❻ Constructing explanations (for science) and designing solutions (for engineering)
- ❼ Engaging in argument from evidence
- ❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Interdependent Relationships in Ecosystems:

- Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support.
- These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease.
- Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite.
- This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.

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.

Performance Expectations

HS-LS2-2

Students who demonstrate understanding can:

Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Clarification Statement:
Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.

Assessment Boundary:
The assessments should provide evidence of students' abilities to analyze and interpret the effect new information has on explanations (e.g., DDT effects on raptor populations, effects of water temperature below reservoirs on fish spawning, invasive species effects when spread to larger scale).

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

Connection to *PASS* Coming Soon

HS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-LS2-6 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

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.

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ 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:
(secondary to HS-LS2-7)
- 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

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-1 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ 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
- 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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-2 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ **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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-3 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)

❷ **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.**

❸ Planning and carrying out investigations

❹ Analyzing and interpreting data

❺ Using mathematics and computational thinking

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

❼ Engaging in argument from evidence

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Earth Materials and Systems:

- 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.
- 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.

Plate Tectonics and Large-Scale System Interactions:

- 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.
- Plate tectonics can be viewed as the surface expression of mantle convection.

Waves Properties:
(secondary to HS-ESS2-3)

- Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet.

Performance Expectations

HS-ESS2-3

Students who demonstrate understanding can:

Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.

Clarification Statement:
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 identification of the composition of Earth's layers from high-pressure laboratory experiments.

Assessment Boundary:
N/A

Crosscutting Concepts: Energy and Matter

- Energy drives the cycling of matter within and between systems.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-4 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ 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.**

❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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, and maps of global and regional temperatures, and atmospheric levels of gases.

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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-5 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ **Planning and carrying out investigations**
Planning and carrying out investigations in 9-12 builds on 6-8 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.**

❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

The Role of Water in Earth's Surface Processes:
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

Performance Expectations

HS-ESS2-5

Students who demonstrate understanding can:

Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Clarification Statement:
Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).

Assessment Boundary:
N/A

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

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-6 Earth's Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ **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.**

❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS2-7 Earth’s Systems

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ **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.**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

Weather and Climate:
- Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen.

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.

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.

Crosscutting Concepts: Stability and Change

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

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-1 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-2 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ 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).**

❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

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.

Performance Expectations

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

Crosscutting Concepts:

- N/A

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

K-2
3-5
6-8
9-12

HS-ESS3-3 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ **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, design device, process or system.**

❻ Constructing explanations (for science) and designing solutions (for engineering)
❼ Engaging in argument from evidence
❽ 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.

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	Mathematics

Connection to *PASS* Coming Soon

HS-ESS3-4 Earth and Human Activities

Science & Engineering Practices

❶ Asking questions (for science) and defining problems (for engineering)
❷ Developing and using models
❸ Planning and carrying out investigations
❹ Analyzing and interpreting data
❺ Using mathematics and computational thinking
❻ **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.**

❼ Engaging in argument from evidence
❽ Obtaining, evaluating, and communicating information

Disciplinary Core Ideas

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.

Performance Expectations

HS-ESS3-4

Students who demonstrate understanding can:

Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems.*

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.

Assessment Boundary:
N/A

Crosscutting Concepts: Stability and Change

- Feedback (negative or positive) can stabilize or destabilize a system.

Oklahoma Academic Standards Connections

ELA/Literacy	Mathematics

Connection to *PASS* Coming Soon

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