ARKANSAS
K-12 SCIENCE STANDARDS

EDUCATION FOR A NEW GENERATION

Grades 5-8

2015

Re-aligned Fall 2016 to the Arkansas Mathematics Standards, Arkansas English Language Arts Standards, and Arkansas Disciplinary Literacy Standards

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How to Read
Arkansas K-12 Science Standards

Topic

An asterisk indicates an engineering connection to a practice or disciplinary core idea.

GRADE TWO

Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

2-LS2-1. Plan and conduct an investigation to determine if pl… …ater to grow. [Assessment Boundary: Assessment is limited to testing one variab…]

2-LS2-2. Develop a simple model that mimics the function o… …eeds or pollinating plants. *

2-LS4-1. Make observations of plants and animals to compa… …fferent habitats. [Clarification Statement: Emphasis is on the diversity of living thing… …] [Assessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]

Student Performance Expectations (PEs)

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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, or storyboard) that represent concrete events or design solutions. ▪ Develop a simple model based on evidence to represent a proposed object or tool. (2-LS2-2) **Planning and Carrying Out Investigations** 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 an investig… collaboratively to produce da… as the basis for evidence to a… question. (2-LS2-1) ▪ Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1) --- **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** ▪ Scientists look for patterns and order when making observations about the world. (2-LS4-1)	**LS2.A: Interdependent Relationships in Ecosystems** ▪ Plants depend on water and light to grow. (2-LS2-1) ▪ Plants depend on animals for pollination or to move their seeds around. (2-LS2-2) **LS4.D: 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. (2-LS4-1) **ETS1.B: 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. (2-LS2-2) ▪	**Cause and Effect** ▪ Events have causes that generate observable patterns. (2-LS2-1) **Structure and Function** ▪ The shape and stability of structures of natural and designed objects are related to their function(s). (2-LS2-2)

Designates which PE uses this practice

Designates which PE incorporates this disciplinary core idea (DCI)

Designates which PE incorporates this crosscutting concept (CC)

Connections to the Nature of Science

DCI codes from *A Framework for K-12 Science Education* in boldface type.

Connections to other DCIs in second grade: N/A

Connections to other DCIs across grade levels: **K.LS1.C** (2-LS2-1); **K-ESS3.A** (2-LS2-1); **K-2.ETS1.A** (2-LS2-2); **3.LS4.C** (2-LS4-1); **3.LS4.D** (2-LS4-1); **5.LS1.C** (2-LS2-1); **5.LS2.A** (2-LS2-2, 2-LS4-1)

Connections to the Arkansas English Language Arts and Mathematics Standards are often found by scrolling to the next page

Arkansas K-12 Science Standards Overview

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

As part of teaching the Arkansas K-12 Science Standards, it will be important to instruct and guide students in adopting appropriate safety precautions for their student-directed science investigations. Reducing risk and preventing accidents in science classrooms begin with planning. The following four steps are recommended in carrying out a hazard and risk assessment for any planned lab investigation:

1) Identify all hazards. Hazards may be physical, chemical, health, or environmental.
2) Evaluate the type of risk associated with each hazard.
3) Write the procedure and all necessary safety precautions in such a way as to eliminate or reduce the risk associated with each hazard.
4) Prepare for any emergency that might arise in spite of all of the required safety precautions.

According to Arkansas Code Annotated § 6-10-113 (2012) for eye protection, every student and teacher in public schools participating in any chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids is required to wear industrial-quality eye protective devices (eye goggles) at all times while participating in science investigations.

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

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

Science and Engineering Practices

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

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

Crosscutting Concepts

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

1. *Patterns*- Observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them.

2. *Cause and effect- Mechanism and explanation*. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
3. *Scale, proportion, and quantity*- In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
4. *Systems and system models*- Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.
5. *Energy and matter: Flows, cycles, and conservation*- Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
6. *Structure and function*- The way in which an object or living thing is shaped and its substructure determines many of its properties and functions.
7. *Stability and change*- For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Disciplinary Core Ideas

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

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

Connections to the Arkansas English Language Arts Standards

Evidence-based reasoning is the foundation of good scientific practice. The Arkansas K-12 Science Standards incorporate reasoning skills used in language arts to help students improve mastery and understanding in all three disciplines. The Arkansas K-8 Science Committee made every effort to align grade-by-grade with the English language arts (ELA) standards so concepts support what students are learning in their entire curriculum. Connections to specific ELA standards are listed for each student performance expectation, giving teachers a blueprint for building comprehensive cross-disciplinary lessons.

The intersections between Arkansas K-12 Science Standards and Arkansas ELA Standards teach students to analyze data, model concepts, and strategically use tools through productive talk and shared activity. Reading in science requires an appreciation of the norms and conventions of the discipline of science, including understanding the nature of evidence used, an attention to precision and detail, and the capacity to make and assess intricate arguments, synthesize complex information, and follow detailed procedures and accounts of events and concepts. These practice-based standards help teachers foster a classroom culture where students think and reason together, connecting around the subject matter and core ideas.

Connections to the Arkansas Disciplinary Literacy Standards

Reading is critical to building knowledge in science. College and career ready reading in science requires an appreciation of the norms and conventions of each discipline, such as the kinds of evidence used in science; an understanding of domain-specific words and phrases; an attention to precise details; and the capacity to evaluate intricate arguments, synthesize complex information, and follow detailed descriptions of events and concepts. When reading scientific and technical texts, students need to be able to gain knowledge from challenging texts that often make extensive use of elaborate diagrams and data to convey information and illustrate concepts. Students must be able to read complex informational texts in science with independence and confidence because the vast majority of reading in college and workforce training programs will be sophisticated nonfiction.

For students, writing is a key means of asserting and defending claims, showing what they know about science, and conveying what they have experienced, imagined, thought, and felt. To be college and career ready writers, students must take task, purpose, and audience into careful consideration, choosing words, information, structures, and formats deliberately. They need to be able to use technology strategically when creating, refining, and collaborating on writing. They have to become adept at gathering information, evaluating sources, and citing material accurately, reporting finds from their research and analysis of sources in a clear and cogent manner. They must have the flexibility, concentration, and fluency to produce high-quality first-draft text under a tight deadline and the capacity to revisit and make improvements to a piece of writing over multiple drafts when circumstances encourage or require it.

Connections to the Arkansas Mathematics Standards

Science is a quantitative discipline, so it is important for educators to ensure that students' science learning coheres well with their understanding of mathematics. To achieve this alignment, the Arkansas K-12 Science Committee made every effort to ensure that the mathematics standards do not outpace or misalign to the grade-by-grade science standards. Connections to specific math standards are listed for each student performance expectation, giving teachers a blueprint for building comprehensive cross-disciplinary lessons.

Table below lists key topics relevant to science and the grades at which topics are first expected in the Arkansas Mathematics Standards.

Number and Operations	**Grade First Expected**
The coordinate plane	5
Ratios, rates (e.g. speed), proportional relationships	6
Simple percent problems	6
Rational number system/signed numbers-concepts	6
Rational number system/signed numbers-arithmetic	7
Measurement	**Grade First Expected**
Convert units within a given measurement system	5
Volume	5
Convert units across measurement systems (e.g. inches to cm)	6
Statistics and Probability	**Grade First Expected**
Statistical distributions (including center, variation, clumping, outliers, mean, median, mode, range, quartiles), and statistical association or trends (including two-way tables, bivariate measurement data, scatter plots, trend line, line of best fit, correlation)	6-8
Probability, including chance, likely outcomes, probability models	7

Grades 5-8 Science Core Ideas and Topics Overview

Grade 5	PHYSICAL SCIENCES	LIFE SCIENCES	EARTH and SPACE SCIENCES	
	5. Structure and Properties of Matter	5. Matter and Energy in Organisms and Ecosystems	5. Earth's Systems	5. Space Systems
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE 5. Engineering Design				

Grade 6	PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES		
	6. Energy	6. Structure, Function, and Information Processing	6. Growth, Development, and Reproduction of Organisms	6. Earth's Systems	6. Human Impacts	6. Weather and Climate

Grade 7	PHYSICAL SCIENCES		LIFE SCIENCES		EARTH and SPACES SCIENCES		
	7. Structure and Properties of Matter	7. Chemical Reactions	7. Interdependent Relationships in Ecosystems	7. Matter and Energy in Organisms and Ecosystems	7. Earth's Systems	7. History of Earth	7. Human Impacts

Grade 8	PHYSICAL SCIENCES		LIFE SCIENCES		EARTH and SPACES SCIENCES		
	8. Waves and Electromagnetic Radiation	8. Forces and Interactions	8. Growth, Development, and Reproduction of Organisms	8. Natural Selection and Adaptations	8. Energy	8. Space Systems	8. History of Earth
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE 6-8. Engineering Design							

Science Grades 5-8 Overview

The Arkansas K-12 Science Standards for Grades 5-8 is a curriculum framework of grade level student performance expectations based on the core ideas of the physical sciences (PS), life sciences (LS), earth and space sciences (ESS), and engineering (ETS) from *A Framework for K-12 Science Education* (NRC 2012). The performance expectations build logically from Grades K-4 to Grades 5-8. The performance expectations clarify what students need to know and be able to do at the end of each grade. Student performance expectations consist of three dimensions: science and engineering practices, disciplinary core ideas, and crosscutting concepts. Engineering performance expectations are meant to be integrated into science instruction to support the learning of science phenomena at all levels from Kindergarten to Grade 12.

As part of teaching the Arkansas K-12 Science Standards, it will be important to instruct and guide students in adopting appropriate safety precautions for their student-directed science investigations. Reducing risk and preventing accidents in science classrooms begin with planning. There are four recommended steps in carrying out a hazard and risk assessment for any planned lab investigation.

1) Identify all hazards. Hazards may be physical, chemical, health, or environmental.
2) Evaluate the type of risk associated with each hazard.
3) Write the procedure and all necessary safety precautions in such a way as to eliminate or reduce the risk associated with each hazard.
4) Prepare for any emergency that might arise in spite of all of the required safety precautions.

According to Arkansas Code Annotated § 6-10-113 (2012) for eye protection, every student and teacher in public schools participating in any chemical or combined chemical-physical laboratories involving caustic or explosive chemicals or hot liquids or solids is required to wear industrial-quality eye protective devices (eye goggles) at all times while participating in science investigations.

Notes:

1. Student Performance Expectations (PEs) may be taught in any sequence or grouping within a grade level.
2. An asterisk (*) indicates an engineering connection to a practice, core idea, or crosscutting concept.
3. The Clarification Statements are examples and additional guidance for the instructor. **AR** indicates Arkansas-specific Clarification Statements.
4. The Assessment Boundaries delineate content that may be taught but not assessed in large-scale assessments. **AR** indicates Arkansas-specific Assessment Boundaries.
5. The examples given (e.g.,) are suggestions for the instructor.
6. Throughout this document, connections are provided to the nature of science as defined by *A Framework for K-12 Science Education* (NRC 2012).
7. Throughout this document, connections are provided to Engineering, Technology, and Applications of Science as defined by *A Framework for K-12 Science Education* (NRC 2012).
8. Each set of PEs lists connections to other disciplinary core ideas (DCIs) within the Arkansas K-12 Science Standards and to the Arkansas Mathematics Standards, Arkansas English Language Arts Standards, and Arkansas Disciplinary Literacy Standards.

Grade 5 Learning Progression by Topic

Grade 5			
EARTH and SPACE SCIENCES		PHYSICAL SCIENCES	LIFE SCIENCES
Earth's Systems	Space Systems	Structure and Properties of Matter	Matter and Energy in Organisms and Ecosystems
5-ESS2-1	5-PS2-1	5-PS1-1	5-PS3-1
5-ESS2-2	5-ESS1-1	5-PS 1-2**AR**	5-LS1-1
5-ESS3-1	5-ESS1-2	5-PS1-3	5-LS2-1
		5-PS1-4**AR**	
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 5-ETS1-1, 5-ETS1-2, 5-ETS1-3			

Arkansas Clarification Statement/Assessment Boundary (**AR**)

Grade 5 Learning Progression by Disciplinary Core Idea

Grade 5							
EARTH and SPACE SCIENCES			PHYSICAL SCIENCES			LIFE SCIENCES	
Earth's Place in the Universe	Earth's Systems	Earth and Human Activity	Matter and its Interactions	Motion and Stability: Forces and Interactions	Energy	From Molecules to Organisms: Structures and Processes	Ecosystems: Interactions, Energy, and Dynamics
5-ESS1-1	5-ESS2-1	5-ESS3-1	5-PS1-1	5-PS2-1	5-PS3-1	5-LS1-1	5-LS2-1
5-ESS1-2	5-ESS2-2		5-PS1-2**AR**				
			5-PS1-3				
			5-PS1-4**AR**				
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 5-ETS1-1, 5-ETS1-2, 5-ETS1-3							

Arkansas Clarification Statement/Assessment Boundary (**AR**)

Grade Five Standards Overview

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

Science and Engineering Practices

Students are expected to demonstrate grade-appropriate proficiency in

- developing and using models,
- planning and carrying out investigations,
- analyzing and interpreting data,
- using mathematics and computational thinking,
- engaging in argument from evidence, and
- obtaining, evaluating, and communicating information.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Crosscutting Concepts

Students are expected to demonstrate grade-appropriate understanding of

- patterns,
- cause and effect,
- scale, proportion, and quantity,
- energy and matter,
- systems and systems models, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

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Disciplinary Core Ideas

Students are expected to continually build on and revise their knowledge of

- PS1 - Matter and Its Interactions,
- PS2 - Motion and Stability: Forces and Interactions,
- PS3 - Energy,
- LS1 - Molecules to Organisms: Structures and Processes,
- LS2 - Ecosystems: Interactions, Energy, and Dynamics,
- ESS1 - Earth's Place in the Universe,
- ESS2 - Earth's Systems,
- ESS3 - Earth and Human Activity, and
- ETS1- Engineering Design in a 3-5 developmental learning progression.

Physical Sciences (PS)

The (PS) performance expectations in fifth grade help students formulate answers to the questions, "Can new substances be created by combining other substances?" and "When matter changes, does its weight change?" Fifth grade students are expected to be able to describe that matter is made of particles too small to be seen through the development of a model. Students determine whether the mixing of two or more substances results in new substances. Students develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved.

Life Sciences (LS)

The (LS) performance expectations in fifth grade help students explore the questions, "Where does the energy in food come from?" and "What is it used for?" Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals' food was once energy from the sun.

Earth and Space Sciences (ESS)

The (ESS) performance expectations in fifth grade help students investigate the questions, "How much water can be found in different places on Earth?", "How does matter cycle through ecosystems?", and "How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?" Students are expected to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. Through the development of a model, fifth grade students describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. Students describe and graph data to provide evidence about the distribution of water on Earth.

Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in the earliest grades introduce students to problems as situations that people want to change. With increased maturity students in third through fifth grade are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems** involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits. In this grade range the additional step of specifying criteria and constraints.
- **Designing solutions to engineering problems** begins with generating a number of different possible solutions, and then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem. In this grade range students generate several alternative solutions and compare them systematically to see which best meet the criteria and constraints of the problem.
- **Optimizing the engineering design** involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important. In this grade range students build and test models or prototypes using controlled experiments in which only one variable is changed from trial to trial while all other variables are kept the same.

By the end of fifth grade students should be able to achieve all three performance expectations (5-ETS1-1, 5-ETS1-2, 5-ETS1-3) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve simple problems, use visual or physical representations to convey solutions, and compare different solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

GRADE FIVE

Earth's Systems

Students who demonstrate understanding can:

5-ESS2-1 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; or 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.]

5-ESS2-2 Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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 a scientific principle. (5-ESS2-1)

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. (5-ESS2-2)

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. (5-ESS3-1)

Disciplinary Core Ideas

ESS2.A: Earth Materials and Systems
- Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. (5-ESS2-1)

ESS2.C: 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. (5-ESS2-2)

ESS3.C: 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)

Crosscutting Concepts

Scale, Proportion, and Quantity
- Standard units are used to measure and describe physical quantities such as weight, and volume. (5-ESS2-2)

Systems and System Models
- A system can be described in terms of its components and their interactions. (5-ESS2-1, 5-ESS3-1)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World
- Science findings are limited to questions that can be answered with empirical evidence. (5-ESS3-1)

Connections to other Disciplinary Core Ideas (DCIs) in fifth grade: N/A

Connections to other DCIs across grade levels: **2.ESS2.A** (5-ESS2-1); **2.ESS2.C** (5-ESS2-2); **3.ESS2.D** (5-ESS2-1); **4.ESS2.A** (5-ESS2-1); **7.ESS2.A** (5-ESS2-1); **7.ESS2.C** (5-ESS2-1, 5-ESS2-2); **6.ESS2.D** (5-ESS2-1); **7.ESS3.A** (5-ESS2-2, 5-ESS3-1)**; 6.ESS3.C** (5-ESS3-1); **6.ESS3.D** (5-ESS3-1)

Connections to the Arkansas English Language Arts Standards –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ESS3-1)

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS2-1, 5-ESS2-2, 5-ESS3-1)

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ESS3-1)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources. Summarize or paraphrase information in notes and finished work. Provide a list of sources. (5-ESS2-2, 5-ESS3-1)

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ESS3-1)

SL.5.5 Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS2-1, 5-ESS2-2)

Connections to the Arkansas Mathematics Standards–

MP.2 Reason abstractly and quantitatively. (5-ESS2-1, 5-ESS2-2, 5-ESS3-1)

MP.4 Model with mathematics. (5-ESS2-1, 5-ESS2-2, 5-ESS3-1)

5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant and on the non-negative x- and y- axes of the coordinate plane**.** Interpret coordinate values of points in the context of the situation. (5-ESS2-1)

Space Systems

Students who demonstrate understanding can:

5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down. [Clarification Statement: "Down" is a local description of the direction that points toward the center of the spherical Earth.] [Assessment Boundary: Assessment does not include mathematical representation of gravitational force.]

5-ESS1-1 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 rather than sizes of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, or stage).]

5-ESS1-2 Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. [Clarification Statement: Examples of patterns could include the position and motion of Earth with respect to the sun and select stars that are visible only in particular months.] [Assessment Boundary: Assessment does not include causes of seasons.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (5-ESS1-2) **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. (5-PS2-1, 5-ESS1-1)	**PS2.B: 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) **ESS1.A: 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) **ESS1.B: 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. (5-ESS1-2)	**Patterns** ▪ Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena. (5-ESS1-2) **Cause and Effect** ▪ Cause and effect relationships are routinely identified and used to explain change. (5-PS2-1) **Scale, Proportion, and Quantity** ▪ Natural objects exist from the very small to the immensely large. (5-ESS1-1)

Connections to other DCIs in fifth grade: N/A

Connections to other DCIs across grade levels: **1.ESS1.A** (5-ESS1-2); **1.ESS1.B** (5-ESS1-2); **3.PS2.A** (5-PS2-1, 5-ESS1-2); **3.PS2.B** (5-PS2-1); **8.PS2.B** (5-PS2-1); **8.ESS1.A** (5-ESS1-1, 5-ESS1-2); **8.ESS1.B** (5-PS2-1, 5-ESS1-1, 5-ESS1-2); **7.ESS2.C** (5-PS2-1)

Connections to the Arkansas English Language Arts Standards –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-PS2-1, 5-ESS1-1)

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ESS1-1)

RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s). (5-ESS1-1)

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-PS2-1, 5-ESS1-1)

W.5.1 Write opinion pieces on topics or texts, supporting the opinion with reasons and information. (5-PS2-1, 5-ESS1-1)

SL.5.5 Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-ESS1-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (5-ESS1-1, 5-ESS1-2)

MP.4 Model with mathematics. (5-ESS1-1, 5-ESS1-2)

5.NBT.A.2 Students understand why multiplying or dividing by a power of 10 shifts the value of the digits of a whole number or decimal.

AR.5.NBT.A.2.A
Explain patterns in the number of zeros of the product when multiplying a whole number by powers of 10.

AR.5.NBT.A.2.B
Explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10.

AR.5.NBT.A.2.C
Use whole-number exponents to denote powers of 10.

5.G.A.2 Represent real world and mathematical problems by graphing points in the first quadrant and on the non-negative x- and y-axes of the coordinate plane. Interpret coordinate values of points in the context of the situation. (5-ESS1-2)

Structure and Properties of Matter
Students who demonstrate understanding can: **5-PS1-1** **Develop a model to describe that matter is made of particles too small to be seen.** [Clarification Statement: Examples of evidence supporting a model could 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 the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.] **5-PS1-2** **Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.** [**AR** Clarification Statement: Examples could include chemical reactions that form new substances or physical changes including phase changes, dissolving, and mixing.] [**AR** Assessment Boundary: Assessment does not include distinguishing mass from weight or reactions that involve gases.] **5-PS1-3** **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 from weight.] **5-PS1-4** **Conduct an investigation to determine whether the mixing of two or more substances results in new substances.** [**AR** Clarification Statement: Examples of qualitative evidence could include temperature change, color change, odor change, and the formation of a gas to determine if a new substance has formed.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (5-PS1-1) **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. (5-PS1-4) ▪ Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (5-PS1-3)	**PS1.A: 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 and the effects of air on larger particles or objects. (5-PS1-1) ▪ The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2) ▪ Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (5-PS1-3) **PS1.B: Chemical Reactions** ▪ When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) ▪ No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)	**Cause and Effect** ▪ Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4) **Scale, Proportion, and Quantity** ▪ Natural objects exist from the very small to the immensely large. (5-PS1-1) ▪ Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. (5-PS1-2, 5-PS1-3) --- **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes consistent patterns in natural systems. (5-PS1-2)

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. (5-PS1-2)		

Connections to other DCIs in fifth grade: N/A

Connections to other DCIs across grade levels: **2.PS1.A** (5-PS1-1, 5-PS1-2, 5-PS1-3); **2.PS1.B** (5-PS1-2, 5-PS1-4); **7.PS1.A** (5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4); **7.PS1.B** (5-PS1-2, 5-PS1-4)

Connections to the Arkansas English Language Arts Standards –

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS1-1)

W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-PS1-2, 5-PS1-3, 5-PS1-4)

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources. Summarize or paraphrase information in notes and finished work. Provide a list of sources. (5-PS1-2, 5-PS1-3, 5-PS1-4)

W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-PS1-2, 5-PS1-3, 5-PS1-4)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (5-PS1-1, 5-PS1-2, 5-PS1-3)

MP.4 Model with mathematics. (5-PS1-1, 5-PS1-2, 5-PS1-3)

MP.5 Use appropriate tools strategically. (5-PS1-2, 5-PS1-3)

5.NBT.A.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. (5-PS1-1)

5.NF.B.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. Interpret division of a unit fraction by a natural number, and compute such quotients. Interpret division of a whole number by a unit fraction, and compute such quotients. Solve real world problems involving division of unit fractions by natural numbers and (5-PS1-1)

5.MD.A.1 Convert among different-sized standard measurement units within the metric system. Convert among different-sized standard measurement units within the customary system. Use these conversions in solving multi-step, real world problems. (5-PS1-2)

5.MD.C.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement. (5-PS1-1) A cube with side length 1 unit, called a “unit cube,” is said to have “one cubic unit” of volume, and can be used to measure volume. A solid figure, which can be packed without gaps or overlaps using n unit cubes, is said to have a volume of n cubic units.

5.MD.C.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft., and improvised units. (5-PS1-1)

GRADE FIVE

Matter and Energy in Organisms and Ecosystems
Students who demonstrate understanding can: **5-PS3-1 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.] **5-LS1-1 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.] **5-LS2-1 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 Boundary: Assessment does not include molecular explanations.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (5-PS3-1) ▪ Develop a model to describe phenomena. (5-LS2-1) **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. (5-LS1-1) **---** **Connections to Nature of Science** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Science explanations describe the mechanisms for natural events. (5-LS2-1)	**PS3.D: 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). (5-PS3-1) **LS1.C: Organization for 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. (secondary to 5-PS3-1) ▪ Plants acquire their material for growth chiefly from air and water. (5-LS1-1) **LS2.A: 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. (5-LS2-1)	**Systems and System Models** ▪ A system can be described in terms of its components and their interactions. (5-LS2-1) **Energy and Matter** ▪ Matter is transported into, out of, and within systems. (5-LS1-1) ▪ Energy can be transferred in various ways and between objects. (5-PS3-1)

	LS2.B: 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. (5-LS2-1)	

Connections to other DCIs in fifth grade: **5.PS1.A** (5-LS1-1, 5-LS2-1); **5.ESS2.A** (5-LS2-1)

Connections to other DCIs across grade levels: **K.LS1.C** (5-PS3-1, 5-LS1-1); **2.PS1.A** (5-LS2-1); **2.LS2.A** (5-PS3-1, 5-LS1-1); **2.LS4.D** (5-LS2-1); **4.PS3.A** (5-PS3-1); **4.PS3.B** (5-PS3-1); **4.PS3.D** (5-PS3-1); **4.ESS2.E** (5-LS2-1); **6.PS3.D** (5-PS3-1, 5-LS2-1); **8.PS4.B** (5-PS3-1); **6.LS1.C** (5-PS3-1, 5-LS1-1, 5-LS2-1); **7.LS2.A** (5-LS2-1); **7.LS2.B** (5-PS3-1, 5-LS2-1)

Connections to the Arkansas English Language Arts Standards –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-LS1-1)

RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-PS3-1, 5-LS2-1)

RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-LS1-1)

W.5.1 Write opinion pieces on topics or texts, supporting the opinion with reasons and information. (5-LS1-1)

SL.5.5 Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes. (5-PS3-1, 5-LS2-1)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (5-LS1-1, 5-LS2-1)

MP.4 Model with mathematics. (5-LS1-1, 5-LS2-1)

MP.5 Use appropriate tools strategically. (5-LS1-1)

5.MD.A.1 Convert among different-sized standard measurement units within the metric system. Convert among different-sized standard measurements units within the customary system. Use these conversions in solving multi-step, real world problems. (5-LS1-1)

GRADE FIVE

Engineering, Technology, and Applications of Science

Students who demonstrate understanding can:

5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships.

- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. (5-ETS1-1)

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.

- Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (5-ETS1-3)

Constructing Explanations and Designing Solutions

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 problem. (5-ETS1-2)

Disciplinary Core Ideas

ETS1.A: Defining and Delimiting Engineering Problems

- 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. (5-ETS1-1)

ETS1.B: Developing Possible Solutions

- Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (5-ETS1-2)
- At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (5-ETS1-2)
- Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (5-ETS1-3)

ETS1.C: Optimizing the Design Solution

- Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (5-ETS1-3)

Crosscutting Concepts

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

- People's needs and wants change over time, as do their demands for new and improved technologies. (5-ETS1-1)
- Engineers improve existing technologies or develop new ones to increase their benefits, decrease known risks, and meet societal demands. (5-ETS1-2)

Connections to 3-5.ETS1.A: Defining and Delimiting Engineering Problems include: **Fourth Grade:** (4-PS3-4)
Connections to 3-5.ETS1.B: Designing Solutions to Engineering Problems include: **Fourth Grade:** (4-ESS3-2)
Connections to K-2.ETS1.C: Optimizing the Design Solution include: **Fourth Grade: (**4-PS4-3)

Connections to other DCIs across grade levels: **K-2.ETS1.A** (5-ETS1-1, 5-ETS1-2, 5-ETS1-3); **K-2.ETS1.B** (5-ETS1-2); **K-2.ETS1.C** (5-ETS1-2, 5-ETS1-3); **6-8.ETS1.A** (5-ETS1-1); **6-8.ETS1.B** (5-ETS1-1, 5-ETS1-2, 5-ETS1-3); **6-8.ETS1.C** (5-ETS1-2, 5-ETS1-3)

Connections to the Arkansas English Language Arts Standards –

RI.5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. (5-ETS1-2)
RI.5.7 Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. (5-ETS1-2)
RI.5.9 Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably. (5-ETS1-2)
W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic. (5-ETS1-1, 5-ETS1-3)
W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources. Summarize or paraphrase information in notes and finished work. Provide a list of sources. (5-ETS1-1, 5-ETS1-3)
W.5.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (5-ETS1-1, 5-ETS1-3)

Connections to the Arkansas Mathematics Standards –

3.0A Operations and Algebraic Thinking (3-ETS1-1, 3-ETS1-2)
MP.2 Reason abstractly and quantitatively. (5-ETS1-1, 5-ETS1-2, 5-ETS1-3)
MP.4 Model with mathematics. (5-ETS1-1, 5-ETS1-2, 5-ETS1-3)
MP.5 Use appropriate tools strategically. (5-ETS1-1, 5-ETS1-2, 5-ETS1-3)
3-5.OA Operations and Algebraic Thinking (5-ETS1-1, 5-ETS1-2)

Grade 6 Learning Progression by Topic

Grade 6					
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES		
Energy	Structure, Function, and Information Processing	Growth, Development, and Reproduction of Organisms	Earth's Systems	Human Impacts	Weather and Climate
6-PS3-3**AR**	6-LS1-1	6-LS1-4	6-ESS2-4	6-ESS3-3	6-ESS2-5
6-PS3-4	6-LS1-2	6-LS1-5		6-ESS3-4	6-ESS2-6
6-PS3-5**AR**	6-LS1-3	6-LS3-2			6-ESS3-5
	6-LS1-8				
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4					

Arkansas Clarification Statement (**AR**)

Grade 6 Learning Progression by Disciplinary Core Idea

Grade 6				
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES	
Energy	From Molecules to Organisms: Structures and Processes	Heredity: Inheritance and Variation of Traits	Earth's Systems	Earth and Human Activity
6-PS3-3	6-LS1-1	6-LS3-2	6-ESS2-4	6-ESS3-3
6-PS3-4	6-LS1-2		6-ESS2-5	6-ESS3-4
6-PS3-5**AR**	6-LS1-3		6-ESS2-6	6-ESS3-5
	6-LS1-4			
	6-LS1-5			
	6-LS1-8			
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4				

Arkansas Clarification Statement (**AR**)

Grade Six Standards Overview

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

Science and Engineering Practices

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Crosscutting Concepts

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

Disciplinary Core Ideas

Students are expected to continually build on and revise their knowledge of

- PS3- Energy,
- LS1- Molecules to Organisms: Structures and Processes,
- LS3- Heredity: Inheritance and Variation of Traits,
- ESS2- Earth's Systems,
- ESS3- Earth and Human Activity, and
- ETS1- Engineering Design in a 6-8 developmental learning progression.

Physical Sciences (PS)

The (PS) performance expectations in sixth grade help students formulate answers to the question, “How can energy be transferred from one object or system to another?” Students are expected to develop understanding of energy and energy transfer.

Life Sciences (LS)

The (LS) performance expectations in sixth grade help students explore the questions, “How do the structures of organisms contribute to life’s functions?”, “How can one explain the ways cells contribute to the function of living organisms?”, and “”How do organisms grow, develop, and reproduce?” Students are expected to develop understanding of structure, function, and information processing as well as growth, development, and reproduction.

Earth and Space Sciences (ESS)

The (ESS) performance expectations help students investigate the questions, “How is water cycled on Earth?”, “How have human activity of land, energy, and water resources impacted Earth’s systems?”, and “How are complex weather systems related to the sun’s energy and the force of gravity?” Students are expected to develop understanding of Earth systems, weather and climate, and consequences of human activity.

Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design. Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

In the sixth grade students begin to develop the ability to achieve all four performance expectations (6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

Energy
Students who demonstrate understanding can: **6-PS3-3** **Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*** [**AR** Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a polystyrene foam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] **6-PS3-4** **Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.** [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice have 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.] **6-PS3-5** **Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.** [**AR** Clarification Statement: Examples of empirical evidence used in arguments could include a diagram, flowchart, or other representation of the energy before and after the transfer in the form of temperature changes or motion of an object.] [Assessment Boundary: Assessment does not include calculations of energy.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (6-PS3-4) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (6-PS3-3) **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. (6-PS3-5)	**PS3.A: Definitions of Energy** ▪ Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (6-PS3-3, 6-PS3-4) **PS3.B: 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. (6-PS3-5) ▪ 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. (6-PS3-4) ▪ Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (6-PS3-3)	**Scale, Proportion, and Quantity** ▪ Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (6-PS3-4) **Energy and Matter** ▪ Energy may take different forms (e.g. energy in fields, thermal energy, and energy of motion). (6-PS3-5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (6-PS3-3)

-- **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations (6-PS3-4, 6-PS3-5)	**ETS1.A: Defining and Delimiting an Engineering Problem** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (6-PS3-3) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (6-PS3-3)	

Connections to other DCIs in sixth grade: 6.**ESS2.D** (6-PS3-3, 6-PS3-4); 6.**ESS3.D** (6-PS3-4)

Connections to other DCIs across grade levels: **4.PS3.B** (6-PS3-3); **4.PS3.C** (6-PS3-4, 6-PS3-5); **7.PS1.B** (6-PS3-4); **8.PS3.A** (6-PS3-4, 6-PS3-5); **8.PS3.B** (6-PS3-3, 6-PS3-4, 6-PS3-5)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (6-PS3-5)
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (6-PS3-3, 6-PS3-4)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
WHST.6-8.1	Write arguments focused on discipline-specific content. (6-PS3-5)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (6-PS3-3, 6-PS3-4)

Connections to the Arkansas Mathematics Standards –

MP.2	Reason abstractly and quantitatively.(6-PS3-4, 6-PS3-5)
6.RP.A.1	Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (6-PS3-5)
6.SP.B.5	Summarize numerical data sets in relation to their context. (6-PS3-4)

GRADE SIX

Structure, Function, and Information Processing
Students who demonstrate understanding can: **6-LS1-1** **Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.** [Clarification Statement: Emphasis is on gathering evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.] **6-LS1-2** **Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.** [Clarification Statement: Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.] [Assessment Boundary: Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.] **6-LS1-3** **Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.** [Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems.] [Assessment Boundary: Assessment is limited to circulatory, excretory, digestive, respiratory, muscular, and nervous systems. Assessment does not include the mechanism of one body system independent of others.] **6-LS1-8** **Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.** [Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (6-LS1-2) **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 <u>multiple variables</u> 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. (6-LS1-1)	**LS1.A: Structure and Function** ▪ All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (6-LS1-1) ▪ Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (6-LS1-2) ▪ 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. (6-LS1-3)	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural systems. (6-LS1-8) **Scale, Proportion, and Quantity** ▪ Phenomena that can be observed at one scale may not be observable at another scale. (6-LS1-1) **Systems and System Models** ▪ Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (6-LS1-3) **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. (6-LS1-2)

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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. (6-LS1-3)
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. (6-LS1-8)
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LS1.D: Information Processing
▪ Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (6-LS1-8)
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Connections to Engineering, Technology, and Applications 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. (6-LS1-1)

Connections to Nature of Science

Science is a Human Endeavor
▪ Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (6-LS1-3)
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Connections to other DCIs in sixth grade: N/A

Connections to other DCIs across grade levels: **4.LS1.A** (6-LS1-2); **4.LS1.D** (6-LS1-8)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (6-LS1-3)

RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (6-LS1-3)

WHST.6-8.1 Write arguments focused on discipline-specific content. (6-LS1-3)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (6-LS1-1)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (6-LS1-8)

Connections to the Arkansas English Language Arts Standards –

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information. (6-LS1-2)

Connections to the Arkansas Mathematics Standards –

6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another. Write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (6-LS1-1, 6-LS1-2, 6-LS1-3)

Growth, Development, and Reproduction of Organisms

Students who demonstrate understanding can:

6-LS1-4 **Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.** [Clarification Statement: Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.]

6-LS1-5 **Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.** [Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]

6-LS3-2 **Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.** [Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop and use a model to describe phenomena. (6-LS3-2)

Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific 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. (6-LS1-5)

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. (6-LS3-2)
- Animals engage in characteristic behaviors that increase the odds of reproduction. (6-LS1-4)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (6-LS1-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (6-LS1-5)
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (6-LS3-2)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural systems. (6-LS3-2)
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (6-LS1-4, 6-LS1-5)

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. (6-LS1-4)	**LS3.B: Variation of Traits** ▪ In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (6-LS3-2)	

Connections to other DCIs in sixth grade: N/A

Connections to other DCIs across grade levels: **3.LS1.B** (6-LS1-4, 6-LS1-5); **3.LS3.A** (6-LS1-5, 6-LS3-2); **3.LS3.B** (6-LS3-2); **7.LS2.A** (6-LS1-4, 6-LS1-5); **7.LS2.D** (6-LS1-4); **8.LS3.A** (6-LS3-2)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (6-LS1-4, 6-LS1-5, 6-LS3-2)
RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (6-LS1-5)
RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to Grades 6-8 texts and topics. (6-LS3-2)
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (6-LS3-2)
RI.6.8 Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (6-LS1-4)
WHST.6-8.1 Write arguments focused on discipline-specific content. (6-LS1-4)
WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (6-LS1-5)
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (6-LS1-5)

Connections to the Arkansas English Language Arts Standards –

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information. (6-LS3-2)

Connections to the Arkansas Mathematics Standards –

MP.4 Model with mathematics. (6-LS3-2)
6.SP.A.2 Determine center, spread, and overall shape from a set of data. (6-LS1-4, 6-LS1-5)
6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (6-LS1-4, 6-LS1-5)
6.SP.B.5 Summarize numerical data sets in relation to their context. (6-LS3-2)

Earth's Systems

Students who demonstrate understanding can:

6-ESS2-4 **Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.** [Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (6-ESS2-4)	**ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (6-ESS2-4) ▪ Global movements of water and its changes in form are propelled by sunlight and gravity. (6-ESS2-4)	**Energy and Matter** ▪ Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (6-ESS2-4)

Connections to other DCIs in sixth grade: **6.PS3.D** (6-ESS2-4)

Connections to other DCIs across grade levels: **3.PS2.A** (6-ESS2-4); **4.PS3.B** (6-ESS2-4); **5.PS2.B** (6-ESS2-4); **5.ESS2.C** (6-ESS2-4); **7.ESS2.C** (6-ESS2-4); **8.PS2.B** (6-ESS2-4); **8.PS3.B** (6-ESS2-4); **8.PS4.B** (6-ESS2-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (6-ESS2-4)

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (6-ESS2-4)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (6-ESS2-4)

Connections to the Arkansas English Language Arts Standards –

SL.6.2 Interpret information that is gained by means other than reading (e.g., texts read aloud; oral presentations of charts, graphs, or diagrams; speeches) and explain how it contributes to a topic, text, or issue under study. (6-ESS2-4)

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information. (6-ESS2-4)

Connections to the Arkansas Mathematics Standards –

MP.4 Model with mathematics. (6-ESS2-4)

Human Impacts

Students who demonstrate understanding can:

6-ESS3-3 **Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*** [Clarification Statement: Examples of the design process could 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 could 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).]

6-ESS3-4 **Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.** [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations or the rates of consumption of food and natural resources (such as freshwater, minerals, or energy). Examples of impacts could include changes to the appearance, composition, or 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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

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

- Apply scientific principles to design an object, tool, process or system. (6-ESS3-3)

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. (6-ESS3-4)

Disciplinary Core Ideas

ESS3.C: 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. (6-ESS3-3)
- 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. (6-ESS3-3, 6-ESS3-4)

Crosscutting Concepts

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (6-ESS3-3)
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (6-ESS3-4)

Connections to Engineering, Technology, and Applications of Science

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

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (6-ESS3-4)
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (6-ESS3-3)

		-- **Connections to Nature of Science** **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (6-ESS3-4)

Connections to other DCIs in sixth grade: N/A

Connections to other DCIs across grade levels: **3.LS2.C** (6-ESS3-3, 6-ESS3-4); **3.LS4.D** (6-ESS3-3, 6-ESS3-4); **5.ESS3.C** (6-ESS3-3, 6-ESS3-4); **7.LS2.A** (6-ESS3-4); **7.LS2.C** (6-ESS3-3, 6-ESS3-4);); **7.ESS2.C** (6-ESS3-3); **7.ESS3.A** (6-ESS3-4); **8.LS4.C** (6-ESS3-3, 6-ESS3-4); **8.LS4.D** (6-ESS3-3, 6-ESS3-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (6-ESS3-4)
WHST.6-8.1	Write arguments focused on discipline-specific content. (6-ESS3-4)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (6-ESS3-3)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (6-ESS3-3)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (6-ESS3-4)

Connections to the Arkansas Mathematics Standards –

6.RP.A.1	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (6-ESS3-3, 6-ESS3-4)
6.RP.A.2	Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. (6-ESS3-3, 6-ESS3-4)
6.EE.B.6	Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (6-ESS3-3, 6-ESS3-4)

Weather and Climate
Students who demonstrate understanding can: **6-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.** [Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, or 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.] **6-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.** [Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models could be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.] **6-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.** [Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, or agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence could include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide or methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ▪ Ask questions to identify and clarify evidence of an argument. (6-ESS3-5) **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. (6-ESS2-6) **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. (6-ESS2-5)	**ESS2.C: The Roles of Water in Earth's Surface Processes** ▪ The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (6-ESS2-5) ▪ Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (6-ESS2-6) **ESS2.D: Weather and Climate** ▪ Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (6-ESS2-6) ▪ Because these patterns are so complex, weather can only be predicted probabilistically. (6-ESS2-5)	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (6-ESS2-5) **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. (6-ESS2-6) **Stability and Change** ▪ Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (6-ESS3-5)

	▪ 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. (6-ESS2-6) **ESS3.D: Global Climate Change** ▪ Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (6-ESS3-5)	

Connections to other DCIs in sixth grade: N/A

Connections to other DCIs across grade levels: **3.PS2.A** (6-ESS2-6); **3.ESS2.D** (6-ESS2-5),(6-ESS2-6); **5.ESS2.A** (6-ESS2-5, 6-ESS2-6); **7.ESS2.A** (6-ESS2-6, 6-ESS3-5); **7.ESS2.C** (6-ESS2-5); **8.PS2.B** (6-ESS2-6); **8.PS3.B** (6-ESS2-6, 6-ESS3-5); **8.PS4.B** (6-ESS3-5); **8.ESS1.B** (6-ESS2-6)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (6-ESS2-5, 6-ESS3-5)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (6-ESS2-5)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (6-ESS2-5)

Connections to the Arkansas English Language Arts Standards –

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information. (6-ESS2-6)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (6-ESS2-5, 6-ESS3-5)

6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, explaining the meaning of 0. (6-ESS2-5)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (6-ESS3-5)

Engineering, Technology, and Applications of Science

Students who demonstrate understanding can:

6-ETS1-1 **Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.** [**AR** Clarification Statement: Examples could include designing an insulated coffee mug or lunch box or designing an energy efficient home, etc.]

6-ETS1-2 **Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** [**AR** Clarification: Examples could include evaluating a community's designs for protecting different aspects of an ecosystem.]

6-ETS1-3 **Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.** [**AR** Clarification Statement: Examples could include determining best materials to use for a building's roof or windows, etc.]

6-ETS1-4 **Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.** [**AR** Clarification Statement: Examples could be using graphs or models to support material choices for a design project.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (6-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (6-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to determine similarities and differences in findings. (6-ETS1-3)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (6-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (6-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (6-ETS1-2, 6-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (6-ETS1-3) ▪ Models of all kinds are important for testing solutions. (6-ETS1-4) **ETS1.C: Optimizing the Design Solution** ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process, some of those characteristics may be incorporated into the new design. (6-ETS1-3)	**Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (6-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (6-ETS1-1)

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. ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (6-ETS1-2)	▪ 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. (6-ETS1-4)	

Connections to 6-8.ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** (6-PS3-3)
Connections to 6-8.ETS1.B: Developing Possible Solutions Problems include: **Physical Science:** (7-PS1-6, 6-PS3-3); **Life Science:** (7-LS2-5)
Connections to 6-8.ETS1.C: Optimizing the Design Solution include: **Physical Science**: (7-PS1-6)

Connections to other DCIs across grade levels: **3-5.ETS1.A** (6-ETS1-1, 6-ETS1-2, 6-ETS1-3); **3-5.ETS1.B** (6-ETS1-2, 6-ETS1-3, 6-ETS1-4); **3-5.ETS1.C** (6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (6-ETS1-1, 6-ETS1-2, 6-ETS1-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (6-ETS1-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (6-ETS1-2, 6-ETS1-3)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (6-ETS1-2)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (6-ETS1-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (6-ETS1-2)

Connections to the Arkansas English Language Arts Standards –

SL.6.5 Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information. (6-ETS1-4)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (6-ETS1-1, 6-ETS1-2, 6-ETS1-3, 6-ETS1-4)

Grade 7 Learning Progression by Topic

Grade 7						
PHISICAL SCIENCES		LIFE SCIENCES		EARTH and SPACES SCIENCES		
Structures and Properties of Matter	Chemical Reactions	Interdependent Relationships in Ecosystems	Matter and Energy in Organisms and Ecosystems	Earth's Systems	History of Earth	Human Impacts
7-PS1-1	7-PS1-2**AR**	7-LS2-2	7-LS1-6	7-ESS2-1**AR**	7-ESS2-2	7-ESS3-2
7-PS1-3	7-PS1-5	7-LS2-5	7-LS1-7	7-ESS3-1	7-ESS2-3	
7-PS1-4	7-PS1-6**AR**		7-LS2-1			
			7-LS2-3			
			7-LS2-4			
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4						

Arkansas Clarification Statement (**AR**)

Grade 7 Learning Progression by Disciplinary Core Idea

Grade 7				
PHYSICAL SCIENCES	LIFE SCIENCES		EARTH and SPACE SCIENCES	
Matter and Its Interactions	From Molecules to Organisms: Structures and Processes	Ecosystems: Interactions, Energy, and Dynamics	Earth's Systems	Earth and Human Activity
7-PS1-1	7-LS1-6	7-LS2-1	7-ESS2-1**AR**	7-ESS3-1
7-PS1-2**AR**	7-LS1-7	7-LS2-2	7-ESS2-2	7-ESS3-2
7-PS1-3		7-LS2-3	7-ESS2-3	
7-PS1-4		7-LS2-4		
7-PS1-5		7-LS2-5		
7-PS1-6**AR**				
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4				

Arkansas Clarification Statement (**AR**)

Grade Seven Standards Overview

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

Science and Engineering Practices

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Crosscutting Concepts

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

Disciplinary Core Ideas

Students are expected to continually build on and revise their knowledge of

- PS1 - Matter and Its Interactions,
- LS1 - Molecules to Organisms: Structures and Processes,
- LS2 - Ecosystems: Interactions, Energy, and Dynamics,
- ESS2 - Earth's Systems,
- ESS3 - Earth and Human Activity, and
- ETS1 - Engineering Design in a 6-8 developmental learning progression

Physical Sciences (PS)

The (PS) performance expectations in seventh grade help students formulate answers to the questions, “How can particles combine to produce substances with different properties?”, “What stays the same and what changes in a chemical reaction?”, and “What happens when new materials are formed?” Students are expected to develop understanding of the structures and properties of matter and chemical reactions.

Life Sciences (LS)

The (LS) performance expectations in seventh grade help students explore the questions, “How does matter and energy move through an ecosystem?” and “How do organisms interact with other organisms in the physical environment to obtain energy?” Students are expected to develop understanding of interdependent relationships in ecosystems and matter and energy in organisms and ecosystems.

Earth and Space Sciences (ESS)

The (ESS) performance expectations in seventh grade help students investigate the questions, “How has Earth developed and changed over time?”, and “How have humans been able to forecast catastrophic events and mitigate their effects?” Students are expected to develop understanding of Earth systems, history of the Earth, and human impacts.

Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design. Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

In the seventh grade students are still developing the ability to achieve all four performance expectations (7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

Structure and Properties of Matter

Students who demonstrate understanding can:

7-PS1-1 **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, 3-D 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.]

7-PS1-3 **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 a synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]

7-PS1-4 **Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.** [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 or diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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. (7-PS1-1, 7-PS1-4)

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. (7-PS1-3)

Disciplinary Core Ideas

PS1.A: 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. (7-PS1-1)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (7-PS1-3)
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (7-PS1-4)
- 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. (7-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (7-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (7-PS1-4)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (7-PS1-4)

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. (7-PS1-1)

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. (7-PS1-3)

	PS1.B: 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. (7-PS1-3) **PS3.A: Definitions of Energy** ▪ 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. (secondary to 7-PS1-4) ▪ 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. *(*7-PS1-4)	-- **Connections to Engineering, Technology, and Applications 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. (7-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** ▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (7-PS1-3)

Connections to other DCIs in seventh grade: **7.ESS2.C** (7-PS1-1),(7-PS1-4); **7.ESS3.A** (7-PS1-3)

Connections to other DCIs across grade levels: **5.PS1.A** (7-PS1-1); **8.PS3.A** (7-PS1-4); **8.LS4.D** (7-PS1-3); **8.ESS1.A** (7-PS1-1)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (7-PS1-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-PS1-1, 7-PS1-4)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (7-PS1-3)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (7-PS1-1)

MP.4 Model with mathematics. (7-PS1-1)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (7-PS1-1)

6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, explaining the meaning of 0. (7-PS1-4)

Chemical Reactions	
Students who demonstrate understanding can:	
7-PS1-2	**Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.** [**AR** Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrochloric acid.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]
7-PS1-5	**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, balancing symbolic equations, or intermolecular forces.]
7-PS1-6	**Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*** [**AR** 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 processes such as dissolving ammonium chloride or calcium chloride or chemical reactions such as burning.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:	

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (7-PS1-5) **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. (7-PS1-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific 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. (7-PS1-6) --	**PS1.A: 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. (7-PS1-2) ▪ **PS1.B: 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. (7-PS1-2, 7-PS1-5) ▪ The total number of each type of atom is conserved, and thus the mass does not change. (7-PS1-5) ▪ Some chemical reactions release energy, others store energy. (7-PS1-6)	**Patterns** ▪ Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (7-PS1-2) **Energy and Matter** ▪ Matter is conserved because atoms are conserved in physical and chemical processes. (7-PS1-5) ▪ The transfer of energy can be tracked as energy flows through a designed or natural system. (7-PS1-6)

Connections to Nature of Science	ETS1.B: Developing Possible Solutions	
Scientific Knowledge is Based on Empirical Evidence ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (7-PS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** ▪ Laws are regularities or mathematical descriptions of natural phenomena. (7-PS1-5)	▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (7-PS1-6) **ETS1.C: Optimizing the Design Solution** ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. (7-PS1-6) ▪ 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. (7-PS1-6)	

Connections to other DCIs in seventh grade: **7.LS2.B** (7-PS1-5); **7.ESS2.A** (7-PS1-2),(7-PS1-5)

Connections to other DCIs across grade levels: **5.PS1.B** (7-PS1-2, 7-PS1-5); **6.PS3.D** (7-PS1-6); **8.PS3.A** (7-PS1-6); **8.PS3.B** (7-PS1-6)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (7-PS1-2)
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (7-PS1-6)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-PS1-2, 7-PS1-5)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (7-PS1-6)

Connections to the Arkansas Mathematics Standards –

MP.2	Reason abstractly and quantitatively. (7-PS1-2, 7-PS1-5)
MP.4	Model with mathematics. (7-PS1-5)
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. (7-PS1-2, 7-PS1-5)
6.SP.B.4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (7-PS1-2)
6.SP.B.5	Summarize numerical data sets in relation to their context. (7-PS1-2)

Interdependent Relationships in Ecosystems

Students who demonstrate understanding can:

7-LS2-2 **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.]

7-LS2-5 **Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*** [Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, or prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Constructing Explanations and Designing Solutions

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

- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (7-LS2-2)

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. (7-LS2-5)

Disciplinary Core Ideas

LS2.A: Interdependent Relationships in Ecosystems

- Similarly, 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. (7-LS2-2)

LS2.C: 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. (7-LS2-5)

LS4.D: Biodiversity and Humans

- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (7-LS2-5)

ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (7-LS2-5)

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause and effect relationships. (7-LS2-2)

Stability and Change

- Small changes in one part of a system might cause large changes in another part. (7-LS2-5)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology 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. (7-LS2-5)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the

		decisions that society takes. (7-LS2-5)

Connections to other DCIs in seventh grade: N/A

Connections to other DCIs across grade levels: **1.LS1.B** (7-LS2-2); **6.ESS3.C** (7-LS2-5); **6.ESS3.D** (7-LS2-5); **8.LS4.D** (7-LS2-5)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (7-LS2-2)
RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (7-LS2-5)
RI.7.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (7-LS2-5)
WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (7-LS2-2)
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (7-LS2-2)

Connections to the Arkansas English Language Arts Standards –

SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. (7-LS2-2)
SL.7.4 Present claims and findings, emphasizing primary points in a focused, coherent manner with pertinent descriptions, facts, details and examples; use appropriate eye contact, adequate volume, and clear pronunciation. (7-LS2-2)

Connections to the Arkansas Mathematics Standards –

MP.4 Model with mathematics. (7-LS2-5)
6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (7-LS2-5)
6.SP.B.5 Summarize numerical data sets in relation to their context. (7-LS2-2)

GRADE SEVEN

Matter and Energy in Organisms and Ecosystems

Students who demonstrate understanding can:

7-LS1-6 **Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.** [Clarification Statement: Emphasis is on tracing movement of matter and flow of energy.] [Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.]

7-LS1-7 **Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.** [Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.] [Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.]

7-LS2-1 **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.]

7-LS2-3 **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.]

7-LS2-4 **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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to describe phenomena. (7-LS2-3)
- Develop a model to describe unobservable mechanisms. (7-LS1-7)

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. (7-LS2-1)

Disciplinary Core Ideas

LS1.C: Organization for Matter and Energy Flow in Organisms
- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (7-LS1-6)
- 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. (7-LS1-7)

LS2.A: Interdependent Relationships in Ecosystems
- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (7-LS2-1)
- 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. (7-LS2-1)

Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (7-LS2-1)

Energy and Matter
- Matter is conserved because atoms are conserved in physical and chemical processes. (7-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (7-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (7-LS2-3)

Stability and Change
- Small changes in one part of a system might cause large changes in another part. (7-LS2-4)

Constructing Explanations and Designing Solutions

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

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (7-LS1-6)

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. (7-LS2-4)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical connections between evidence and explanations. (7-LS1-6)
- Science disciplines share common rules of obtaining and evaluating empirical evidence. (7-LS2-4)

- Growth of organisms and population increases are limited by access to resources. (7-LS2-1)

LS2.B: 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. (7-LS2-3)

LS2.C: 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. (7-LS2-4)

PS3.D: Energy in Chemical Processes and Everyday Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (7-LS1-6)
- 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. (7-LS1-7)

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (7-LS2-3)

Connections to other DCIs in seventh grade: **7.PS1.B** (7-LS1-6, 7-LS1-7, 7-LS2-3); **7.ESS2.A** (7-LS1-6, 7-LS2-3, 7-LS2-4); **7.ESS3.A** (7-LS2-1, 7-LS2-4)

Connections to other DCIs across grade levels: **3.LS2.C** (7-LS2-1, 7-LS2-4); **3.LS4.D** (7-LS2-1, 7-LS2-4); **5.PS3.D** (7-LS1-6, 7-LS1-7); **5.LS1.C** (7-LS1-6, 7-LS1-7); **5.LS2.A** (7-LS1-6, 7-LS2-1, 7-LS2-3); **5.LS2.B** (7-LS1-6, 7-LS1-7, 7-LS2-3); **6.LS1.C** (7-LS1-6, 7-LS1-7, 7-LS2-3); **6.ESS2.D** (7-LS1-6); **6.ESS2.E** (7-LS2-4); **6.ESS3.C** (7-LS2-4); **8.PS3.B** (7-LS2-3); **8.LS4.C** (7-LS2-1, 7-LS2-4); **8.LS4.D** (7-LS2-1, 7-LS2-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (7-LS1-6, 7-LS2-1, 7-LS2-4)
RST.6-8.2	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (7-LS1-6)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-LS2-1)
RI.7.8	Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (7-LS2-4)
WHST.6-8.1	Write arguments focused on discipline-specific content. (7-LS2-4)
WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (7-LS1-6)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (7-LS1-6, 7-LS2-4)

Connections to the Arkansas English Language Arts Standards –

SL.7.5	Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize the primary points. (7-LS1-7, 7-LS2-3)

Connections to the Arkansas Mathematics Standards –

6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another**.** Write an equation to express one quantity, thought as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the question. (7-LS1-6, 7-LS2-3)

Earth's Systems

Students who demonstrate understanding can:

7-ESS2-1 **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.** [**AR** 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. Arkansas specific examples of geologic materials include Karst, bauxite, and diamonds.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]

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

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

Developing and Using Models

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

- Develop and use a model to describe phenomena. (7-ESS2-1)

Constructing Explanations and Designing Solutions

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

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (7-ESS3-1)

Disciplinary Core Ideas

ESS2.A: 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. (7-ESS2-1)

ESS3.A: Natural Resources

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. (7-ESS3-1)

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (7-ESS3-1)

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. (7-ESS2-1)

Connections to Engineering, Technology, and Applications of Science

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

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (7-ESS3-1)

Connections to other DCIs in seventh grade: **7.PS1.A** (7-ESS2-1, 7-ESS3-1); **7.PS1.B** (7-ESS2-1, 7-ESS3-1); **7.LS2.B** (7-ESS2-1); **7.LS2.C** (7-ESS2-1)
Connections to other DCIs across grade levels: **4.PS3.B** (7-ESS2-1); **4.PS3.D** (7-ESS3-1); **4.ESS2.A** (7-ESS2-1); **4.ESS3.A** (7-ESS3-1); **5.ESS2.A** (7-ESS2-1); **6.LS1.C** (7-ESS2-1, 7-ESS3-1); **6.ESS2.E** (7-ESS2-1); **8.PS3.B** (7-ESS2-1, 7-ESS3-1); **8.PS4.B** (7-ESS2-4)
Connections to the Arkansas Disciplinary Literacy Standards – **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (7-ESS3-1) **WHST.6-8.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (7-ESS3-1) **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (7-ESS3-1) *Connections to the Arkansas English Language Arts Standards –* **SL.7.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize the primary points. (7-ESS2-1) *Connections to the Arkansas Mathematics Standards –* **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (7-ESS3-1) **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution of identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q >$ or $px + q < r$ where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. (7-ESS3-1)

History of Earth

Students who demonstrate understanding can:

7-ESS2-2 **Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.** [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]

7-ESS2-3 **Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.** [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, or trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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 provide evidence for phenomena. (7-ESS2-3)

Constructing Explanations and Designing Solutions

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

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.(7-ESS2-2)

Connections to Nature of Science

Scientific Knowledge is Open to Revision in Light of New Evidence

- Science findings are frequently revised and/or reinterpreted based on new evidence. (7-ESS2-3)

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (7-ESS2-3)

ESS2.A: Earth's Materials and Systems

- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (7-ESS2-2)

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

- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (7-ESS2-3)

ESS2.C: The Roles of Water in Earth's Surface Processes

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. (7-ESS2-2)

Crosscutting Concepts

Patterns

- Patterns in rates of change and other numerical relationships can provide information about natural systems. (7-ESS2-3)

Scale Proportion and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (7-ESS2-2)

Connections to other DCIs in seventh grade: **7.PS1.B** (7-ESS2-2); **7.LS2.B** (7-ESS2-2)

Connections to other DCIs across grade levels: **3.LS4.A** (7-ESS2-3); **3.ESS3.B** (7-ESS2-3); **4.ESS1.C** (7-ESS2-2, 7-ESS2-3); **4.ESS2.A** (7-ESS2-2); **4.ESS2.B** (7-ESS2-3); **4.ESS2.E** (7-ESS2-2); **4.ESS3.B** (7-ESS2-3); **5.ESS2.A** (7-ESS2-2); **6.PS3.D** (7-ESS2-2); **6.ESS2.D** (7-ESS2-2); **6.ESS2.E** (7-ESS2-2); **6.ESS3.D** (7-ESS2-2); **8.LS4.A** (7-ESS2-3); **8.LS4.C** (7-ESS2-3); **8.ESS1.C** (7-ESS2-2, 7-ESS2-3)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (7-ESS2-2, 7-ESS2-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-ESS2-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (7-ESS2-3)

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (7-ESS2-2)

Connections to the Arkansas English Language Arts Standards –

SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize the primary points. (7-ESS2-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (7-ESS2-2, 7-ESS2-3)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (7-ESS2-2, 7-ESS2-3)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution of identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q >$ or $px + q < r$ where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem (7-ESS1-4, 7-ESS2-2, 7-ESS2-3)

GRADE SEVEN

Human Impacts

Students who demonstrate understanding can:

7-ESS3-2 **Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.** [Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (7-ESS3-2)	**ESS3.B: Natural Hazards** ▪ Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (7-ESS3-2)	**Patterns** ▪ Graphs, charts, and images can be used to identify patterns in data. (7-ESS3-2) -- **Connections to Engineering, Technology, and Applications of Science** **Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (7-ESS3-2)

Connections to other DCIs in seventh grade: N/A

Connections to other DCIs across grade levels: **3.ESS3.B** (7-ESS3-2); **4.ESS3.B** (7-ESS3-2); **6.ESS2.D** (7-ESS3-2); **6.ESS3.D** (7-ESS3-2)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (7-ESS3-2)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-ESS3-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (7-ESS3-2)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (7-ESS3-2)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution of the inequality and interpret it in the context of the problem. (7-ESS3-2)

Engineering, Technology, and Applications of Science

Students who demonstrate understanding can:

7-ETS1-1 **Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.** [**AR** Clarification Statement: Examples could include designing technologies (e.g., levees, dams, storm shelters) and determining their ability to mitigate the effects of future weather events.

7-ETS1-2 **Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** [**AR** Clarification Statement: Examples could include evaluating human technologies (e.g., levees, dams, storm shelters) and determining their ability to mitigate the effects of future weather events.]

7-ETS1-3 **Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.** [**AR** Clarification Statement: Examples could include performing a school energy audit, evaluating the recycling program in the school or local area, or determining alternative transportation options for residents in rural or urban areas.]

7-ETS1-4 **Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.** [**AR** Clarification Statement: Examples could include creating a variety of devices that perform an assortment of tasks (such as design and test airplane wings and determine the success of the design by how far the airplane can be piloted]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (7-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (7-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (7-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (7-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (7-ETS1-2, 7-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (7-ETS1-3) ▪ Models of all kinds are important for testing solutions. (7-ETS1-4) **ETS1.C: Optimizing the Design Solution**	**Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (7-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (7-ETS1-1)

▪ Analyze and interpret data to determine similarities and differences in findings. (7-ETS1-3) **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. ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (7-ETS1-2)	▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (7-ETS1-3) ▪ 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. (7-ETS1-4)	

Connections to 6-8.ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** (6-PS3-3)
Connections to 6-8.ETS1.B: Developing Possible Solutions Problems include: **Physical Science:** (7-PS1-6, 6-PS3-3); **Life Science:** (7-LS2-5)
Connections to 6-8.ETS1.C: Optimizing the Design Solution include: **Physical Science**: (7-PS1-6)

Connections to other DCIs across grade levels: **3-5.ETS1.A** (7-ETS1-1, 7-ETS1-2, 7-ETS1-3); **3-5.ETS1.B** (7-ETS1-2, 7-ETS1-3, 7-ETS1-4); **3-5.ETS1.C** (7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (7-ETS1-1, 7-ETS1-2, 7-ETS1-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (7-ETS1-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (7-ETS1-2, 7-ETS1-3)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (7-ETS1-2)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (7-ETS1-1)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (7-ETS1-2)

Connections to the Arkansas English Language Arts Standards –

SL.7.5 Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize the primary points. (7-ETS1-4)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (7-ETS1-1, 7-ETS1-2, 7-ETS1-3, 7-ETS1-4)

7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form using tools strategically. Apply properties of operations to calculate with numbers in any form. Convert between forms as appropriate. Assess the reasonableness of answers using mental computation and estimation strategies. (7-ETS1-1, 7-ETS1-2, 7-ETS1-3)

7.SP.C.7 Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. Develop a uniform probability model, assigning equal probability to all outcomes, and use the model to determine probabilities of events. Develop a probability model, which may not be uniform, by observing frequencies in data generated from a chance process. (7-ETS1-4)

Grade 8 Learning Progression by Topic

Grade 8						
PHYSICAL SCIENCES			EARTH and SPACE SCIENCES		LIFE SCIENCES	
Waves and Electromagnetic Radiation	Forces and Interactions	Energy	Space Systems	History of Earth	Growth, Development, and Reproduction of Organisms	Natural Selection and Adaptations
8-PS4-1	8-PS2-1	8-PS3-1**AR**	8-ESS1-1	8-ESS1-4	8-LS3-1	8-LS4-1
8-PS4-2	8-PS2-2	8-PS3-2	8-ESS1-2		8-LS4-5	8-LS4-2
8-PS4-3	8-PS2-3		8-ESS1-3			8-LS4-3
	8-PS2-4					8-LS4-4
	8-PS2-5					8-LS4-6
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4						

Arkansas Clarification Statement (**AR**)

Grade 8 Learning Progression by Disciplinary Core Idea

Grade 8					
PHYSICAL SCIENCES			EARTH and SPACE SCIENCES	LIFE SCIENCES	
Waves and Their Applications in Technologies for Information Transfer	Motion and Stability: Forces and Interactions	Energy	Earth's Place in the Universe	Heredity: Inheritance and Variation of Traits	Natural Selection and Adaptations
8-PS4-1	8-PS2-1	8-PS3-1 **AR**	8-ESS1-1	8-LS3-1	8-LS4-1
8-PS4-2	8-PS2-2	8-PS3-2	8-ESS1-2		8-LS4-2
8-PS4-3	8-PS2-3		8-ESS1-3		8-LS4-3
	8-PS2-4		8-ESS1-4		8-LS4-4
	8-PS2-5				8-LS4-5
					8-LS4-6
ENGINEERING, TECHNOLOGY, and APPLICATIONS of SCIENCE Engineering Design 8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4					

Arkansas Clarification Statement (**AR**)

Grade Eight Standards Overview

The Arkansas K-12 Science Standards are based on *A Framework for K-12 Science Education* (NRC 2012) and are meant to reflect a new vision for science education. The following conceptual shifts reflect what is new about these science standards. The Arkansas K-12 Science Standards

- reflect science as it is practiced and experienced in the real world,
- build logically from Kindergarten through Grade 12,
- focus on deeper understanding as well as application of content,
- integrate practices, crosscutting concepts, and core ideas, and
- make explicit connections to literacy and math.

Science and Engineering Practices

Students are expected to demonstrate grade-appropriate proficiency in

- analyzing and interpreting data,
- developing and using models,
- constructing explanations and designing solutions,
- engaging in argument from evidence,
- obtaining, evaluating, and communicating information,
- using mathematics and computational thinking, and
- planning and carrying out investigations.

Students are expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Crosscutting Concepts

Students are expected to demonstrate grade-appropriate understanding of

- cause and effect,
- scale, proportion and quantity,
- structure and function,
- systems and system models,
- stability and change,
- patterns, and
- the influence of engineering, technology, and science on society and the natural world as organizing concepts for the disciplinary core ideas.

Disciplinary Core Ideas

Students are expected to continually build on and revise their knowledge of

- PS2 - Motion and Stability: Forces and Interactions,
- PS3 - Energy,
- PS4 - Waves and Their Applications in Technologies for Information Transfer,
- LS3 - Heredity: Inheritance and Variation of Traits,
- LS4 - Biological Evolution: Unity and Diversity,
- ESS1 - Earth's Place in the Universe,
- ESS3 - Earth and Human Activity, and
- ETS1 - Engineering Design in a 6-8 developmental learning progression.

Physical Sciences (PS)

The (PS) performance expectations in eighth grade help students formulate answers to the questions, “What are the characteristic properties of waves and how can they be used?”, “How can Newton’s Third Law of Motion be used to explain the movement of objects?”, “How can one describe interactions between objects and within systems of objects?”, and “How can the total change of energy in any system be equal to the total energy transferred into or out of the system?” Students are expected to develop understanding of waves and electromagnetic radiation, forces and interactions, and energy.

Life Sciences (LS)

The (LS) performance expectations in eighth grade help students explore the questions, “How does genetic variation among organisms in a species affect survival and reproduction?”, “What are the ethical responsibilities related to selective breeding?”, and “How does the environment influence genetic traits in populations over multiple generations?” Students are expected to develop understanding of natural selection and adaptation, and growth, development, and reproduction.

Earth and Space Science (ESS)

The (ESS) performance expectations in eighth grade help students investigate the questions, “How have instruments and technology allowed us to explore objects in the solar system and obtain data to support the theories of the origin and evolution of the universe?” and “How can models be used to explain cyclic patterns of eclipses, tides, and seasons?” Students are expected to develop understanding of space systems, history of Earth, and human impacts.

Engineering, Technology, and Applications of Science (ETS)

Engineering design performance expectations in middle school continue to engage students in numerous design experiences. The goal at this level is to define problems more precisely, conduct a more thorough process for choosing the best solution, and optimize the final design. Students are able to develop these capabilities in various scientific contexts. The engineering design process involves three stages:

- **Defining and delimiting engineering problems with precision** involves thinking more deeply than is expected in the earlier grades about the needs a problem is intended to address or the goals a design is intended to reach. Students now are expected to consider not only the end user, but also the broader society and the environment. Every technological change is likely to have both intended and unintended effects. It is up to the designer to try to anticipate the effects it may have and to behave responsibly in developing a new or improved technology. These considerations may take the form of either criteria or constraints on possible solutions.
- **Designing solutions to engineering problems is a two stage process** in middle school of evaluating the different ideas that have been proposed by using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising, and by testing different solutions. Then designers combine the best ideas into a new solution that may be better than any of the preliminary ideas.
- **Optimizing the engineering design** involves an iterative process in which students test the best design, analyze the results, modify the design accordingly, and then re-test and modify the design again. Students may go through this cycle multiple times in order to reach the best possible result.

By the end of the eighth grade students should able to achieve all four performance expectations (8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4) related to a single problem in order to understand the interrelated processes of engineering design. Students can use tools and materials to solve problems, use visual or physical representations to convey solutions, and optimize solutions to a problem, test them, and determine which is best. These component ideas do not always follow in order. At any stage, a problem-solver can redefine the problem or generate new solutions to replace an idea that is not working.

Waves and Electromagnetic Radiation

Students who demonstrate understanding can:

8-PS4-1 **Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.** [Clarification Statement: Emphasis is on describing waves applying both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.]

8-PS4-2 **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.]

8-PS4-3 **Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.** [Clarification Statement: Emphasis is on the 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 Wi-Fi 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.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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. (8-PS4-2)

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. (8-PS4-1)

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. (8-PS4-3)

Disciplinary Core Ideas

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (8-PS4-1)
- A sound wave needs a medium through which it is transmitted. (8-PS4-2)

PS4.B: 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. (8-PS4-2)
- 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. (8-PS4-2)
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (8-PS4-2)
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (8-PS4-2)

PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (8-PS4-3)

Crosscutting Concepts

Patterns

- Graphs and charts can be used to identify patterns in data. (8-PS4-1)

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. (8-PS4-2)
- Structures can be designed to serve particular functions. (8-PS4-3)

Connections to Engineering, Technology, and Applications of Science

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

- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (8-PS4-3)

--- **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (8-PS4-1)		--- **Connections to Nature of Science** **Science is a Human Endeavor** ▪ Advances in technology influence the progress of science and science has influenced advances in technology. (8-PS4-3)

Connections to other DCIs in eighth grade: N/A

Connections to other DCIs across grade levels: **4.PS3.A** (8-PS4-1); **4.PS3.B** (8-PS4-1); **4.PS4.A** (8-PS4-1); **4.PS4.B** (8-PS4-2); **4.PS4.C** (8-PS4-3); **6.ESS2.D** (8-PS4-2); **7.ESS2.A** (8-PS4-2); **7.ESS2.C** (8-PS4-2)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-PS4-3)

RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (8-PS4-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (8-PS4-3)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (8-PS4-3)

Connections to the Arkansas English Language Arts Standards –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (8-PS4-1, 8-PS4-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (8-PS4-1)

MP.4 Model with mathematics. (8-PS4-1)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (8-PS4-1)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (8-PS4-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (8-PS4-1)

8.F.A.3 Identify the unique characteristics of functions (e.g., linear, quadratic, and exponential) by comparing their graphs, equations, and input/ output tables. (8-PS4-1)

GRADE EIGHT

Forces and Interactions
Students who demonstrate understanding can: **8-PS2-1** **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.] **8-PS2-2** **Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [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.] **8-PS2-3** **Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.** [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, and 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.] **8-PS2-4** **Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.** [Clarification Statement: Examples of evidence for arguments could include charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system or data generated from simulations or digital tools.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.] **8-PS2-5** **Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.** [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ▪ Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (8-PS2-3) **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use <u>multiple variables</u> and provide evidence to support explanations or design solutions.	**PS2.A: Forces and Motion** ▪ For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (8-PS2-1) ▪ 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. (8-PS2-2)	**Cause and Effect** ▪ Cause and effect relationships may be used to predict phenomena in natural or designed systems. (8-PS2-3, 8-PS2-5) **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. (8-PS2-1, 8-PS2-4) **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. (8-PS2-2) ---

- 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. (8-PS2-2)
- 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. (8-PS2-5)

Constructing Explanations and Designing Solutions

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

- Apply scientific ideas or principles to design an object, tool, process or system. (8-PS2-1)

Engaging in Argument from Evidence

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

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (8-PS2-4)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (8-PS2-2, 8-PS2-4)

- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (8-PS2-2)

PS2.B: Types of Interactions

- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (8-PS2-3)
- 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. (8-PS2-4)
- 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). (8-PS2-5)

Connections to Engineering, Technology, and Applications of Science

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

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (8-PS2-1)

Connections to other DCIs in eighth grade: **8.PS3.A** (8-PS2-2); **8.PS3.B** (8-PS2-2); **8.ESS1.A** (8-PS2-4); **8.ESS1.B** (8-PS2-4)

Connections to other DCIs across grade levels: **3.PS2.A** (8-PS2-1, 8-PS2-2); **3.PS2.B** (8-PS2-3, 8-PS2-5); **5.PS2.B** (8-PS2-4); **6.PS3.C** (8-PS2-5)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-PS2-1, 8-PS2-3)

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (8-PS2-1, 8-PS2-2, 8-PS2-5)

WHST.6-8.1 Write arguments focused on discipline-specific content. (8-PS2-4)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (8-PS2-1, 8-PS2-2, 8-PS2-5)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (8-PS2-1, 8-PS2-2, 8-PS2-3)

6.NS.C.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values, explaining the meaning of 0. (8-PS2-1)

6.EE.A.2 Write, read, and evaluate expressions in which letters (variables) stand for numbers. (8-PS2-1, 8-PS2-2)

7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form using tools strategically. Apply properties of operations to calculate with numbers in any form.

	Convert between forms as appropriate. Assess the reasonableness of answers using mental computation and estimation strategies. (8-PS2-1, 8-PS2-2)
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of problem. (8-PS2-1, 8-PS2-2)

GRADE EIGHT

Energy

Students who demonstrate understanding can:

8-PS3-1 **Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.** [**AR** 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 sized rocks downhill, or getting hit by a plastic ball versus a tennis ball.]

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

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (8-PS3-2) **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. (8-PS3-1)	**PS3.A: Definitions of Energy** ▪ Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (8-PS3-1) ▪ A system of objects may also contain stored (potential) energy, depending on their relative positions. (8-PS3-2) **PS3.C: Relationship Between Energy and Forces** ▪ When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (8-PS3-2)	**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. (8-PS3-1) **Systems and System Models** ▪ Models can be used to represent systems and their interactions – e.g., processes, and outputs – and energy and matter flows within systems. (8-PS3-2)

Connections to other DCIs in eighth grade: **8.PS2.A** (8-PS3-1)

Connections to other DCIs across grade levels: **4.PS3.B** (8-PS3-1); **6.PS3.C** (8-PS3-2)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-PS3-1)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (8-PS3-1)

Connections to the Arkansas English Language Arts Standards –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (8-PS3-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (8-PS3-1)

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (8-PS3-1)

6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. (8-PS3-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (8-PS3-1)

8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions using product, quotient, power to a power, or expanded form. (8-PS3-1)
8.EE.A.2	Use square root and cube root symbols to represent solutions to equations. Use square root symbols to represent solutions to equations of the form $x^2 = p$, where p is a positive rational number. Evaluate square roots of small prefect squares. Use cube root symbols to represent solutions to equations of the form x^3 = p, where *p* is a rational number. Evaluate square roots and cube roots of small perfect cubes. (8-PS3-1)
8.F.A.3	Interpret the unique characteristics of functions (e.g., linear, quadratic, and exponential) by comparing their graphs, equations, and input/output tables. (8-PS3-1)

GRADE EIGHT

Space Systems

Students who demonstrate understanding can:

8-ESS1-1 **Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.** [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

8-ESS1-2 **Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.** [Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]

8-ESS1-3 **Analyze and interpret data to determine scale properties of objects in the solar system.** [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, or 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 or atmosphere), surface features (such as volcanoes), or orbital radius. Examples of data include statistical information, drawings and photographs, or models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets or other solar system bodies.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices

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

- Develop and use a model to describe phenomena. (8-ESS1-1),(8-ESS1-2)

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. (8-ESS1-3)

Disciplinary Core Ideas

ESS1.A: The Universe and Its Stars

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (8-ESS1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (8-ESS1-2)

ESS1.B: Earth and the Solar System

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. (8-ESS1-2),(8-ESS1-3)
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (8-ESS1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (8-ESS1-2)

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause and effect relationships. (8-ESS1-1)

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. (8-ESS1-3)

Systems and System Models

- Models can be used to represent systems and their interactions. (8-ESS1-2)

Connections to Engineering, Technology, and Applications 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. (8-ESS1-3)

		--- **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (8-ESS1-1, 8-ESS1-2)

Connections to other DCIs in eighth grade: **8.PS2.A** (8-ESS1-1, 8-ESS1-2); **8.PS2.B** (8-ESS1-1, 8-ESS1-2)

Connections to other DCIs across grade levels: **3.PS2.A** (8-ESS1-1, 8-ESS1-2); **5.PS2.B** (8-ESS1-1, 8-ESS1-2); **5.ESS1.A** (8-ESS1-2); **5.ESS1.B** (8-ESS1-1, 8-ESS1-2, 8-ESS1-3); **7.ESS2.A** (8-ESS1-3)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-ESS1-3)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (8-ESS1-3)

Connections to the Arkansas English Language Arts Standards –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (8-ESS1-1, 8-ESS1-2)

Connections to the Arkansas Mathematics Standards –

MP.2 Reason abstractly and quantitatively. (8-ESS1-3)

MP.4 Model with mathematics. (8-ESS1-1, 8-ESS1-2)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (8-ESS1-1, 8-ESS1-2, 8-ESS1-3)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (8-ESS1-1, 8-ESS1-2, 8-ESS1-3)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (8-ESS1-2)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. (8-ESS1-2)

History of Earth

Students who demonstrate understanding can:

8-ESS1-4 Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of Homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains or ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.]

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (8-ESS1-4)	**ESS1.C: The History of Planet Earth** ▪ The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (8-ESS1-4)	**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. (8-ESS1-4)

Connections to other DCIs in eighth grade: **8.LS4.C** (8-ESS1-4)

Connections to other DCIs across grade levels: **3.LS4.A** (8-ESS1-4); **3.LS4.C** (8-ESS1-4); **4.ESS1.C** (8-ESS1-4); **7.PS1.C** (8-ESS1-4); **7.ESS2.A** (8-ESS1-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-ESS1-4)

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (8-ESS1-4)

Connections to the Arkansas Mathematics Standards –

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (8-ESS1-4)

7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem. Construct simple equations and inequalities to solve problems by reasoning about the quantities. Solve word problems leading to equations of these forms $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Write an algebraic solution identifying the sequence of the operations used to mirror the arithmetic solution. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. (8-ESS1-2)

Growth, Development, and Reproduction of Organisms
Students who demonstrate understanding can: **8-LS3-1** **Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.** [Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.] **8-LS4-5** **Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.** [Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, or gene therapy); or, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (8-LS3-1) **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. (8-LS4-5)	**LS3.A: Inheritance of Traits** ▪ Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (8-LS3-1) **LS3.B: Variation of Traits** ▪ In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (8-LS3-1) **LS4.B: Natural Selection** ▪ In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (8-LS4-5)	**Cause and Effect** ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (8-LS4-5) **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. (8-LS3-1) ---------- **Connections to Engineering, Technology, and Applications 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. (8-LS4-5)

		--- **Connections to Nature of Science** **Science Addresses Questions About the Natural and Material World** ▪ Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (8-LS4-5)

Connections to other DCIs in eighth grade: **8.LS1.A** (8-LS3-1); **8.LS4.A** (8-LS3-1)

Connections to other DCIs across grade levels: **3.LS3.A** (8-LS3-1, 8-LS3-2); **3.LS3.B** (8-LS3-1); **6.LS1.A** (8-LS3-1); **6.LS1.B** (8-LS3-1); **6.LS3.B** (8-LS3-1, 8-LS4-5)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-LS3-1),(8-LS4-5)

RST.6-8.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to Grades 6-8 texts and topics. (8-LS3-1)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (8-LS3-1)

WHST.6-8.8 Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (8-LS4-5)

Connections to the Arkansas English Language Arts Standards –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (8-LS3-1)

Connections to the Arkansas Mathematics Standards – N/A

Natural Selection and Adaptations
Students who demonstrate understanding can: **8-LS4-1** **Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** [Clarification Statement: Emphasis is on finding patterns of change in the level of complexity of anatomical structures in organisms or 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.] **8-LS4-2** **Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.** [Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarities or differences of the gross appearance of anatomical structures.] **8-LS4-3** **Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.** [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.] **8-LS4-4** **Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.** **8-LS4-6** **Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.** [Clarification Statement: Emphasis is on using mathematical models, probability statements, or proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (8-LS4-3) ▪ Analyze and interpret data to determine similarities and differences in findings. (8-LS4-1) **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. (8-LS4-6)	**LS4.A: Evidence of Common Ancestry and Diversity** ▪ The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (8-LS4-1) ▪ Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (8-LS4-2) ▪ Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (8-LS4-3)	**Patterns** ▪ Patterns can be used to identify cause and effect relationships. (8-LS4-2) ▪ Graphs, charts, and images can be used to identify patterns in data. (8-LS4-1, 8-LS4-3) **Cause and Effect** ▪ Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (8-LS4-4, 8-LS4-6)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. ▪ Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (8-LS4-2) ▪ Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (8-LS4-4) --- **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** ▪ Science knowledge is based upon logical and conceptual connections between evidence and explanations. (8-LS4-1)	**LS4.B: Natural Selection** ▪ Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (8-LS4-4) **LS4.C: Adaptation** ▪ Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (8-LS4-6)	--- **Connections to Nature of Science** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** ▪ Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (8-LS4-1, 8-LS4-2)

Connections to other DCIs in eighth grade: **8.LS3.A** (8-LS4-2),(8-LS4-4); **8.ESS1.C** (8-LS4-1),(8-LS4-2),(8-LS4-6)

Connections to other DCIs across grade levels: **3.LS3.B** (8-LS4-4); **3.LS4.A** (8-LS4-1, 8-LS4-2); **3. LS4.B** (8-LS4-4); **3.LS4.C** (8-LS4-6); **7.LS2.A** (8-LS4-4, 8-LS4-6); **7.LS2.C** (8-LS4-6); **6.LS3.B** (8-LS4-4, 8-LS4-6)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (8-LS4-1, 8-LS4-2, 8-LS4-3, 8-LS4-4)

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (8-LS4-1, 8-LS4-3)

RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (8-LS4-3, 8-LS4-4)

WHST.6-8.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (8-LS4-2, 8-LS4-4)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (8-LS4-2, 8-LS4-4)

Connections to the Arkansas English Language Arts Standards –

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on Grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (8-LS4-2, 8-LS4-4)

SL.8.4 Present claims and findings, emphasizing the most important points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (8-LS4-2, 8-LS4-4)

Connections to the Arkansas Mathematics Standards –

MP.4 Model with mathematics. (8-LS4-6)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (8-LS4-4, 8-LS4-6)

6.SP.B.5 Summarize numerical data sets in relation to their context. (8-LS4-4, 8-LS4-6)

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number or any number in a specified set. (8-LS4-1, 8-LS4-2)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (8-LS4-4, 8-LS4-6)

Engineering, Technology, and Applications of Science
Students who demonstrate understanding can: **8-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.** AR Clarification: Examples could include designing methods for monitoring human impacts and designing solutions to environmental challenges (such as water quality testing, etc.). **8-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.** [**AR** Clarification Statement: Students could investigate ways that humans consume resources and design a solution to a problem created by increased human population and consumption.] **8-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.** [**AR** Clarification Statement: Examples could include analyzing data collected from areas such as GMO crops, gene therapy, selective breeding, etc. to determine the success of the technology used.] **8-ETS1-4 Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.** [**AR** Clarification Statement: Examples could include exploring the sources of synthetic materials such as plastics, toxins, fertilizers, etc. and their impacts on the society and the environment.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. ▪ Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (8-ETS1-1) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ▪ Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (8-ETS1-4) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ▪ Analyze and interpret data to determine similarities and differences in findings. (8-ETS1-3)	**ETS1.A: Defining and Delimiting Engineering Problems** ▪ The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (8-ETS1-1) **ETS1.B: Developing Possible Solutions** ▪ A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (8-ETS1-4) ▪ There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (8-ETS1-2, 8-ETS1-3) ▪ Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (8-ETS1-3) ▪ Models of all kinds are important for testing solutions. (8-ETS1-4)	**Influence of Science, Engineering, and Technology on Society and the Natural World** ▪ All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (8-ETS1-1) ▪ The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (8-ETS1-1)

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. ▪ Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (8-ETS1-2)	**ETS1.C: Optimizing the Design Solution** ▪ Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (8-ETS1-3) ▪ 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. (8-ETS1-4)	

Connections to 6-8.ETS1.A: Defining and Delimiting Engineering Problems include: **Physical Science:** (6-PS3-3)
Connections to 6-8.ETS1.B: Developing Possible Solutions Problems include: **Physical Science:** (7-PS1-6, 6-PS3-3); **Life Science:** (7-LS2-5)
Connections to 6-8.ETS1.C: Optimizing the Design Solution include: **Physical Science**: (7-PS1-6)

Articulation to DCIs across grade levels: **3-5.ETS1.A** (6-8-ETS1-1, 6-8-ETS1-2, 6-8-ETS1-3); **3-5.ETS1.B** (6-8-ETS1-2, 6-8-ETS1-3, 6-8-ETS1-4); **3-5.ETS1.C** (6-8-ETS1-1, 6-8-ETS1-2, 6-8-ETS1-3, 6-8-ETS1-4)

Connections to the Arkansas Disciplinary Literacy Standards –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (8-ETS1-1, 8-ETS1-2, 8-ETS1-3)
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (8-ETS1-3)
RST.6-8.9	Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (8-ETS1-2, 8-ETS1-3)
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (8-ETS1-2)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (8-ETS1-1)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (8-ETS1-2)

Connections to the Arkansas English Language Arts Standards –

SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (8-ETS1-4)

Connections to the Arkansas Mathematics Standards –

MP.2	Reason abstractly and quantitatively. (8-ETS1-1, 8-ETS1-2, 8-ETS1-3, 8-ETS1-4)
7.EE.B.3	Solve multi-step, real-life, and mathematical problems posed with positive and negative rational numbers in any form using tools strategically. (8-ETS1-1, 8-ETS1-2, 8-ETS1-3)
7.SP.C.7	Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (8-ETS1-4)

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