ARKANSAS
K-12 SCIENCE STANDARDS
EDUCATION FOR A NEW GENERATION

Grade 8

2015

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

Table of Contents

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 plants need sunlight and water 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… …ssessment Boundary: Assessment does not include specific animal and plant names in specific habitats.]
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Student Performance Expectations (PEs)

Science and Engineering Practices

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 … question. (2-LS2-1)
- Make observations (firsthand or from media) to collect data that can be used to make comparisons. (2-LS4-1)

Designates which PE uses this practice

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)

Connections to the Nature of Science

Disciplinary Core Ideas

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 H…
- 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)

Designates which PE incorporates this disciplinary core idea (DCI)

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

Crosscutting Concepts

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 incorporates this crosscutting concept (CC)

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 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

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)

Disciplinary Core Ideas

PS3.A: Definitions of Energy

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

Crosscutting Concepts

Scale, Proportion, and Quantity

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

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

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)

Disciplinary Core Ideas

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)

Crosscutting Concepts

Cause and Effect

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

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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