Assessment Development Guide
Educator Resource
Science: Grade 8

This document is intended to describe how the Kansas assessments align to the Kansas standards. It illustrates how standards, evidence statements, performance level descriptors (PLDs), and depth of knowledge influence the Kansas summative assessment.

The Kansas science content standards serve as the foundation of the assessment. These standards are grouped into claims, which are composed of targets, and the assessment mirrors these same groupings. By assessing at the claim level, it is possible to highlight student mastery of the connected material contained in the standards. Emphasis on particular targets captures the focus, coherence, and rigor of the standards. These content emphases guide the development of each assessment.

Suggested Uses

Educators can use this document to

- better understand the standards and the assessment.
- understand what is expected of students in order to achieve performance level 3.
- check the alignment of curriculum and learning activities.
- ensure that long-range instructional plans match the major emphases of the standards.
- apply standards at the level of rigor necessary to allow students to demonstrate success or mastery within a balanced assessment system.
- develop learning goals.
- build a greater understanding of student, grade-level, school, and district results and plan for future learning activities accordingly.
- provide professional development opportunities within a school or district, and for vertical team planning, grade-level planning, and professional learning communities.

Evidence Statements

Evidence statements are derived from the content standards and describe the knowledge and skills that an assessment item or task elicits from students.

Evidence statements are also designed to provide guidance for teachers in creating classroom learning opportunities that align with the expectations of the standards. Evidence statements should not be used as a checklist of student understanding, nor should they be used to limit instructional practices.

Performance Level Descriptors

To help educators and parents understand students' performance at each level, PLDs are available for each test. PLDs define the knowledge, skills, and processes that students likely demonstrate at different levels of proficiency within the reporting categories (1, 2, 3, 4). PLDs are not inclusive: they do not describe all possible skills students could demonstrate at each of the levels. PLDs should not be viewed as checklists of what students should know or be able to do.

These PLDs appear on Individual Student Reports and describe student performance on the assessment.

Level 1: A student at Level 1 shows a *limited* ability to understand and use the skills and knowledge needed for post-secondary readiness.

Level 2: A student at Level 2 shows a *basic* ability to understand and use the skills and knowledge needed for post-secondary readiness.

Level 3: A student at Level 3 shows an *effective* ability to understand and use the skills and knowledge needed for post-secondary readiness.

Level 4: A student at Level 4 shows an *excellen*t ability to understand and use the skills and knowledge needed for post-secondary readiness.

Detailed descriptions of performance levels for grade 8 science are contained within this document.

Depth of Knowledge

The Kansas Assessment Program (KAP) uses Webb's depth of knowledge (DOK) framework to classify each assessment item based on the level of cognitive demand required by students. The four DOK levels **do not** directly correspond to the four performance levels of the KAP summative assessments.

DOK is a measure of cognitive complexity, not a measure of difficulty. Item difficulty is determined by the percentage of students who correctly respond to an item. It is possible for a DOK 2 item to be very difficult and for a DOK 3 item to be relatively easy.

Items within an assessment include a range of DOK levels and correspond to the levels of cognitive complexity required by the content standards. There are four DOK levels, as outlined below.

Level 1 Recall and Reproduction: Recall a fact, term, definition, principle, or concept; perform a simple procedure.

Level 2 Basic Application of Skills and Concepts: Apply conceptual knowledge; use provided information to select appropriate procedures for a task; perform two or more steps with decision points along the way; solve routine problems; organize or display data; interpret or use simple graphs.

Level 3 Strategic Thinking: Apply reasoning, using evidence, and developing a plan to approach or solve abstract, complex, or nonroutine problems; interpret information and provide justification when more than one approach is possible.

Level 4 Extended Thinking: Perform investigations or apply concepts and skills that require research and problem-solving across content areas or multiple sources.

Test Content Summary

The test summary provides general information related to the development and frequency of items on the summative assessment. Individual standards, while important, are impossible to accurately measure with limited testing time. By assessing at the claim level, it is possible to highlight student comprehension of the connected material contained in the standards. The pattern of emphasis for the targets that comprise the claims is adapted from the work of national science assessment initiatives and captures the focus, coherence, and rigor of the standards. Therefore, the emphasis assigned to each target varies. However, all content is eligible for assessment, and the balance of tested content is derived from the expectations of the standards.

The claims are the broadest categories of knowledge, skills, and abilities about which inferences can be drawn. At eighth grade, the claims are physical science, life science, and Earth and space science. Claims represent the domains of the targets; targets represent topics in the standards. The evidence statements for each target describe the performance expected of students who have mastered the topic in the standards.

The goal DOK is provided as a general reference for the projected maximum DOK of items. Typically, items are at DOK 2 or 3 to complement the performance expectations of the standards. DOK 4 is generally reserved for complex tasks requiring data analysis.

TABLE 1. Grade 8 Science Test Summary

Physical Science	Percentage of Assessment	Depth of Knowledge
Structure and Properties of Matter	27%–33%	2, 3
Chemical Reactions		
Forces and Interactions		
Energy		
Waves		
Engineering Design		
Life Science	**Percentage of Assessment**	**Depth of Knowledge**
Structure and Function	34%–40%	2, 3
Matter and Energy in Organisms and Ecosystems		
Interdependent Relationships in Ecosystems		
Inheritance and Variation of Traits		
Natural Selection and Evolution		
Engineering Design		
Earth and Space Science	**Percentage of Assessment**	**Depth of Knowledge**
Space Systems	27%–33%	2, 3
History of Earth		
Earth's Systems		
Weather and Climate		
Human Sustainability		
Engineering Design		

Kansas Assessment Program Specifications

The Kansas science standards are a set of specific, rigorous expectations that build students' conceptual understanding and ability to apply processes and procedures across grades. The standards are designed to establish a focused, deep understanding of science and engineering and to develop a logical progression of scientific conceptual knowledge and engineering applications, moving students toward college and career readiness.

The Kansas science standards are organized into domains of disciplinary core ideas (DCI), topics, and performance expectation standards. The performance expectations are the most specific level of the science standards and define what students should understand and be able to do. A common criticism of academic achievement tests is that they focus on the level of the standard, which in many cases is a very discrete part of science understanding but does not reflect the depth and breadth of student knowledge. Parsing science out in this way for assessment may not be the most accurate model for assessing student achievement. The acquisition of discrete facts is usually neither how students learn nor how teachers teach. Instead, students commonly incorporate concepts from all three dimensions of disciplinary content knowledge, crosscutting concepts, and science and engineering practices to solve real-world problems, such as determining which products to use to meet material, time, and budget constraints in a construction scenario.

Therefore, test development for the Kansas summative assessment focuses on item development at the level of the topic. Topics are groups of related performance expectations in terms of content. (Note: The DCI arrangement has the same performance expectations in a different grouping.) The topics are reflected in this document as targets (e.g., target A, target B).

To report meaningful results, the targets are organized into larger claims about student learning and mastery. These claims are based on the first three domains of the standards: physical science, life science, and Earth and space science. The fourth domain, engineering, is included as a target within each of the three claims. Each target within a claim is followed by evidence statements that guide item writers in creating test questions that give students the opportunity to demonstrate mastery of that target. The performance expectations, from which the evidence statements are derived, are given below each target as well. For each claim, all targets will be assessed; there will be no nonassessed targets. Each claim will comprise 25%–35% of the assessment so that all domains will be approximately equal in assessment emphasis. Each claim will also include deeper problem-solving strategies.

Although the performance expectations are given with the targets and claims, there may be targets in which not all performance expectations will be assessed. While not all targets will be equally emphasized in the test, all of the content described by the target is important. Some of the content in a target may also be reflected in another target, or the content in a target in the current grade may be a critical foundation skill for success in subsequent grades. Thus, attempts to pattern instruction on the perceived or actual numbers of items in a test may not adequately serve students' needs.

Claim 1: Physical Science

Students are able to comprehend and explain physical science concepts and practices, as well as apply their knowledge to scientific investigations and engineering design problems with precision and accuracy.

The evidence statements marked with an asterisk (*) integrate traditional science content with engineering through a practice or domain.

Target A Understand the structure, properties, and interactions of matter at the molecular scale.

Standards MS-PS1-1, MS-PS1-3, MS-PS1-4

Evidence Statements
Students who demonstrate understanding can 1. develop models to describe the atomic composition of simple molecules and extended structures. 2. gather and make sense of information to describe that synthetic materials come from natural resources and impact society. 3. 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.

Target B Understand chemical reactions at the molecular scale.

Standards MS-PS1-1, MS-PS1-5, MS-PS1-6

Evidence Statements
Students who demonstrate understanding can 1. analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. 2. 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. 3. undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*

Target C Understand the relationships among forces and motion and interactions between objects and within systems of objects.

Standards MS-PS2-1, MS-PS2-2, MS-PS2-3, MS-PS2-4, MS-PS2-5

Evidence Statements
Students who demonstrate understanding can 1. apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.* 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. 3. ask questions about data to determine the factors that affect the strength of electric and magnetic forces. 4. construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. 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.

Target D Understand how energy is defined, transferred, transformed, and conserved by objects and within systems.

Standards MS-PS3-1, MS-PS3-2, MS-PS3-3, MS-PS3-4, MS-PS3-5

Evidence Statements
Students who demonstrate understanding can 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. 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. 3. apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* 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. 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.

Target E Understand characteristic properties of waves and electromagnetic radiation and how they behave and transmit information.

Standards MS-PS4-1, MS-PS4-2, MS-PS4-3

Evidence Statements
Students who demonstrate understanding can 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. 2. develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. 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.

Target F Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in physical science.

Standards MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Evidence Statements
Students who demonstrate understanding can 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. 2. evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 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. 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.

Performance Level Descriptors (PLDs)			
	Level 2	**Level 3**	**Level 4**
Claim 1 Physical Science	Students in this range typically comprehend and **describe** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **low complexity** and **inconsistently** to problems of **moderate complexity** in the physical sciences (targets A–F).	Students in this range typically comprehend and **explain** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **moderate complexity** and **inconsistently** to problems of **high complexity** in the physical sciences (targets A–F).	Students in this range typically comprehend and **analyze** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **high complexity** in the physical sciences (targets A–F).
Target A Structure and Properties of Matter	Students can identify atomic or molecular structures, organize information about the chemical properties of substances, and describe the effects of temperature changes on substances.	Students can use models to describe atomic or molecular structures, relate collected information about the properties of designed materials to their chemical properties, and develop a model to describe changes to substances caused by temperature changes.	Students can use models to relate chemical properties to atomic or molecular structures, collect and synthesize information about the chemical properties of designed materials to evaluate potential impacts, and develop models to explain the chemical or physical changes that occur when the material's thermal energy changes.
Target B Chemical Reactions	Students can identify the occurrence of chemical reactions, describe how mass is conserved in a chemical reaction, and recognize different factors that cause changes in thermal energy.	Students can analyze data to identify the occurrence of chemical reactions, develop a model to describe how mass is conserved in a chemical reaction, and design a device that uses changes in thermal energy.	Students can support an argument with evidence for the occurrence of chemical changes, develop and use models to explain how mass is conserved in chemical reactions, and design and optimize a device that uses changes in thermal energy.

Target C Forces and Interactions	Students can observe and record the changes in motion of unbalanced forces, recognize that gravity is an attractive force between objects of various masses, and describe the effects of electric and magnetic fields on objects.	Students can investigate the changes in motion of unbalanced forces, use evidence to argue for the gravitational interaction between objects of various masses, and collect evidence for the effects of electric and magnetic fields on objects.	Students can investigate and analyze data from the changes in motion of unbalanced forces, evaluate evidence to argue for the gravitational interaction between objects of various masses, and collect evidence to explain the effects of electric and magnetic fields on objects.
Target D Energy	Students can describe the relationship of kinetic energy to the mass and speed of objects; identify potential energy in different systems; and describe how the temperature of objects depends upon energy, mass, and types of matter.	Students can construct and interpret data to describe the relationship of kinetic energy to the mass and speed of objects; develop a model to describe the interactions of objects in a system based upon potential energy; and investigate changes in temperature relating to energy transfer, mass, and types of matter.	Students can generate, collect, and interpret data to explain the relationship of kinetic energy to the mass and speed of objects; develop models to explain the interactions of objects in a system based upon different forms of potential energy; and investigate and analyze changes in temperature relating to energy transfer, mass, and types of matter.
Target E Waves and Electromagnetic Radiation	Students can identify various wave properties and behavior, observe how waves interact with different media, and describe the reliability of digital and analog signals.	Students can use mathematical representations to describe wave properties and behavior, develop models to describe wave interactions with different media, and support a claim for the reliability of digital over analog signals.	Students can use mathematical representations and models to describe wave properties and behavior, collect data and develop models that describe wave interactions with different media, and use evidence to support an argument for the reliability of digital over analog signals.

Target F Engineering Design in Physical Science	Students can describe potential impacts of a design, compare competing designs to solve a specific problem, use test data to compare design solutions, and explain how to improve a design through repeated testing.	Students can describe the potential impacts of a design in order to define criteria and constraints, evaluate competing designs to solve a specific problem using criteria and constraints, analyze test data to compare design solutions, and develop a model to optimize a design through repeated testing.	Students can evaluate the potential impacts of a design in order to prioritize criteria and constraints, support an argument for the best design to solve a specific problem using criteria and constraints, analyze test data to support an argument for an optimal design, and synthesize data to develop a model to optimize a design through repeated testing.

Claim 2: Life Science

Students are able to comprehend and explain life science concepts and practices, as well as apply their knowledge to scientific investigations and engineering design problems with precision and accuracy.

The evidence statements marked with an asterisk (*) integrate traditional science content with engineering through a practice or domain.

Target A Understand the relationship between an organisms' structures, their organization, and its life functions, including information processing.

Standards MS-LS1-1, MS-LS1-2, MS-LS1-3, MS-LS1-8

Evidence Statements
Students who demonstrate understanding can 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. 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. 3. use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. 4. gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Target B Understand how organisms use matter and energy and how it flows through an ecosystem.

Standards MS-LS1-6, MS-LS1-7, MS-LS2-1, MS-LS2-3, MS-LS2-4

Evidence Statements
Students who demonstrate understanding can 1. 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. 2. 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. 3. analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. 4. develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. 5. construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

Target C Understand how organisms interact within an environment to obtain matter and energy.

Standards MS-LS2-2, MS-LS2-5

Evidence Statements
Students who demonstrate understanding can 1. construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. 2. evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Target D Understand how organisms within an ecosystem use matter and energy to grow, develop, and reproduce.

Standards MS-LS1-4, MS-LS1-5, MS-LS3-1, MS-LS3-2, MS-LS4-5

Evidence Statements
Students who demonstrate understanding can 1. 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. 2. construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. 3. 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. 4. 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. 5. gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Target E Understand why the relationship between the environment and genetic variation within a species affects survival and reproduction over time.

Standards MS-LS4-1, MS-LS4-2, MS-LS4-3, MS-LS4-4, MS-LS4-6

Evidence Statements
Students who demonstrate understanding can 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. 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. 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. 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. 5. use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Target F Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in life science.

Standards MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Evidence Statements
Students who demonstrate understanding can 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. 2. evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 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. 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.

Performance Level Descriptors (PLDs)			
	Level 2	**Level 3**	**Level 4**
Claim 2 Life Science	Students typically comprehend and **describe** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **low complexity** and **inconsistently** to problems of **moderate complexity** in the life sciences (targets A–F).	Students typically comprehend and **explain** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **moderate complexity** and **inconsistently** to problems of **high complexity** in the life sciences (targets A–F).	Students typically comprehend and **analyze** scientific and engineering ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **high complexity** in the life sciences (targets A–F).
Target A Structure, Function, and Information Processing	Students can recognize that living things are made of cells, describe how cells or parts of cells work together, and describe how interacting groups of cells perform life functions.	Students can use data from investigations as evidence that living things are made of cells, develop models to describe how cells or parts of cells work together, and support an argument for how interacting groups of cells perform life functions.	Students can use models and data from investigations as evidence that living things are made of cells, develop models to support an argument for how cells or parts of cells work together, and critique an argument of how interacting groups of cells perform life functions.
Target B Matter and Energy in Organisms and Ecosystems	Students can explain how photosynthesis moves matter and energy through organisms in cycles, explain how energy is used in organisms, and describe how organisms within an ecosystem depend upon living and nonliving components.	Students can use evidence to explain how photosynthesis moves matter and energy through organisms in cycles, develop a model of chemical reactions involving food molecules to explain how energy is used in organisms, and develop a model that describes how organisms within an ecosystem depend upon the cycling of living and nonliving components.	Students can collect and use evidence to explain how photosynthesis moves matter and energy through organisms in cycles, collect data to develop a model of chemical reactions involving food molecules to explain how energy is used in organisms, and collect data to develop models that explain how organisms within an ecosystem depend upon the cycling of living and nonliving components.

Target C Interdependent Relationships in Ecosystems	Students can identify different interactions of organisms in ecosystems and describe the effects of human actions upon biodiversity.	Students can explain interaction patterns among organisms in ecosystems and evaluate solutions that minimize the effects of human actions upon biodiversity.	Students can make generalized hypotheses about interaction patterns among organisms in ecosystems and evaluate and refine solutions that minimize the effects of human actions upon biodiversity or upon ecosystem services.
Target D Growth, Development, and Reproduction in Organisms	Students can identify various animal behaviors or plant structures that affect reproduction, explain how genetic and environmental factors affect organisms, and identify information about how humans influence inheritance of traits in organisms.	Students can use evidence to support the claim that animal behaviors or plant structures affect reproduction, use evidence to explain how genetic and environmental factors affect organisms, and gather and synthesize information about how humans influence the inheritance of traits in organisms.	Students can gather and use evidence to support the claim that animal behaviors or plant structures affect reproduction; use models and evidence to explain how genetic and environmental factors affect organisms; and gather, synthesize, and communicate information about how humans influence the inheritance of traits in organisms.
Target E Natural Selection and Adaptations	Students can explain patterns of relatedness of organisms and fossils based on anatomy, recognize that specific traits will lead to increases or decreases in survival or reproduction chances, and predict changes in traits within populations over time.	Students can analyze data to explain patterns of relatedness of organisms and fossils based on anatomy, use evidence to explain why specific traits will lead to increases or decreases in survival or reproduction chances, and use mathematical relationships to explain changes in traits within populations over time.	Students can investigate and analyze data to explain patterns of relatedness of organisms and fossils based on anatomy, use evidence and models to explain why specific traits will lead to increases or decreases in survival or reproduction chances, and analyze data and use mathematical relationships to explain changes in traits within populations over time.

Target F Engineering Design in Life Science	Students can describe potential impacts of a design, compare competing designs to solve a specific problem, use test data to compare design solutions, and explain how to improve a design through repeated testing.	Students can describe the potential impacts of a design in order to define criteria and constraints, evaluate competing designs to solve a specific problem using criteria and constraints, analyze test data to compare design solutions, and develop a model to optimize a design through repeated testing.	Students can evaluate the potential impacts of a design in order to prioritize criteria and constraints, support an argument for the best design to solve a specific problem using criteria and constraints, analyze test data to support an argument for an optimal design, and synthesize data to develop a model to optimize a design through repeated testing.

Claim 3: Earth and Space Science

Students are able to comprehend and explain Earth and space science concepts and practices, as well as apply their knowledge to scientific investigations and engineering design problems with precision and accuracy.

The evidence statements marked with an asterisk (*) integrate traditional science content with engineering through a practice or domain.

Target A	Understand the properties and predictable patterns of objects and phenomena in the universe and our Solar System.
Standards	MS-ESS1-1, MS-ESS1-2, MS-ESS1-3

Evidence Statements
Students who demonstrate understanding can 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. 2. develop and use a model to describe the role of gravity in the motions within galaxies and the Solar System. 3. analyze and interpret data to determine scale properties of objects in the Solar System.

Target B	Understand how Earth's conditions and processes and life on Earth have changed over time.
Standards	MS-ESS1-4, MS-ESS2-2, MS-ESS2-3

Evidence Statements
Students who demonstrate understanding can 1. 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. 2. construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. 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.

Target C Understand how Earth materials and the major systems of Earth interact over time.

Standards MS-ESS2-1, MS-ESS2-4, MS-ESS3-1

Evidence Statements
Students who demonstrate understanding can 1. develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. 2. develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity. 3. 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.

Target D Understand the factors and processes that regulate climate and weather on Earth.

Standards MS-ESS2-5, MS-ESS2-6, MS-ESS3-5

Evidence Statements
Students who demonstrate understanding can 1. collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. 2. develop and use a model to describe how unequal heating and rotation of Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. 3. ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Target E	Understand how natural hazards can be predicted and how human activities affect Earth systems.
Standards	MS-ESS3-2, MS-ESS3-3, MS-ESS3-4

Evidence Statements
Students who demonstrate understanding can 1. analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. 2. apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* 3. construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Target F	Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in Earth and space science.
Standards	MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4

Evidence Statements
Students who demonstrate understanding can 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. 2. evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. 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. 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.

*The evidence statements marked with an asterisk integrate traditional science content with engineering through a practice or domain.

Performance Level Descriptors (PLDs)			
	Level 2	**Level 3**	**Level 4**
Claim 3 Earth and Space Science	Students typically comprehend and **describe** scientific ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **low complexity** and **inconsistently** to problems of **moderate complexity** in the Earth and space sciences (targets A–F).	Students typically comprehend and **explain** scientific ideas, connecting concepts, and procedures or practices (targets A–E), and they apply scientific and engineering knowledge **consistently** to problems of **moderate complexity** and **inconsistently** to problems of **high complexity** in the Earth and space sciences (targets A–F).	Students typically comprehend and **analyze** scientific ideas, connecting concepts, and procedures or practices (target A–E), and they apply scientific and engineering knowledge **consistently** to problems of **high complexity** in the Earth and space sciences (targets A–F).
Target A Space Systems	Students can identify patterns involving the Sun and the Moon based upon their relative positions, recognize how gravity affects motion within the Solar System and within galaxies, and identify properties of objects in the Solar System.	Students can use a model to explain patterns involving the Sun and the Moon based upon their relative positions, model how gravity explains motion within the Solar System and within galaxies, and analyze data to determine the properties of objects in the Solar System.	Students can use a model to explain patterns and make predictions involving the Sun and the Moon based upon their relative positions, gather information to develop a model of how gravity explains motion within the Solar System and within galaxies, and analyze data to explain the differences in the properties of objects in the Solar System.
Target B History of Earth	Students can use rock formations and fossils to describe Earth's history, identify geological processes that create geological features, and describe evidence of past tectonic-plate motions.	Students can use rock formations and fossil evidence to explain Earth's history, explain how geological processes of different time and spatial scales create geological features, and analyze and interpret data that provide evidence of past tectonic-plate motions.	Students can synthesize information from rock formations and fossil evidence to explain Earth's history, gather evidence to explain how geological processes of varying time and spatial scales create geological features, and analyze and interpret data to develop models that provide evidence of past tectonic-plate motions.

Target C Earth's Systems	Students can describe the role of energy in the cycling of Earth's materials, describe the roles of energy and gravity in the water cycle, and describe how Earth's processes are related to the distribution of natural resources.	Students can model and describe the role of energy in the cycling of Earth's materials, develop a model to describe the roles of energy and gravity in the water cycle, and use evidence from Earth's processes to explain the distribution of natural resources.	Students can model and use evidence to explain the role of energy in the cycling of Earth's materials, develop and use a model to explain the roles of energy and gravity in the water cycle, and evaluate evidence from Earth's processes to explain the distribution of natural resources.
Target D Weather and Climate	Students can relate the interaction of air masses to changes in weather and describe how heat and Earth's rotation produce differences in atmospheric and oceanic circulation patterns that lead to different climates.	Students can gather evidence of the interaction of air masses to explain changes in weather and use a model to describe how heat and Earth's rotation produce differences in atmospheric and oceanic circulation patterns that lead to different climates.	Students can gather and evaluate evidence of the interaction of air masses to explain changes in weather and use evidence to develop a model that explains how heat and Earth's rotation produce differences in atmospheric and oceanic circulation patterns that lead to different climates.
Target E Human Impacts	Students can recognize characteristics of natural hazards, describe human impacts on the environment, and describe how population growth increases the use of natural resources and causes environmental changes.	Students can identify data patterns about natural hazards, design a method to monitor or minimize human impacts on the environment, and use evidence to argue that population growth increases the use of natural resources and causes environmental changes.	Students can evaluate strategies to minimize dangers from natural hazards through forecasting and technology, design and refine a method to monitor or minimize human impacts on the environment, and gather and use evidence to argue that population growth increases the use of natural resources and causes environmental changes.

Target F Engineering Design in Earth and Space Science	Students can describe potential impacts of a design, compare competing designs to solve a specific problem, use test data to compare design solutions, and explain how to improve a design through repeated testing.	Students can describe the potential impacts of a design in order to define criteria and constraints, evaluate competing designs to solve a specific problem using criteria and constraints, analyze test data to compare design solutions, and develop a model to optimize a design through repeated testing.	Students can evaluate the potential impacts of a design in order to prioritize criteria and constraints, support an argument for the best design to solve a specific problem using criteria and constraints, analyze test data to support an argument for an optimal design, and synthesize data to develop a model to optimize a design through repeated testing.

Note: All engineering targets share similar PLD features but should not be compared.