Kansas Assessment Program

Assessment Development Guide
Educator Resource
Science: Grade 11

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 postsecondary readiness.

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

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

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

Detailed descriptions of performance levels for grade 11 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 eleventh 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 11 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 atomic scale.
Standards	HS-PS1-1, HS-PS1-3, HS-PS1-8, HS-PS2-6

Evidence Statements

Students who demonstrate understanding can

1. use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
2. plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
3. develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
4. communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*

Target B Understand how substances react or change at the atomic scale to produce new substances.

Standards HS-PS1-2, HS-PS1-4, HS-PS1-5, HS-PS1-6, HS-PS1-7

Evidence Statements

Students who demonstrate understanding can

1. construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
2. develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
3. apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
4. refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*
5. use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

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

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

Evidence Statements

Students who demonstrate understanding can

1. analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
2. use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
3. apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*
4. Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects.
5. plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.

Target D Understand why energy is transferred, transformed, and conserved by the interaction of objects or objects with forces and within systems.

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

Evidence Statements

Students who demonstrate understanding can

1. create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
2. develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
3. design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*
4. plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
5. develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects caused by the interaction.

Target E Understand characteristic properties of waves and electromagnetic radiation and how they transfer energy and send or store information.

Standards HS-PS4-1, HS-PS4-2, HS-PS4-3, HS-PS4-4, HS-PS4-5

Evidence Statements

Students who demonstrate understanding can

1. use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
2. evaluate questions about the advantages of using a digital transmission and storage of information.
3. evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described by either a wave model or a particle model and that for some situations one model is more useful than the other.
4. evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
5. communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.*

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

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

Evidence Statements

Students who demonstrate understanding can

1. analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
2. design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
3. evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
4. use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Performance Level Descriptors (PLDs)	**Level 2**	**Level 3**	**Level 4**
Claim 1 Physical Science	Students in this range 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 physical sciences (targets A–F).	Students in this range 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 physical sciences (targets A–F).	Students in this range typically comprehend and **analyze** scientific 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 describe chemical and atomic properties, identify the different types of subatomic particles, measure or record different bulk properties of matter and its physical changes, and describe molecular properties of designed materials.	Students can predict chemical and atomic properties using the periodic table, investigate different bulk properties of matter and its physical changes, and communicate the function of a designed material based upon its molecular properties.	Students can explain chemical and atomic properties by examining the relative placement of elements on the periodic table, investigate and evaluate different bulk properties of matter and its physical changes, and evaluate the function of a designed material based upon its molecular properties.
Target B Chemical Reactions	Students can describe the chemical properties that can change during a chemical reaction, identify changes in chemical reaction rates, and recognize that mass is conserved during chemical reactions.	Students can use chemical properties to explain the outcome of a chemical reaction, use evidence to explain changes in chemical reaction rates, and use mathematical representations to support an argument for the conservation of mass in a chemical reaction.	Students can investigate and explain the results of a chemical reaction using chemical properties, collect and use evidence to explain changes to chemical reaction rates, and use evidence and mathematical representations to support an argument for the conservation of mass in a chemical reaction.
Target C Forces and Interactions	Students can use Newton's second law to describe force and motion relationships, explain the concept of the conservation of momentum, and describe and predict forces that act at a distance.	Students can compare the effects of forces on an object's motion, use a mathematical representation to support the claim there is conservation of momentum in a system, and use mathematical representations to describe and predict forces that act at a distance.	Students can analyze evidence that supports Newton's second law of motion, use mathematical representations to explain the conservation of momentum, and use models and mathematical representations to describe and predict forces that act at a distance.
Target D Energy	Students can use objects' positions and motions to describe their energy, describe a design that involves the conversion of energy, and describe how thermal energy is distributed in a closed system.	Students can use the position and motion of objects to develop and use models that illustrate changes in energy, refine a design that involves the conversion of energy, and investigate how thermal energy is distributed in a closed system.	Students can use the position and motion of objects to develop and use models that explain the changes in energy, refine a design that involves multiple conversions of energy, and investigate and explain how thermal energy is distributed in a closed system.

Target E Waves and Electromagnetic Radiation	Students can describe how waves behave in different media, describe wave and particle models of electromagnetic radiation, and identify the advantages of using digital information over analog.	Students can use mathematical representations to explain how waves behave in different media, evaluate the use of wave and particle models to describe light, and evaluate questions about the advantages of using digital information over analog.	Students can use mathematical representations and models to explain how waves behave in different media, investigate and evaluate the use of wave and particle models to describe light, and evaluate questions and data about the advantages of using digital information over analog.
Target F Engineering Design in Physical Science	Students can identify that engineering problems can be broken down into smaller problems, identify the needs and trade-offs of an engineering design, and identify the most appropriate solution to a design problem.	Students can design solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to evaluate a complex real-world problem to prioritize, and use models to explain the most appropriate solution to a design problem.	Students can evaluate solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to optimize a solution to a complex real-world problem, and evaluate models to argue for the most appropriate solution to a design problem.

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 how the interactions among structures and functions in complex organisms support and maintain life.
Standards	HS-LS1-1, HS-LS1-2, HS-LS1-3-6

Evidence Statements

Students who demonstrate understanding can

1. construct an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.
2. develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
3. plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.

Target B Explain how organisms obtain and use matter and energy to live and grow and how matter and energy flow through an ecosystem.

Standards HS-LS1-5, HS-LS1-6, HS-LS1-7, HS-LS2-3, HS-LS2-4, HS-LS2-5

Evidence Statements

Students who demonstrate understanding can

1. use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
2. construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
3. use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.
4. use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
5. develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

Target C

Explain how organisms interact with the living and nonliving components of an environment to obtain matter and energy and how humans affect these relationships.

Standards HS-LS2-1, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS2-8, HS-LS4-6

Evidence Statements

Students who demonstrate understanding can

1. use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
2. use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
3. evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
4. design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
5. evaluate the evidence for the role of group behavior on individual and species’ chances to survive and reproduce.
6. create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.*

Target D Understand how organisms inherit genetic traits and how genetic variation is maintained.

Standards HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3

Evidence Statements

Students who demonstrate understanding can

1. use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
2. ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
3. make and defend a claim based on evidence that inheritable genetic variations may result from new genetic combinations through meiosis, viable errors occurring during replication, and/or mutations caused by environmental factors.
4. apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.

Target E Understand the processes that produce similarities found among the diversity of living organisms and how that diversity relates to humans.

Standards HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

Evidence Statements

Students who demonstrate understanding can

1. communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
2. construct an explanation based on evidence that the process of evolution primarily results from four factors: the potential for a species to increase in number, the heritable genetic variation of individuals in a species caused by mutation and sexual reproduction, competition for limited resources, and the proliferation of those organisms that are better able to survive and reproduce in the environment.
3. apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
4. construct an explanation based on evidence for how natural selection leads to adaptation of populations.
5. evaluate the evidence supporting claims that changes in environmental conditions may result in increases in the number of individuals of some species, the emergence of new species over time, and the extinction of other species.

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

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

Evidence Statements

Students who demonstrate understanding can

1. analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
2. design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
3. evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
4. use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Performance Level Descriptors (PLDs)	**Level 2**	**Level 3**	**Level 4**
Claim 2 Life Science	Students in this range 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 life sciences (targets A–F).	Students in this range 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 life sciences (targets A–F).	Students in this range typically comprehend and **analyze** scientific 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 and Function	Students can describe how DNA sequences relate to specialized cell functions, identify how interacting cells or organs provide specific functions, and summarize how life functions rely upon homeostasis.	Students can use evidence to explain how DNA sequences relate to specialized cell functions, use models to explain how interacting cells or organs provide specific functions, and investigate how life functions rely upon feedback mechanisms in homeostasis.	Students can collect evidence to explain how DNA sequences relate to specialized cell functions, use models and evidence to explain how interacting cells or organs provide specific functions, and investigate and evaluate evidence of how life functions rely upon feedback mechanisms in homeostasis.
Target B Matter and Energy in Organisms and Ecosystems	Students can describe the transformation in plants of light into chemical energy, describe how matter and energy found in food molecules are used in organisms, and identify the biological processes that cycle carbon and energy within Earth systems.	Students can use models to explain the transformation in plants of light into chemical energy, use models to explain how matter and energy found in food molecules are used in organisms, and model the biological processes that cycle carbon and energy within Earth systems.	Students can use models and data to explain the transformation in plants of light into chemical energy, evaluate models that explain how matter and energy found in food molecules are used in organisms, and collect evidence to model the biological processes that cycle carbon and energy within Earth systems.
Target C Interdependent Relationships in Ecosystems	Students can describe factors affecting biodiversity and ecosystem populations, identify physical or biological changes that affect ecosystem conditions and stability, and identify a design that minimizes human impacts on the environment and biodiversity.	Students can use mathematical representations to explain factors affecting biodiversity and ecosystem populations, evaluate evidence of complex physical or biological changes that affect ecosystem conditions and stability, and evaluate designs that minimize human impacts on the environment and biodiversity.	Students can analyze data and use mathematical representations to explain factors affecting biodiversity and ecosystem populations, gather and evaluate evidence of complex physical or biological changes that affect ecosystem conditions and stability, and evaluate and communicate designs that minimize human impacts on the environment and biodiversity.

Target D Inheritance and Variation of Traits	Students can recognize differences in the complexity of organisms caused by cellular divisions, make a claim about the causes of inheritable genetic variation, and use DNA data to describe genetic variation in individuals and in populations.	Students can use models to explain differences in the complexity of organisms caused by cellular divisions, use evidence to make and defend a claim about the causes of inheritable genetic variation, and use DNA data to defend a claim with evidence for the cause of genetic variation in individuals and in populations.	Students can use models and data to explain differences in the complexity of organisms caused by cellular divisions, use evidence and models to make and defend a claim about the causes of inheritable genetic variation, and use DNA data to evaluate evidence for the cause of genetic variation in individuals and in populations.
Target E Natural Selection and Evolution	Students can describe ecological and genetic factors related to evolutionary processes, describe the adaptation of populations through natural selection, and describe environmental changes that affect species populations over time.	Students can use evidence to explain that ecological and genetic factors result in evolutionary processes, use evidence to support the adaptation of populations through natural selection, and evaluate evidence that environmental changes affect species populations over time.	Students can evaluate evidence for ecological and genetic factors that result in evolutionary processes, use models and evidence to support the adaptation of populations through natural selection, and collect and evaluate evidence that environmental changes affect species populations over time.
Target F Engineering Design in Life Science	Students can identify that engineering problems can be broken down into smaller problems, identify the needs and trade-offs of an engineering design, and identify the most appropriate solution to a design problem.	Students can design solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to evaluate a complex real-world problem to prioritize, and use models to explain the most appropriate solution to a design problem.	Students can evaluate solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to optimize a solution to a complex real-world problem, and evaluate models to argue for the most appropriate solution to a design problem.

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 phenomena in the universe, processes in stars, and the predictable patterns of movement of solar system objects.

Standards HS-ESS1-1, HS-ESS1-2, HS-ESS1-3, HS-ESS1-4

Evidence Statements

Students who demonstrate understanding can

1. develop a model based on evidence to illustrate the life span of the Sun and the role of nuclear fusion in the Sun's core to release energy that eventually reaches Earth in the form of radiation.
2. construct an explanation of the big bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe.
3. communicate scientific ideas about the way stars, over their life cycle, produce elements.
4. use mathematical or computational representations to predict the motion of orbiting objects in the Solar System.

Target B Understand events in Earth's past and how Earth materials, features, and processes change over time.

Standards HS-ESS1-5, HS-ESS1-6, HS-ESS2-1

Evidence Statements

Students who demonstrate understanding can

1. evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.
2. apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.
3. develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

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

Standards HS-ESS2-2, HS-ESS2-3, HS-ESS2-5, HS-ESS2-6, HS-ESS2-7

Evidence Statements

Students who demonstrate understanding can

1. analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
2. develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
3. plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.
4. develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
5. construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.

Target D Understand the factors and processes that regulate weather and change the climate over time.

Standards HS-ESS2-4, HS-ESS3-5

Evidence Statements

Students who demonstrate understanding can

1. use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
2. plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Target E Understand how humans obtain and use natural resources and how human activities affect Earth systems and the climate.

Standards HS-ESS3-1, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4, HS-ESS3-6

Evidence Statements

Students who demonstrate understanding can

1. construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
2. evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*
3. create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
4. evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
5. use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified by human activity.

Target F Understand engineering designs to define problems, analyze problems, develop solutions, and optimize solutions to a major problem in Earth and space science.

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

Evidence Statements

Students who demonstrate understanding can

1. analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
2. design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
3. evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
4. use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Performance Level Descriptors (PLDs)	**Level 2**	**Level 3**	**Level 4**
Claim 3 Earth and Space Science	Students in this range 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 in this range 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 in this range typically comprehend and **analyze** scientific 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 Earth and space sciences (targets A–F).
Target A Space Systems	Students can identify the relationship between star properties and released energy, summarize the big bang theory, and describe the present orbital motions of objects in the Solar System.	Students can develop a model to explain the relationship between star properties and released energy, use astronomical evidence to support the big bang theory, and use mathematical representations to predict orbital motions of objects in the Solar System.	Students can use evidence and models to explain the relationship between star properties and released energy, synthesize astronomical evidence to support the big bang theory, and use mathematical representations and models to explain predictions of orbital motions of objects in the Solar System.
Target B History of Earth	Students can use tectonic-plate movements to describe the relative ages of different materials on Earth, identify data used to describe Earth's formation or early history, and describe how physical processes on Earth's surface and within Earth shape Earth's features over time and space.	Students can use tectonic-plate movements to evaluate evidence for the ages of different materials on Earth, use physical evidence to explain Earth's formation or early history, and use models to explain how physical processes on Earth's surface and within Earth shape Earth's features over time and space.	Students can use tectonic-plate movements and models to evaluate evidence for the ages of different materials on Earth, use physical evidence to support an argument about Earth's formation or early history, and use models and data to explain how physical processes on Earth's surface and within Earth shape Earth's features over time and space.

Target C Earth's Systems	Students can identify a feedback cycle in Earth's systems, describe the carbon cycle within the four Earth spheres, and describe the effects of the water cycle on Earth's systems.	Students can analyze data to claim that Earth's systems are connected through feedback cycles, develop a quantitative model to describe the carbon cycle within the four Earth spheres, and plan an investigation of the effects of the water cycle on Earth's systems.	Students can analyze data to support an argument that Earth's systems are connected through feedback cycles, develop and use a quantitative model to describe the carbon cycle within the four Earth spheres, and use data from investigations to evaluate and model the effects of the water cycle on Earth's systems.
Target D Weather and Climate	Students can describe the energy flow through Earth's systems related to the climate, and they can graph data to find changes in Earth's climate and related impacts to Earth's systems.	Students can use a model connecting the energy flow through Earth's systems to the climate and climatic changes, and they can analyze data to hypothesize future changes to Earth's climate and related impacts to Earth's systems.	Students can create a model connecting the energy flow through Earth's systems to the climate and climatic changes, and they can analyze data to hypothesize future changes and explain past changes to Earth's climate and related impacts to Earth's systems.
Target E Human Sustainability	Students can describe the effects of natural resources or natural hazards on human activity, recognize the impacts of human use of natural resources, and describe a solution that reduces human impacts on natural systems.	Students can use evidence to explain the effects of natural resources or natural hazards on human activity, evaluate cost-benefit design solutions for the use of natural resources, and evaluate or refine a solution that is designed to reduce human impacts on natural systems.	Students can create a model connecting the energy flow through Earth's systems to the climate and climatic changes, and they can analyze data to hypothesize future changes and explain past changes to Earth's climate and related impacts to Earth's systems.

Target F Engineering Design in Space Science	Students can identify that engineering problems can be broken down into smaller problems, identify the needs and trade-offs of an engineering design, and identify the most appropriate solution to a design problem.	Students can design solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to evaluate a complex real-world problem to prioritize, and use models to explain the most appropriate solution to a design problem.	Students can evaluate solutions to smaller problems in the context of a larger problem, use prioritized needs and trade-offs of an engineering design to optimize a solution to a complex real-world problem, and evaluate models to argue for the most appropriate solution to a design problem.

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