## Kansas Assessment Program Item Specifications

The Kansas College and Career Ready Standards for Science is 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 develop a logical progression of scientific conceptual knowledge and engineering applications, moving students toward college and career readiness.

The Kansas College and Career Ready Standards for Science are organized into Domains of Disciplinary Core Ideas, Topics, and Performance Expectation Standards. The Performance Expectations are the most specific level of the KCCR 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, as this is usually neither how students learn nor how teachers teach. For example, students will incorporate concepts from all three dimensions of disciplinary content knowledge, crosscutting concepts, and science and engineering practices in order to solve real-world problems, such as determining which products to use in order to meet material, time, and budget constraints in a construction scenario.

Test development for the Kansas Summative Assessment is instead focusing item development at the level of the Topic, which is the **bold** heading in the Topical Arrangement of the Standards (Note: The DCI arrangement has the same Performance Expectations in a different grouping). Topics are groups of related Performance Expectations in terms of content.

The Topics are reflected in this document, the Item Specifications, as Assessment Targets, or just Targets.

For the purposes of reporting meaningful results, the Targets are organized into larger Claims about student learning and mastery which are based on the first three Disciplinary Core Ideas of the Standards: Physical Science, Life Science, and Earth and Space Science. The Engineering Disciplinary Core Idea is included as a Target within each of the three Claims. Each Target in Claim 1 is followed by Evidence Statements, which correspond to Performance Expectations that are used to guide item writers in creating test questions that give students the opportunity to demonstrate mastery of that Target. The Standards from which the Evidence Statements are derived are listed below each Claim 1 Target as well. For each Claim, all Topics or Targets will be assessed. There will be no assessed and non-assessed Topics or Targets. Each Claim will be approximately 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 and Topics are listed with the Targets and Claims, the test blueprint cannot be derived by counting up the Performance Expectations listed. There may be Topics in which not all Performance Expectations will be assessed within that Topic. While not all Targets will be equally emphasized in the test, all of the content described by the Topics 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.

## How to Read This Document

This document is organized by grade. Within each grade, the Claim statement is introduced, followed by each Target. The Target descriptions include evidence statements and the corresponding Kansas Standards. The outline below shows the organization of the Item Specifications. *Italics* are used to further describe the content of each part of the test.

**Claim #: Short Title** *indicates the main subject of the Claim*. *Explanatory text describes in greater detail the expectation of what students will have mastered to make this Claim about student learning*.

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| **Target X** | *Targets in Science correspond to the Topics (the **bold** heading text) in the Kansas College and Career Ready Standards. Targets describe an overall theme of a group of related Standards.* |
| **Evidence Required** | 1. *One or more statements describe the types of things a student could do to demonstrate mastery of the skills that contribute to the Target.*<br>2. *Items may address more than one evidence statement at a time.* |
| **Standards** | *Numbered Standards indicate how the Target is connected to the Kansas College and Career Ready Standards.* |

## Glossary/Alignment of Terms

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| **Kansas College and Career Ready Standards for Science**: KCCRS; the collection of science content that defines what students should understand and be able to do in their study of Science at each grade level, from Kindergarten through college and career readiness. | **Kansas Summative Assessment**: The computer-delivered assessment that is aligned to the KCCRS for Science. |
| **Domain**: A large group of coherently related Standards in the KCCRS. Domains are the main disciplinary core ideas, excluding engineering, in the Standards document. | **Claim**: A "big picture" goal for describing student mastery of a skill, area, or subject within the content Standards. |
| **Topic**: Groups of related Standards in the KCCRS. Topics are **bolded** headings in the Topical arrangement of the Standards document. | **Target**: Smaller goals for student mastery that combine to make a Claim about student achievement. In Science, Targets correspond to the Topics in the Standards. |
| **Performance Expectations**: Standards from the KCCRS that define what students should understand and be able to do at each grade level. Standards are numbered in the Standards document. (e.g., 5-PS1-1 is the first fifth-grade Standard in the Physical Science Domain.) | |
| | **Evidence**: Observable, measurable descriptions of how students can demonstrate mastery within a Target. |

## Grade 5

**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.

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| **Target A** | Understand the structure and properties of matter and its changes or reactions. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Develop a model to describe that matter is made of particles too small to be seen.<br>2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.<br>3. Make observations and measurements to identify materials based on their properties.<br>4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances. |
| **Standards** | 5-PS1-1, 5-PS1-2, 5-PS1-3, 5-PS1-4 |

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| **Target B** | Understand that engineering designs are defined, developed, and optimized to solve physical science problems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.<br>2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. |

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| | 3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |
| **Standards** | 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3 |

**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.

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| **Target A** | Understand the relationships among matter and energy in organisms within ecosystems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.<br>2. Support an argument that plants get the materials they need for growth chiefly from air and water.<br>3. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. |
| **Standards** | 5-PS3-1, 5-LS1-1, 5-LS2-1 |

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| **Target B** | Understand that engineering designs are defined, developed, and optimized to solve life science problems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. |

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| | 2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.<br>3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |
| **Standards** | 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3 |

**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.

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| **Target A** | Understand the major systems of Earth, how they interact, and how humans can protect them. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.<br>2. Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.<br>3. Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment. |
| **Standards** | 5-ESS2-1, 5-ESS2-2, 5-ESS3-1 |

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| **Target B** | Understand the properties of bodies and objects within the universe and our solar system and their predictable patterns of movement. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Support an argument that the gravitational force exerted by Earth on objects is directed down.<br>2. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.<br>3. Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky. |
| **Standards** | 5-PS2-1, 5-ESS1-1, 5-ESS1-2 |

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| **Target C** | Understand that engineering designs are defined, developed, and optimized to solve earth and space science problems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.<br>2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.<br>3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. |

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| **Standards** | 3-5-ETS1-1, 3-5-ETS1-2, 3-5-ETS1-3 |

## Grade 8

**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.

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| **Target A** | Understand the structure, properties, and interactions of matter at the molecular scale. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Develop models to describe the atomic composition of simple molecules and extended structures.<br>2. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.<br>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. |
| **Standards** | MS-PS1-1, MS-PS1-3, MS-PS1-4 |

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| **Target B** | Understand chemical reactions at the molecular scale. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.<br>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. |

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| | 3. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* |
| **Standards** | MS-PS1-2, MS-PS1-5, MS-PS1-6 |

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| **Target C** | Understand the relationships among forces and motion and interactions between objects and within systems of objects. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.*<br>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.<br>3. Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.<br>4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.<br>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. |
| **Standards** | MS-PS2-1, MS-PS2-2, MS-PS2-3, MS-PS2-4, MS-PS2-5 |

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| **Target D** | Understand how energy is defined, transferred, transformed, and conserved by objects and within systems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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.<br>3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.*<br>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.<br>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. |
| **Standards** | MS-PS3-1, MS-PS3-2, MS-PS3-3, MS-PS3-4, MS-PS3-5 |

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| **Target E** | Understand characteristic properties of waves and electromagnetic radiation and how they behave and transmit information. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use mathematical representations to describe a simple model for waves that includes how |

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| | the amplitude of a wave is related to the energy in a wave.<br>2. Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.<br>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. |
| **Standards** | MS-PS4-1, MS-PS4-2, MS-PS4-3 |

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| **Target F** | Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in physical science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.<br>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.<br>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. |

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

**Claim 2: Concepts and Procedures.** 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.

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| **Target A** | Understand the relationship between an organisms' structures, their organization, and its life functions including information processing. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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.<br>3. Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.<br>4. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. |
| **Standards** | MS-LS1-1, LS1-2, MS-LS1-3, MS-LS1-8 |

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| **Target B** | Understand how organisms use matter and energy and how it flows through an ecosystem. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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. |

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| | 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.<br>3. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.<br>4. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.<br>5. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. |
| **Standards** | MS-LS1-6, MS-LS1-7 and MS-LS2-1, MS-LS2-3, MS-LS2-4 |

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| **Target C** | Understand how organisms interact within an environment to obtain matter and energy. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.<br>2. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.* |
| **Standards** | MS-LS2-2, MS-LS2-5 |

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

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| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.<br>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.<br>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.<br>5. Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. |
| **Standards** | MS-LS1-4, MS-LS1-5 and MS-LS3-1, MS-LS3-2, MS-LS4-5 |

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| **Target E** | Understand why the relationship between the environment and genetic variation within a species affects survival and reproduction over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms |

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| | throughout the history of life on Earth under the assumption that natural laws operate today as in the past.<br>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.<br>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.<br>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.<br>5. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. |
| **Standards** | MS-LS4-1, MS-LS4-2, MS-LS4-3, MS-LS4-4, MS-LS4-6 |

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| **Target F** | Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in life science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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. |

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| | 2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.<br>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.<br>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. |
| **Standards** | MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4 |

**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.

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| **Target A** | Understand the properties and predictable patterns of objects and phenomena in the universe and our solar system. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.<br>3. Analyze and interpret data to determine scale properties of objects in the solar system. |

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| **Standards** | MS-ESS1-1, MS-ESS1-2, MS-ESS1-3 |

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| **Target B** | Understand how the Earth’s conditions and processes and life on Earth has changed over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Construct an explanation based on evidence for how geoscience processes have changed Earth’s surface at varying time and spatial scales.<br>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. |
| **Standards** | MS-ESS1-4 and MS-ESS2-2, MS-ESS2-3 |

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| **Target C** | Understand how Earth materials and the major systems of the Earth interact over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Develop a model to describe the cycling of Earth’s materials and the flow of energy that drives this process.<br>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.<br>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. |

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| **Standards** | MS-ESS2-1, MS-ESS2-4 and MS-ESS3-1 |

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| **Target D** | Understand the factors and processes that regulate climate and weather on Earth. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.<br>2. Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.<br>3. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. |
| **Standards** | MS-ESS2-5, MS-ESS2-6 and MS-ESS3-5 |

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| **Target E** | Understand how natural hazards can be predicted and how human activities affect Earth systems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.<br>2. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*<br>3. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. |
| **Standards** | MS-ESS3-2, MS-ESS3-3, MS-ESS3-4 |

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| **Target F** | Understand engineering designs to define problems, develop solutions, and optimize solutions to a problem in earth and space science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.<br>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.<br>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. |
| **Standards** | MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4 |

*The Evidence Statements marked with an asterisk integrate traditional science content with engineering through a Practice or Domain.

## Grade 11

**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.

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| **Target A** | Understand the structure, properties, and interactions of matter at the atomic scale. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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.<br>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.<br>4. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.* |
| **Standards** | HS-PS1-1, HS-PS1-3, HS-PS1-8, HS-PS2-6 |

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| **Target B** | Understand how substances react or change at the atomic scale to produce new substances. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Develop a model to illustrate that the release or absorption of energy from a chemical |

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| | reaction system depends upon the changes in total bond energy.<br>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.<br>4. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.*<br>5. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. |
| **Standards** | HS-PS1-2, HS-PS1-4, HS-PS1-5, HS-PS1-6, HS-PS1-7 |

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| **Target C** | Understand the relationships among forces and motion and predict interactions between objects and within systems of objects. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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.<br>3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*<br>4. Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to |

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| | describe and predict the gravitational and electrostatic forces between objects.<br>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. |
| **Standards** | HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-PS2-4, HS-PS2-5 |

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| **Target D** | Understand why energy is transferred, transformed, and conserved by the interaction of objects or objects with forces and within systems. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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).<br>3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*<br>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).<br>5. Develop and use a model of two objects interacting through electric or magnetic fields |

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| | to illustrate the forces between objects and the changes in energy of the objects due to the interaction. |
| **Standards** | HS-PS3-1, HS-PS3-2, HS-PS3-3, HS-PS3-4, HS-PS3-5 |

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| **Target E** | Understand characteristic properties of waves and electromagnetic radiation and how they transfer energy and send or store information. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.<br>2. Evaluate questions about the advantages of using a digital transmission and storage of information.<br>3. Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other.<br>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.<br>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.* |
| **Standards** | HS-PS4-1, HS-PS4-2, HS-PS4-3, HS-PS4-4, HS-PS4-5 |

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| **Target F** | Understand engineering designs to define problems, analyze problems, develop solutions, and optimize solutions to a major problem in physical science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.<br>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.<br>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.<br>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. |
| **Standards** | HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4 |

**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.

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| **Target A** | Understand how the interactions among structures and functions in complex organisms support and maintain life. |

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| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.<br>3. Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis. |
| **Standards** | HS-LS1-1, HS-LS1-2, HS-LS1-3 |

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| **Target B** | Explain how organisms obtain and use matter and energy to live and grow and how matter and energy flow through an ecosystem. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.<br>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.<br>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.<br>4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. |

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| | 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. |
| **Standards** | HS-LS1-5, HS-LS1-6, HS-LS1-7 and HS-LS2-3, HS-LS2-4, HS-LS2-5 |

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| **Target C** | Explain how organisms interact with the living and non-living components of an environment to obtain matter and energy and how humans affect these relationships. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.<br>2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.<br>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.<br>4. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*<br>5. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.<br>6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.* |

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| **Standards** | HS-LS2-1, HS-LS2-2, HS-LS2-6, HS-LS2-7, HS-LS2-8 and HS-LS4-6 |

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| **Target D** | Understand how organisms inherit genetic traits and how genetic variation is maintained. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.<br>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.<br>3. Make and defend a claim based on evidence that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.<br>4. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. |
| **Standards** | HS-LS1-4 and HS-LS3-1, HS-LS3-2, HS-LS3-3 |

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| **Target E** | Understand the processes that produce similarities found among the diversity of living organisms and how that diversity relates to humans. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence. |

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| | 2. Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.<br>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.<br>4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.<br>5. Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in<br>6. The number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. |
| **Standards** | HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5 |

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| **Target F** | Understand engineering designs to define problems, analyze problems, develop solutions, and optimize solutions to a major problem in life science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. |

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| | 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.<br>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.<br>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. |
| **Standards** | HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4 |

**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.

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| **Target A** | Understand phenomena in the universe, processes in stars, and the predictable patterns of movement of solar system objects. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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. |

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| | 3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.<br>4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system. |
| **Standards** | HS-ESS1-1, HS-ESS1-2, HS-ESS1-3, HS-ESS1-4 |

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| **Target B** | Understand events in Earth's past and how Earth materials, features, and processes change over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>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.<br>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. |
| **Standards** | HS-ESS1-5, HS-ESS1-6 and HS-ESS2-1 |

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| **Target C** | Understand how Earth materials, water, and the major systems of the Earth interact and change the Earth over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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. |

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| | 2. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.<br>3. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.<br>4. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.<br>5. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. |
| **Standards** | HS-ESS2-2, HS-ESS2-3, HS-ESS2-5, HS-ESS2-6, HS-ESS2-7 |

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| **Target D** | Understand the factors and processes that regulate weather and change the climate over time. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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.<br>2. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. |
| **Standards** | HS-ESS2-4, HS-ESS2-5 |

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| **Target E** | Understand how humans obtain and use natural resources and how human activities affect Earth systems and the climate. |
| **Evidence Required** | Students who demonstrate understanding can:<br>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. |

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| | 2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.*<br>3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.<br>4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*<br>5. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. |
| **Standards** | HS-ESS3-1, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4, HS-ESS3-6 |

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| **Target F** | Understand engineering designs to define problems, analyze problems, develop solutions, and optimize solutions to a major problem in earth and space science. |
| **Evidence Required** | Students who demonstrate understanding can:<br>1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.<br>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.<br>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, |

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| | and aesthetics, as well as possible social, cultural, and environmental impacts.<br>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. |
| **Standards** | HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4 |

*The Evidence Statements marked with an asterisk integrate traditional science content with engineering through a Practice or Domain.