Kentucky Alternate Assessment

Kentucky Department of
EDUCATION

Kentucky Academic Standards
Alternate Assessment Targets

Science Grade 7

INTRODUCTION

Background on the Kentucky Academic Standards for Science

In a world that is becoming increasingly complex, it is important that students have the knowledge and understanding to engage in public discussions around issues infused in science. The *Framework for K-12 Science Education* outlines three dimensions that, when used together, support students' deep understanding of the sciences, how science knowledge is acquired and understood and how the sciences are all connected through concepts that have a common application across the disciplines.

Promoting scientific literacy in an equitable and quality manner for *all* students is an ideal worthy of focused attention and continued effort. Equitable access to high-quality educational standards provides common expectations for all students and equips students with the strong science-based skills, including critical thinking and inquiry-based problem-solving, to be scientifically literate and succeed in college, careers and citizenship.

Engineering is taking science and applying it to create solutions that benefit society and the environment. The *Kentucky Academic Standards for Science* represents a commitment to integrate engineering thinking through engineering design practices into the structure of science education from kindergarten through grade 12 by raising engineering design thinking to the same level as scientific inquiry when teaching science disciplines. Providing all students with a foundation in engineering design allows them to better engage in and aspire to solve major societal and environmental challenges they will face in the decades ahead and to engage in public discussions on science-related issues related to their everyday lives.

Kentucky's Vision for Students

Knowledge about science and the ability to be critically educated consumers of scientific information related to their everyday lives directly aligns with the vision of the Kentucky Board of Education (KBE). The board's vision is that each and every student is empowered and equipped to pursue a successful future. To equip and empower students, the following capacity and goal statements frame instructional programs in Kentucky schools. These statements were established by the Kentucky Education Reform Act (KERA) of 1990, as found in Kentucky Revised Statute (KRS) 158.645 and KRS 158.6451, stating that all students shall have the opportunity to acquire the following capacities and learning goals:

- Communication skills necessary to function in a complex and changing civilization;
- Knowledge to make economic, social and political choices;
- Core values and qualities of good character to make moral and ethical decisions throughout life;
- Understanding of governmental processes as they affect the community, the state and the nation;
- Sufficient self-knowledge and knowledge of their mental health and physical wellness;
- Sufficient grounding in the arts to enable each student to appreciate their cultural and historical heritage;
- Sufficient preparation to choose and pursue their life's work intelligently; and
- Skills to enable students to compete favorably with students in other states

Furthermore, schools shall:

- Expect a high level of achievement from all students.
- Develop their students' ability to:
  - Use basic communication and mathematics skills for purposes and situations they will encounter throughout their lives;
  - Apply core concepts and principles from mathematics, the sciences, the arts, the humanities, social studies and practical living studies to situations they will encounter throughout their lives;
  - Become self-sufficient individuals of good character exhibiting the qualities of altruism, citizenship, courtesy, hard work, honesty, human worth, justice, knowledge, patriotism, respect, responsibility and self-discipline;
  - Become responsible members of a family, work group or community, including demonstrating effectiveness in community service;
  - Think and solve problems in school situations and a variety of other situations they will encounter in life;
  - Connect and integrate experiences and new knowledge from all subject matter fields with what students have previously learned and build on past learning experiences to acquire new information through various media sources; and
  - Express their creative talents and interests in visual arts, music, dance and dramatic arts.
- Increase student attendance rates.
- Increase students' graduation rates and reduce dropout and retention rates.
- Reduce physical and mental health barriers to learning.
- Be measured on the proportion of students who make a successful transition to work, postsecondary education and the military.

To ensure legal requirements of science classes are met, the Kentucky Department of Education (KDE) encourages schools to use the *Model Curriculum Framework* to ensure curricular coherence in the development of curricula that meet the grade-level expectations set forth by standards. The Model Curriculum Framework describes curricular coherence as the "local alignment of the standards, curriculum, instructional resources, assessment and instructional practices within and across grade-levels in a school or district to help students meet grade-level expectations."

Legal Basis

The following KRS and Kentucky Administrative Regulations (KAR) provide a legal basis for this publication:

KRS 156.160 Promulgation of administrative regulations by the Kentucky Board of Education
With the advice of the Local Superintendents Advisory Council (LSAC), the KBE shall promulgate administrative regulations establishing standards that public school districts shall meet in student, program, service and operational performance. These regulations shall comply with the expected outcomes for students and schools set forth in KRS 158:6451.

KRS 158.6453 Review of academic standards and assessments
Beginning in fiscal year 2017-2018, and every six (6) years thereafter, the Kentucky Department of Education shall implement a process for reviewing Kentucky's academic standards and the alignment of corresponding assessments for possible revision or replacement to ensure alignment with post-secondary readiness standards necessary for global competitiveness and with state career and technical education standards. The revisions to the content standards shall:

1. Focus on critical knowledge, skills, and capacities needed for success in the global economy;
2. Result in fewer but more in-depth standards to facilitate mastery learning;
3. Communicate expectations more clearly and concisely to teachers, parents, students and citizens;
4. Be based on evidence-based research;
5. Consider international benchmarks; and
6. Ensure that the standards are aligned from elementary to high school to post-secondary education so that students can be successful at each education level.

704 KAR 3:305 Minimum high school graduation requirements
This administrative regulation establishes the minimum high school graduation requirements necessary for entitlement to a public high school diploma.

704 KAR 008:120 Kentucky Academic Standards for Science
This administrative regulation adopts into law the *Kentucky Academic Standards for Science*.

Standards Creation Process

Per KRS 158.6453, the *Kentucky Academic Standards for Science* were entirely conceived and written by teams of Kentucky educators. Kentucky teachers understand that elementary and secondary academic standards must align with postsecondary readiness standards and state career and technical education standards. This focus helps ensure that students are prepared for the jobs of the future and can compete with students from other states and nations.

The Science Advisory Panel (AP) was composed of 28 teachers, three public post-secondary professors from institutes of higher education and three community members. The function of the AP was to review public comments on the existing standards and make recommendations for changes to a Review Committee (RC). The Science RC was composed of six science teachers, two public post-secondary professors from institutes of higher education and three community members. The function of the Science RC was to review the work and findings from the AP and make recommendation to revise or replace existing standards.

The team was selected based on their expertise in the field of science and their role as practicing science teachers. When choosing writers, the selection committee considered state-wide representation for public elementary, middle and high school teachers as well as higher education instructors and community members.

Writers' Vision Statement

The writing team was guided by a vision for equitable science education in Kentucky that begins in kindergarten and progresses yearly through grade 12 to ensure that all students possess sufficient understanding of the science and engineering practices, crosscutting concepts and core ideas of science to engage in public discussions on science-related issues and are critically educated consumers of scientific information related to their everyday lives. To achieve this, *all* students at *all* grade levels must experience multiple sustained and authentic learning opportunities to investigate phenomena, engage in collaborative conversations and reflect the diversity encountered within the classroom in the local community and across the globe.

To meet this vision, the writers recognize that students need sustained opportunities to work with and develop the ideas that underly science and engineering practices and to appreciate how those ideas are interconnected over a period of years rather than weeks or months. Students should be provided multiple, ongoing opportunities to engage with the interconnectedness of the three dimensions of science as they work to make sense of the natural world. To assist teachers in this endeavor, the writers recommend that teachers at all grade levels have ongoing access to high-quality professional learning and resources about science.

The KDE provided the following foundational documents to inform the writing team's work:

- Bell, P. (2019). Infrastructuring Teacher Learning about Equitable Science Instruction. *Journal of Science Teacher Education*, *30*(7), 681–690. https://doi.org/10.1080/1046560X.2019.1668218
- Bell, P. & Bang, M. (2015). *STEM Teaching Tool #15 Overview: How can we promote equity in science education?* http://stemteachingtools.org/brief/15
- Michaels, S., Shouse, A., & Schweingruber, H. (2008). Ready, Set, SCIENCE!: Putting Research to Work in K-8 Science Classrooms. The National Academies Press. https://www.nap.edu/catalog/11882/ready-set-science-putting-research-to-work-in-k-8
- Morrison, D. & Bell, P. (2018). *STEM Teaching Tool #54 How to build an equitable learning community in your science classroom.* http://stemteachingtools.org/brief/54
- National Research Council. (2012). *A Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas.* https://www.nap.edu/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts
- NGSS Lead States. (2013). *The Next Generation Science Standards: For States, By States.* Appendix D: All Standards, All Students. https://www.nextgenscience.org/sites/default/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf
- NGSS Lead States. (2013). *The Next Generation Science Standards: For States, By States.* Appendix E: DCI Progressions in the NGSS. https://www.nextgenscience.org/sites/default/files/resource/files/AppendixE-ProgressionswithinNGSS-061617.pdf
- NGSS Lead States. (2013). *The Next Generation Science Standards: For States, By States.* Appendix F: Science and Engineering Practices. https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf

- NGSS Lead States. (2013). *The Next Generation Science Standards: For States, By States.* Appendix G: Crosscutting Concepts. https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20G%20-%20Crosscutting%20Concepts%20FINAL%20edited%204.10.13.pdf
- Review of state academic documents and frameworks (Alaska, Arizona, Massachusetts, New York, Oklahoma, South Dakota, Tennessee, Utah).
- Duncan, R., Krajcik, J., & Rivet, A. (Eds.). (2017). *Disciplinary Core Ideas Reshaping Teaching and Learning*. NSTA Press.
- Schwarz, C., Passmore, C., & Reiser, B. (Eds.). (2017). *Helping Students Make Sense of the World Using Next Generation Science and Engineering Practices.* NSTA Press.

Additionally, participants brought their own knowledge to the process. The writers also thoughtfully considered feedback from the public and science community.

Design Considerations

Design considerations were informed by research, public comment and review of science standards from other states. A recurring theme reported from the first round of public comment was the desire to have more clarity about what specific performance expectations required. Upon examination, it was determined that examples and further information were provided but that the information was not readily accessible. This resulted in a redesign of the layout to address this concern.

Three-Dimensional Science

Understanding science and how it works goes beyond knowing discrete pieces of information. To meet the vision of scientifically literate students, the integration of the three dimensions of science, as outlined in the *Framework for K-12 Science Education*, must be maintained. These dimensions are:

- Science and Engineering Practices – describe the methods and way that:
  - Scientists investigate and develop models about the natural world and
  - Engineers design and build systems;
- Crosscutting Concepts – intellectual tools that students can draw from as they begin to investigate the natural/designed world;
- Disciplinary Core Ideas – ideas that have broad importance across multiple sciences or a key principle in a discipline

For students to develop a deep understanding of the core ideas, they must engage in exploring the natural and designed world. This is accomplished through the use of the practices and the crosscutting concepts. While only a subset of science and engineering practices and crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery of a performance expectation at the end of instruction, students should still use all of the science and engineering practices and crosscutting concepts as they develop their understanding of each disciplinary core idea.

Engineering, Technology and Application of Science

The linkage between learning science and learning engineering is demonstrated within the *Kentucky Academic Standards for Science*.

> *Just as new science enables or sometimes demands new technologies, new technologies enable new scientific investigations, allowing scientists to probe realms and handle quantities of data previously inaccessible to them. It is impossible to do engineering today without applying science in the process, and, in many areas of science, designing and building new experiments requires scientists to engage in some engineering practices. This interplay of science and engineering makes it appropriate to [include] engineering and technology.* (National Research Council, 2012)

Engineering design in the earliest grades introduces students to "problems" as situations that people want to change. They can use tools and materials to solve simple problems, use different representations to convey solutions, and compare different solutions to a problem and determine which is best. Students in all grade levels are not expected to come up with original solutions, although original solutions are always welcome. Emphasis is on thinking through the needs or goals that need to be met, and which solutions best meet those needs and goals.

For those engineering design standards with no crosscutting concepts identified, the crosscutting concept will be identified by the nature of the problem chosen.

Clarification Statements and Assessment Boundaries

A recurring theme reported from the first round of public comment was the desire to have more clarity about what specific performance expectations required. Most of the performance expectations defined in the *Kentucky Academic Standards for Science* include clarification statements and assessment boundaries. Clarification statements are one or two sentences that provide examples or particular emphasis that can assist in further understanding of the intent and in developing instructional experiences. Assessment boundaries define the limits of large-scale assessment. This, however, does not limit assessment practices within the classroom.

Science for All

The vision set forth by the writers emphasizes that "*all* students will possess sufficient understanding … to engage in public discussion … and be critically educated consumers of scientific information." The *Kentucky Academic Standards for Science*, written as performance expectations, imply that students will be active participants in the scientific and engineering process. The inclusion of the science and engineering practices "offer rich opportunities and demands for language learning while they support science learning for all students" (Appendix D, p. 5).

The crosscutting concepts demonstrate the interrelatedness of scientific concepts, which is often seen as implied background knowledge – knowledge that derives from experiences that not all students have access to. As noted in Appendix D of the Next Generation Science Standards (NGSS), "Explicit teaching of the crosscutting concepts enables less privileged students … to make connections among big ideas that cut across science disciplines" (Appendix D, p. 6). As such, the multidimensionality demonstrated in the *Kentucky Academic Standards for Science* levels the playing field for all students to actively engage in scientific sensemaking and engineering design.

Standards Use and Development

The Kentucky Academic Standards Are Standards, Not Curriculum

The *Kentucky Academic Standards for Science* outlines the minimum standards Kentucky students should learn in each grade level kindergarten through eighth grade or high school grade-span. The standards address a foundational framework of what is to be learned, but do not address how learning experiences are to be designed or what resources should be used.
A standard represents a goal or outcome of an educational program; standards are vertically aligned expected outcomes for all students. The standards do not dictate the design of a lesson plan or how units should be organized. The standards establish a statewide baseline of what students should know and be able to do at the conclusion of a grade or grade-span. The instructional program should emphasize the development of students' abilities to acquire and apply the standards. The curriculum must ensure that appropriate accommodations are made for diverse populations of students found within Kentucky schools.

These standards are not a set of instructional or assessment tasks, but rather statements of what students should be able to master after instruction. Decisions on how best to help students meet these program goals are left to local school districts and teachers. Curriculum includes the vast array of instructional materials, readings, learning experiences and local mechanisms of assessment, including the full body of content knowledge to be covered, all of which are to be selected at the local level according to Kentucky law.

Translating the Standards into Curriculum

The Kentucky Department of Education does not require specific curricula or strategies to be used to engage students in the *Kentucky Academic Standards*. Local schools and districts choose to meet the minimum required standards using a locally adopted curriculum according to KRS 160.345, which outlines the method by which the curriculum is to be determined. As educators implement academic standards, they, along with community members, must guarantee postsecondary readiness that will ensure all learners are transition ready. To achieve this, Kentucky students need a curriculum designed and structured for a rigorous, relevant and personalized learning experience, including a wide variety of learning opportunities. The Kentucky *Model Curriculum Framework* is a resource to support districts and schools in the continuous process of designing and reviewing local curriculum.

Organization of the Standards

The *Kentucky Academic Standards for Science* are organized by grade level for kindergarten through grade 8, with high school standards being grade banded. Within each grade level/band, the performance expectations are organized around the disciplinary core ideas, resulting in a coherence of understanding as students move through their academic career. This, in turn, provides for greater flexibility for arranging the performance expectations in a grade level in a way that best represents the needs of schools and districts without sacrificing coherence.

The National Research Council, the functional staffing of the National Academies of Science, released the *Framework for K-12 Science Education* in 2011, which is the research base that was used in the development of the science standards. The framework provides that a quality science education for K-12 students integrates the three dimensions of science: science and engineering practices, disciplinary core ideas and the crosscutting concepts.

This results in the *Kentucky Academic Standards for Science* being written at the intersection of these three dimensions and being described as performance expectations students are required to demonstrate to show mastery. These dimensions describe the processes of doing science, the structure that helps organize and connect understanding and the deep knowledge that provides predictive power. Taken together, these represent how we use science to make sense of the natural/designed world and are most meaningful when learned in concert with one another.

Science and Engineering Practices: Practices refer to the way in which scientists and engineers engage in their work. They engage in wonder, design, modeling, argumentation, communication, and engineering thinking. While a specific practice may be identified in each performance expectation, students should engage in all practices because this helps them understand how scientific knowledge develops and the links between science and engineering.

Disciplinary Core Ideas: Core ideas found in the *Kentucky Academic Standards for Science* are foundational understandings so that students may later acquire additional information on their own. The core ideas are organized within physical, life and earth/space science, which are traditionally associated with science knowledge. Also found here are the ideas used in the engineering design process, identified as ETS (engineering, technology, and application of science).

Crosscutting Concepts: Crosscutting concepts are conceptual tools that are used as lenses for understanding the natural/designed world. They provide ways of thinking and reasoning about phenomena across disciplines, uniting core ideas throughout the fields of science and engineering. While specific crosscutting concepts may be identified in each performance expectation, explicit instruction and engagement in all of the crosscutting concepts is expected. This will help deepen students' sensemaking across a range of disciplinary contexts.

The table below provides a summary of each science dimension mentioned above.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking questions or defining problems: Students engage in asking testable questions and defining problems to pursue understanding of phenomena. **Developing and using models:** Students develop physical, conceptual and other models to represent relationships, explain mechanisms, communicate ideas and predict outcomes. **Planning and carrying out investigations:** Students plan and conduct scientific investigations to test, revise or develop explanations.	**Physical Sciences:** (PS1) Matter and Its Interactions (PS2) Motion and Stability: Forces and Interactions (PS3) Energy (PS4) Waves **Life Sciences:** (LS1) Molecules to Organisms (LS2) Ecosystems (LS3) Heredity (LS4) Biological Evolution	**Patterns:** Students observe patterns to organize and classify factors that influence relationships. **Cause and effect mechanisms and explanation**: Students investigate and explain causal relationships and their mechanisms to make tests and predictions. **Scale, proportion and quantity:** Students recognize the relevancy of and changes in scale, proportions and quantities of measurement within and between various systems.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and interpreting data: Students analyze various types of data to identify features or patterns for interpretation and further use. **Using mathematics and computational thinking:** Students use fundamental tools in science to compute relationships and interpret results. **Constructing explanations and designing solutions:** Students construct explanations about the world and design solutions to problems using observations that are consistent with current evidence and scientific principles. **Engaging in argument from evidence:** Students support their best conclusions and solutions with lines of reasoning using evidence to defend their claims. **Obtaining, evaluating and communicating information:** Students obtain, evaluate and derive meaning from scientific information or presented evidence using appropriate scientific language. They communicate their findings clearly and persuasively in a variety of ways including written text, graphs, diagrams, charts, tables or orally.	**Earth and Space Sciences:** (ESS1) Earth's Place in the Universe (ESS2) Earth's Systems (ESS3) Earth and Human Activity **Engineering Design:** (ETS1.A) Defining and Delimiting an Engineering Problem (ETS1.B) Developing Possible Solutions (ETS1.B) Optimizing the Design Solution	**Systems and system models:** Students use models to explain the boundaries and relationships that describe complex systems. **Energy and matter flows, cycles and conservation:** Students describe cycling of matter and flow of energy through systems, including transfer, transformation and conservation of energy and matter. **Structure and function:** Students relate the shape and structure of an object or living thing to its properties and functions. **Stability and change:** Students explain how and why a natural or built system can change or remain stable over time.

How to Read the Standards

Performance Expectation (PE): The performance students demonstrate to show mastery

Foundation Boxes: Provides further information about each dimension that was combined to develop the PE.

K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.		
Clarification Statement: Examples of pushes or pulls could include a string attached to an object being pulled, swings on a playground, a person pushing an object, a person stopping a rolling ball, and two objects colliding and pushing on each other. **Assessment Boundary:** Assessment is limited to different relative strengths or different directions, but not both at the same time. Assessment does not include non-contact pushes or pulls such as those produced by magnets.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Planning and Carrying Out Investigations With guidance, plan and conduct an investigation in collaboration with peers.	**PS2.A: Forces and Motion** Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. **PS2.B: Types of Interactions** When objects touch or collide, they push on one another and can change motion. **PS3.C: Relationship Between Energy and Forces** A bigger push or pull makes things speed up or slow down more quickly.	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Clarification Statement: Provide examples or additional information

Assessment Boundary: States the limit of assessment for large-scale assessment

Meaning of Each Component

Performance Expectation: The performance students demonstrate to show mastery. It states how a student will demonstrate their understanding of a core idea on a large-scale assessment. Some performance expectations include an asterisk, which signifies the inclusion of engineering design.

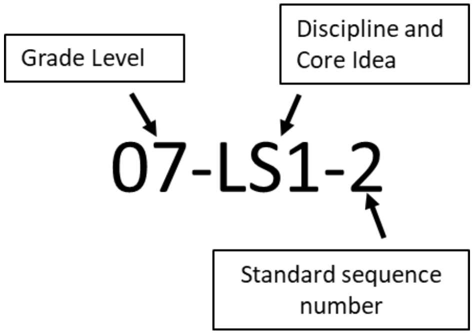
Clarification Statement: These provide examples or additional information about the performance expectation. Not all performance expectations include a clarification statement. In instances in which the committee felt clarification was not necessary, the notation “none provided” is present.

Assessment Boundary: This states the limit of assessment for a large-scale assessment. It does not, however, limit the assessment that could occur in the classroom. The notation “none provided” indicates that the committee did not believe a boundary needed to be identified.

Foundation Boxes: These boxes represent the foundational components of three dimensions that encompass the performance expectation, which are:

- Science and Engineering Practices: This box describes the element of the practice associated with the performance expectation.
- Disciplinary Core Idea: This box includes conceptual information related to the overall core idea of the performance expectation. The coding found in this box is consistent with the coding and component ideas described in the framework.
- Crosscutting Concepts: This box describes the element of the concept associated with the performance expectation.

How to Read the Coding



Discipline Codes	
PS	Physical Science
LS	Life Science
ESS	Earth and Space Science
ETS	Engineering, Technology and Applications of Science

Supplementary Materials to the Standards

Appendix A: Writing and Review Teams

This appendix includes information on the writing teams who developed the Kentucky Academic Standards for Science.

Alternate Assessment Targets: (not a standard)

An Alternate Assessment Target represents limits to a selected Kentucky Academic Standard. An Alternate Assessment Target may reduce parts of the standard with specific guidance to what an assessment item could represent. Not all Kentucky Academic Standards selected for assessments will have an Alternate Assessment Target and may display the language: *"No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item."* This would mean that the entire standard in its original form is reduced in depth and breadth and is eligible in its entirety to be used in the development of assessment items.

Grade 7 Science Kentucky Academic Standards Assessed by Window

Window	Standard
1	6-PS2-1
1	7-PS2-2
1	6-ESS2-2
1	6-ESS2-3
1	6-ESS2-4
1	6-8-ETS1-1*

Window	Standard
2	6-PS1-4
2	7-PS3-4
2	6-LS2-1
2	7-LS1-3
2	6-8-ETS1-1*

* In Grade 7 Science, some standards are tested across both testing windows (in both Windows 1 and 2).

Sixth Grade Overview

To meet the sixth-grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, analyzing and interpreting data, constructing explanations and engaging in arguments from evidence. Students are expected to use these practices to demonstrate their understanding of the core ideas. Sixth grade performance expectations include gravitational interactions, Earth-Sun-Moon system, scale and properties of the solar system, scales of geoscience processes, evidence of plate tectonics, cycling of Earth's materials, cycling of water, motions and interactions of air masses, Earth's circulation patterns, resource availability on organisms, cycling of matter within ecosystems, patterns of interactions among organisms, atomic composition, and changes in particle motion with thermal energy. Students are expected to develop an understanding of the role of gravity in astronomy. Students will develop an understanding of the role of photosynthesis in the cycling of matter and energy. Students will also develop understanding that resource availability and energy flow influence patterns of organism interactions. Students will apply their understanding of changes in Earth's materials including plate movement, water and air. Students will model the cyclical patterns of lunar phases and eclipses are a result of the Earth-Sun-Moon system. Through the development and use of a model, students will describe the role of gravity in the motions of the solar system and galaxies, building towards creating arguments that gravitational interactions depend on the masses of interacting objects. Students will construct an explanation of how geoscience processes occur at varying time and spatial scales. Students will use models to describe atomic composition and changes in particle motion and state based on energy changes. The crosscutting concepts of patterns that include scale, proportion and quantity; systems and system models; energy and matter; and cause and effect are highlighted as organizing concepts for these disciplinary core ideas.

Note While only a subset of science and engineering practices and crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the science and engineering practices and crosscutting concepts as they develop their understanding. See front matter for more information.

6-PS1-4.	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.	
Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium. **Assessment Boundary:** None provided.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Developing and Using Models Develop a model to predict and/or describe phenomena.	**PS1.A: Structure and Properties of Matter** Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. **PS3.A: Definitions of Energy** The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material.	**Cause and Effect** Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

Alternate Assessment Target: Limit full standard to using (or completing) a given model.

6-PS2-1. Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects. *		
Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle. **Assessment Boundary:** Assessment is limited to vertical or horizontal interactions in one dimension.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Apply scientific ideas or principles to design an object, tool, process, or system.	**PS2.A: Forces and Motion** For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).	**Systems and System Models** Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

6-LS2-1. Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.		
Clarification Statement: Emphasis is on cause-and-effect relationships between resources, the growth of individual organisms, and the numbers of organisms in ecosystems during periods of abundant and scarce resources. **Assessment Boundary:** None provided.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyze and interpret data to provide evidence for phenomena.	**LS2.A: Interdependent Relationships in Ecosystems** Organisms and populations of organisms are dependent on their environmental interactions both with other living things and with non-living factors. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. The growth of organisms and population increases are limited by access to resources.	**Cause and Effect** Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

6-ESS2-2.	Construct an explanation based on evidence for how biological and geoscience processes have changed Earth's surface at varying time and spatial scales.

Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides, biological or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition caused by the movements of water, ice, and wind. Examples of biological processes could include the decomposition of living organisms resulting in soil formation, the effect of vegetation on erosion, and the impact of beaver dams on the natural flow of waterways. Emphasis is on biological processes and geoscience processes that shape local geographic features, where appropriate.

Assessment Boundary: None provided.

Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concepts
Constructing Explanations and Designing Solutions Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future.	**ESS2.A: Earth's Materials and Systems** The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. **ESS2.E: Biogeology** The evolution and proliferation of living things over geological time have in turn changed the rates of weathering and erosion of land surfaces, altered the composition of Earth's soils and atmosphere, and affected the distribution of water in the hydrosphere.	**Scale, Proportion, and Quantity** Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

6-ESS2-3.	**Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.**	
Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches). **Assessment Boundary:** Paleomagnetic anomalies in oceanic and continental crust are not assessed.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyze and interpret data to provide evidence for phenomena.	**ESS1.C: The History of Planet Earth** Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.	**Patterns** Patterns in rates of change and other numerical relationships can provide information about natural systems.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

6-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.		
Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical. **Assessment Boundary:** A quantitative understanding of the latent heats of vaporization and fusion is not assessed.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Developing and Using Models Develop a model to describe unobservable mechanisms.	**ESS2.C: The Roles of Water in Earth's Surface Processes** Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. Global movements of water and its changes in form are propelled by sunlight and gravity.	**Energy and Matter** Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.

Alternate Assessment Target: Limit full standard to using (or completing) a given model.

Seventh Grade Overview

To meet the seventh-grade performance expectations, students are expected to demonstrate grade-appropriate proficiency in developing and using models, asking questions and defining problems, analyzing and interpreting data, constructing explanations and designing solutions, planning and carrying out investigations, using mathematics and computational thinking, and engaging in arguments from evidence. Students are expected to use these practices to demonstrate their understanding of the core ideas. Seventh-grade performance expectations include forces and motion, kinetic energy, cellular organization and function, matter and energy flow in organisms, stimuli response, chemical reactions, conservation of mass, thermal energy, electromagnetic forces and fields, gravitational interactions and potential energy, transfer of energy, energy and movement of waves, and transmission of information.

Students will be able to apply Newton's third law of motion to relate forces to explain the motion of objects. Students also apply ideas about gravitational, electrical and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while others repel. Students can describe, predict, and model characteristic properties and behaviors of waves when the waves interact with matter. Students can apply an understanding of waves as a means to send digital information. Students also can apply an understanding of design to the process of energy transfer. Students can gather information and use this information to support explanations of the structural and functional relationship of cells. Students will synthesize information relating sensory receptors and processing of stimuli by the brain.

By the end of the seventh grade, students will be able to provide molecular-level accounts to explain that chemical reactions involve regrouping of atoms to form new substances, and that atoms rearrange during chemical reactions. Students will develop an understanding that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. Students develop their understanding of important qualitative ideas about energy including that the interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students understand that objects that are moving have kinetic energy and that objects also may contain stored (potential) energy, depending on their relative positions. Students also will come to know the difference between energy and temperature and begin to develop an understanding of the relationship between force and energy. Students develop the understanding that cells, the basic unit of life, carry out life's functions of growth, development and reproduction (cell theory).

The crosscutting concepts of patterns that include structure and function; energy and matter; scale, proportion and quantity; systems and system models; cause and effect; and stability and change are highlighted as organizing concepts for these disciplinary core ideas.

Note While only a subset of science and engineering practices and crosscutting concepts are explicitly identified as the mechanism for how students demonstrate mastery at the end of instruction, students should still utilize all of the science and engineering practices and crosscutting concepts as they develop their understanding. See front matter for more information.

7-PS2-2.	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.	
Clarification Statement: Emphasis is on balanced (Newton's first law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's second law), frame of reference, and specification of units. **Assessment Boundary:** Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	**PS2.A: Forces and Motion** The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.	**Stability and Change** Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

7-PS3-4.	**Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**	
Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added. **Assessment Boundary:** Assessment does not include calculating the total amount of thermal energy transferred.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.	**PS3.A: Definitions of Energy** Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. **PS3.B: Conservation of Energy and Energy Transfer** The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment.	**Scale, Proportion, and Quantity** Proportional relationships (e.g., speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

7-LS1-3.	**Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.**	
Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems. **Assessment Boundary:** Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Engaging in Argument from Evidence Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon.	**LS1.A: Structure and Function** In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.	**Systems and System Models** Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems.

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.

6-8 Engineering Design Overview

At the middle school level, students learn to sharpen the focus of problems by precisely specifying criteria and constraints of successful solutions, considering not only what needs the problem is intended to meet, but also the larger context within which the problem is defined, including limits to possible solutions. Students can identify elements of different solutions and combine them to create new solutions. Students at this level are expected to use systematic methods to compare different solutions to see which best meet criteria and constraints, and to test and revise solutions several times in order to arrive at an optimal design.

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. *		
Clarification Statement: None provided. **Assessment Boundary:** None provided.		
Science and Engineering Practice	**Disciplinary Core Idea**	**Crosscutting Concepts**
Asking Questions and Defining Problems Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.	**ETS1.A: Defining and Delimiting Engineering Problems** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	

Alternate Assessment Target: No limitations. All parts of the Kentucky Academic Standard are eligible to be included as an assessment item.