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DEPARTMENT OF EDUCATION

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South Carolina College- and Career-Ready Science Standards 2021

South Carolina State Board of Education

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SC Education Oversight Committee (EOC) Science Standards Review Panel
The 5 members of the SC EOC science standards national review panel and 43 members of the state review panel recommended revisions to the *South Carolina Academic Standards and Performance Indicators for Science 2014.*

SCDE Science Standards Review Panel
The 54 members of the SCDE science standards review panel recommended revisions to the *South Carolina Academic Standards and Performance Indicators for Science 2014.*

SCDE Writing Team
The 48 members of the SCDE science standards writing team wrote the *South Carolina College- and Career-Ready Science Standards 2021.*

SCDE Local Writing Advisory Team
The 28 members of the SCDE local advisory writing team provided recommendations to the *writing team.*

SCDE National Advisory Writing Team
The 10 members of the SCDE national advisory writing team provided recommendations to the *writing team.*

SCDE Standards Design Team
The 13 members of the SCDE design team produced the engineering design process for the *South Carolina College- and Career-Ready Science Standards 2021.*

South Carolina Department of Education
The standard document writers developed this document under the direction of Dr. David Mathis, Deputy Superintendent, Division of College & Career Readiness, Dr. Anne Pressley, Director, Office of Standards and Learning, Gwendolynn Shealy, Team Lead and Elementary Science Education Associate, Office of Standards and Learning, Kathryn Stabell, Secondary Science Education Associate, Kirsten Hural, Program Manager End-of-Course Examination Program, Office of Assessment, and Brenda Ponsard, Science Education Associate, Office of Assessment.

South Carolina's Vision for Science Education

Our vision is that by the end of 12th grade, all students are provided with a coherent progression of authentic and relevant learning experiences where they actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of each field's disciplinary core ideas. As the three dimensions are integrated into standards, curriculum, instruction, and assessment and engineering and technology are featured alongside the natural sciences (physical sciences, life sciences, and Earth and space sciences), students will build a readiness for college, career, and lifelong learning. South Carolina students will be prepared to be careful consumers of scientific and technological information related to their everyday lives, to engage in public discussions on science related issues, to be civic-minded decision makers, to appreciate the beauty and wonder of science, to make sense of everyday phenomena, and identify creative solutions to local, national, and global problems.

***-Although the intrinsic beauty of science and a fascination with how the world works have driven exploration and discovery for centuries, many of the challenges that face humanity now and in the future—related, for example, to the environment, energy, and health—require social, political, and economic solutions that must be informed deeply by knowledge of the underlying science and engineering* (NRC, 2012, p.7).**

Academic Standards

The standards are performance expectations that are three-dimensional. These three dimensions are represented by science and engineering practices, disciplinary core ideas, and crosscutting concepts. The standards derive from foundational research that ensures in-depth opportunities for students to authentically explore the core ideas of the natural and human built world as scientists and engineers.

The standards are considered flexible for the organization of any course as they are not sequenced for curriculum and do not represent a scope or sequence. The three-dimensional standards describe a small number of disciplinary core ideas, so that all students learn what is most important for proficiency in the discipline at a particular level.

In accordance with the South Carolina Educational Accountability Act of 1998 (S.C. Code Ann. § 59- 18- 110), the purpose of academic standards is to provide the basis for the development of local curricula and statewide assessment.

The *South Carolina College- and Career-Ready Science Standards 2021* was informed by The Framework for K-12 Science Education, the Next Generation Science Standards, and other states' standards.

Science Dimensions Overview

The *South Carolina College- and Career-Ready Science Standards 2021* contain standards that are three-dimensional performance expectations (PEs) that include a science and engineering practice (everyday knowledge and skills of scientists and engineers), disciplinary core ideas (science ideas used by scientists and engineers), and crosscutting concepts (ways of thinking like scientists and engineers).

Performance Expectation: The three-dimensional standard that represents the things students should know, understand, and be able to perform to be proficient in science and engineering at the end of instruction.

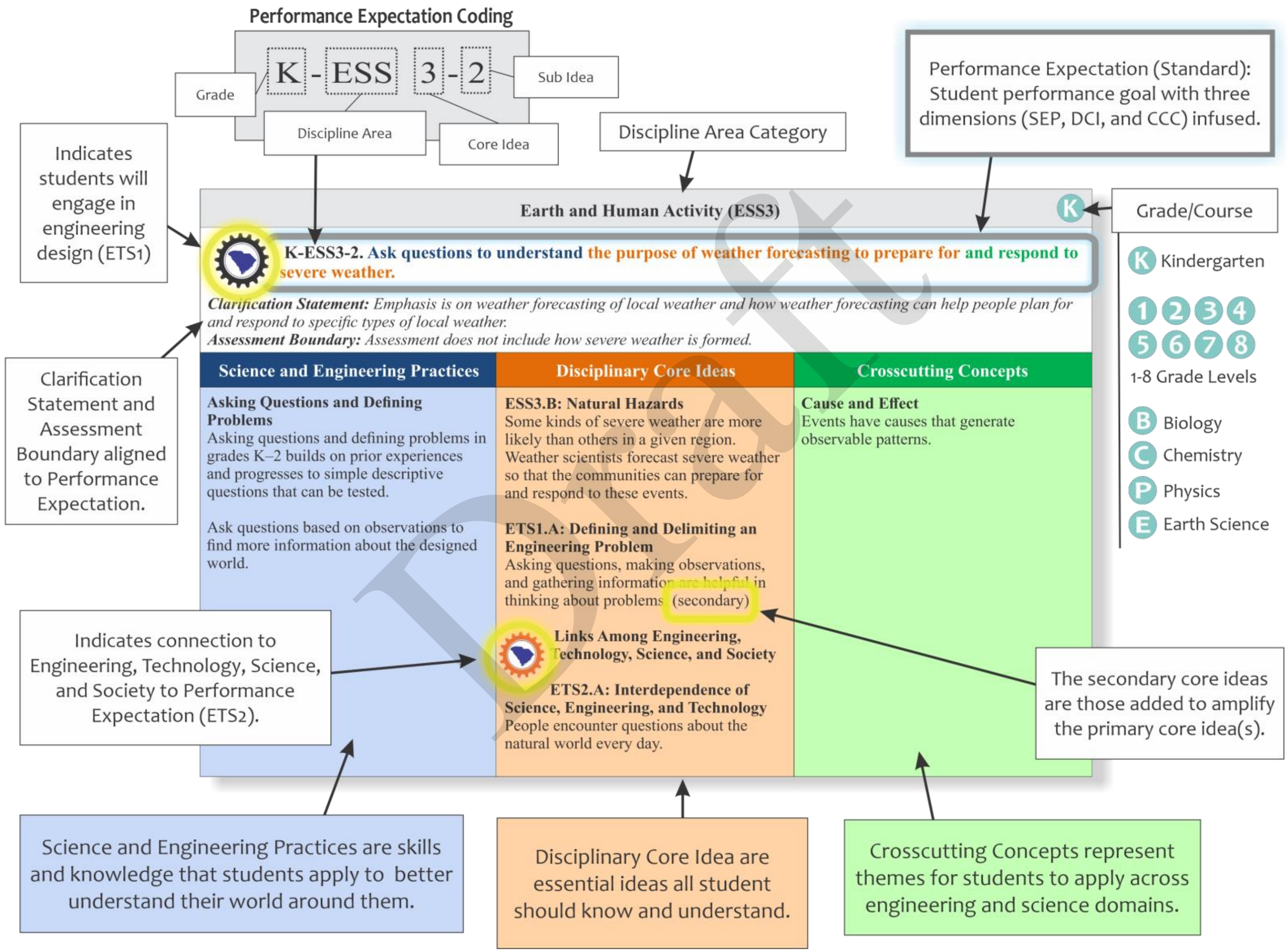
1. Science and Engineering Practices
2. Disciplinary Core Ideas
3. Crosscutting Concepts

The additional components in the performance expectation architecture listed below serves as support for instructors in providing clarity and further guidance for each Performance Expectation.

Clarification Statement: Where needed, a clarification statement accompanies a performance expectation. The intent of a clarification statement is to provide further explanation or examples to better support educators in understanding the aim of the performance expectation.

Assessment Boundary: Where applicable, an assessment boundary accompanies a performance expectation. For specific grades determined by legislation, the assessment boundaries clarifies limits to the state large-scale assessments.

Foundation Boxes: When viewed in tandem with the Performance Expectation, the foundation boxes provides a more coherent and complete view of what students should be able to do. These three boxes include the science and engineering practices, disciplinary core ideas, and crosscutting concepts.



Performance Expectation Coding
K - ESS 3 - 2
Grade
Discipline Area
Core Idea
Sub Idea
Discipline Area Category
Performance Expectation (Standard): Student performance goal with three dimensions (SEP, DCI, and CCC) infused.
Indicates students will engage in engineering design (ETS1)
Earth and Human Activity (ESS3)
K-ESS3-2. Ask questions to understand the purpose of weather forecasting to prepare for and respond to severe weather.
Clarification Statement: Emphasis is on weather forecasting of local weather and how weather forecasting can help people plan for and respond to specific types of local weather.
Assessment Boundary: Assessment does not include how severe weather is formed.
Clarification Statement and Assessment Boundary aligned to Performance Expectation.
Grade/Course
Kindergarten
1 2 3 4 5 6 7 8
1-8 Grade Levels
Biology
Chemistry
Physics
Earth Science
Science and Engineering Practices
Asking Questions and Defining Problems
Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested.
Ask questions based on observations to find more information about the designed world.
Disciplinary Core Ideas
ESS3.B: Natural Hazards
Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events.
ETS1.A: Defining and Delimiting an Engineering Problem
Asking questions, making observations, and gathering information are helpful in thinking about problems (secondary)
Links Among Engineering, Technology, Science, and Society
ETS2.A: Interdependence of Science, Engineering, and Technology
People encounter questions about the natural world every day.
Crosscutting Concepts
Cause and Effect
Events have causes that generate observable patterns.
Indicates connection to Engineering, Technology, Science, and Society to Performance Expectation (ETS2).
The secondary core ideas are those added to amplify the primary core idea(s).
Science and Engineering Practices are skills and knowledge that students apply to better understand their world around them.
Disciplinary Core Idea are essential ideas all student should know and understand.
Crosscutting Concepts represent themes for students to apply across engineering and science domains.

Dimension 1: Science and Engineering Practices

The Science and Engineering Practices (SEPs) are the skills and knowledge that scientists apply as they investigate and build models and theories about the world, and that engineers use as they design and build systems. The fields of science and engineering are related and mutually supportive and the eight SEPs that students DO are (NRC, 2012, p. 50-53):

Asking Questions and Defining Problems
Scientists ask and refine questions about phenomena that lead to explanations of how the natural and designed world(s) works. **Engineers** ask questions to define the problems, identify constraints, and determine criteria for an effective solution.

Use Mathematical and Computational Thinking
In **science**, mathematics and computation are tools for representing physical variables and their relationships. In **engineering**, mathematical and computational representations of established relationships and principles are an integral part of design.

Developing and Using Models
Scientists construct and use models to help develop explanations about natural phenomena. **Engineers** use models as helpful tools to test proposed systems and to recognize strengths and limitations of new designs.

Constructing Explanations and Designing Solutions
The goal for student **scientists** is to construct logically coherent explanations of phenomena that are consistent with the available evidence. **Engineer's** designs are based on scientific knowledge and models of the material world.

Planning and Carrying our Scientific Investigations
Scientists use observations and data collected to test existing theories and explanations or to revise and develop new ones. **Engineers** use investigation to gain data to specify design criteria and to test their designs.

Engaging in Argument from Evidence
Scientists identify the strengths and weaknesses of a line of reasoning to determine argument for finding the best explanation of a natural phenomenon. **Engineers** engage in argument from evidence to find the best possible solution to a problem.

Analyzing and Interpreting Data
Scientists use a range of tools to identify the significant features and patterns in data. **Engineers** analyze data collected in the tests of their designs and investigations.

Obtaining, Evaluating, and Communicating Information
Scientists derive meaning from texts and evaluate the validity of information to then communicate ideas. **Engineers** derive meaning from other's work and texts and evaluate the information, to apply it usefully to express their ideas.

Dimension 2: Disciplinary Core Ideas

Disciplinary Core Ideas are a set of four science and engineering domains for K–12 science that have broad importance across multiple science and engineering disciplines; provide a tool for understanding or investigating more complex ideas and solving problems; relate to the interests and life experiences of students; and are learnable over multiple grades at increasing levels of depth and sophistication (NRC, 2012, p. 31).

Physical Science

PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Students gain awareness of the structure of matter, interactions occurring in terms of the forces between objects, related energy transfers, and their consequences to understand the physical and chemical basis of a system. Chemistry and physics underlie all natural and human-created phenomena and helps students see the mechanisms of cause and effect in all systems and processes that are understood through a common set of physical and chemical principles.

Life Science

LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Students focus on patterns, processes, and relationships of living organisms. The study of life ranges over scales from single molecules, organisms and ecosystems, to the biosphere. A core principle of the life sciences is that organisms are related through common ancestry and that processes of natural selection have led to the tremendous diversity on Earth. Students in life science courses explore all aspects of living things and the environments they live in.

Earth and Space Science

ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Students investigate processes that operate on Earth and address Earth's place in the universe. Earth and space science involve phenomena that range in scale from unimaginably large to invisibly small. Earth and space sciences also provide students opportunities to understand how the atmosphere, geosphere, and biosphere are interconnected.

Engineering, Technology, and Applications of Science

ETS1: Engineering Design
ETS2: Links among Engineering, Technology, Science and Society

Students learn how science is utilized, in particular through the engineering design process, and have the opportunity to appreciate the distinctions and relationships between engineering, technology, and applications of science alongside the physical, life, and Earth and space sciences of other core idea domains. Science-based designs of technologies and systems affect the ways in which people interact with each other and with the environment, indicating how these deigns deeply influence society.

Dimension 3: Crosscutting Concepts

The Crosscutting Concepts represent seven common themes that span across science domains (Physical Science, Life, Earth and Space Science, and Engineering, Technology, Applications of Science) and have value to both scientists and engineers as they identify and connect universal properties and processes found in all domains.

Patterns
Students observe patterns of forms and events to guide organization and classification. Patterns prompt student questions about the factors that influence cause and effect relationships and are useful as evidence to support student explanations and arguments.

Cause and Effect
Students investigate and explain causal relationships and the mechanisms by which they are mediated. Events have causes, some simple, some multifaceted and complex. Students can test such mechanisms across given contexts and the mechanisms can be used to predict and explain events in new contexts.

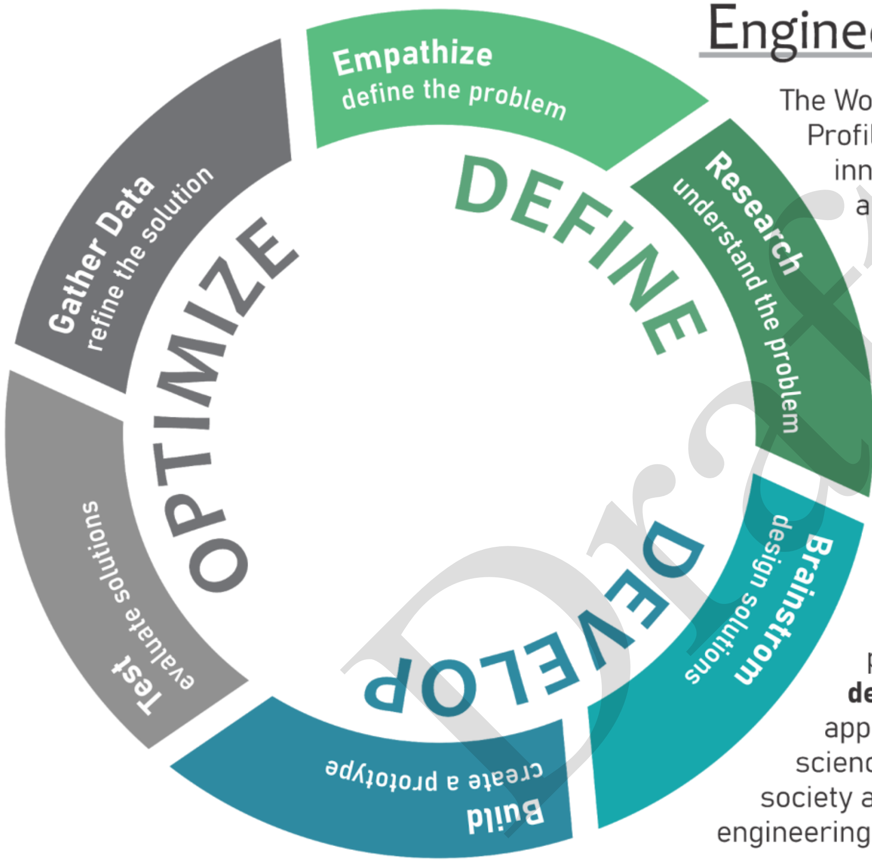
Scale, Proportion, Quantity
It is critical for students, in considering phenomena, to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

Systems and System Models
As students define the system(s) under study, specifying its boundaries and making explicit a model of that system, they are provided tools for understanding and testing ideas that are applicable throughout science and engineering.

Energy and Matter
Students understand the system's possibilities and limitations by tracking fluxes of energy and matter into, out of, and within systems.

Structure and Function
Students explore the relationship of structure and function observe an object's structure and shape to determine many of its properties and functions. The structures, shapes, and substructures of living organisms determine how the organism functions to meet its needs within an environment.

Stability and Change
For natural and built systems alike, conditions of stability and rates of change provide the focus for understanding how the system operates and causes for changes in systems.



Engineering Design Process:

The World Class Skills as articulated in the Profile of the SC Graduate: creativity and innovation, critical thinking, collaboration and teamwork, and communication are infused in the **engineering design process** to support student development of both individual and cooperative engineering practices. During the iterative process, students **define** problems to **develop** and **optimize** solutions to local, national, and global issues. The fields of science and engineering are related and mutually supportive and by engaging students in the knowledge and practices related to the **engineering design process**, students establish an appreciation for the interdependence of science, engineering, and technology within society and the natural world and view engineering as a possible career path.

This icon is found within each performance expectation that aligns to ETS1 - the Design Process.	This icon is found within each DCI foundation box that aligns to ETS2 - Links Among Engineering, Technology, and Society.

Kindergarten

South Carolina kindergarten students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in kindergarten help students engage in inquiry questions such as:

What happens if you change how hard you push or pull an object? Students plan and conduct investigations to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object to analyze data to design solutions.	**Where do animals and plants live and why do they live there?** Students develop an understanding of what plants and animals (including humans) need to survive and use models to understand the relationship between their needs and where they live.
What is the weather like today and how is it different from yesterday? Students ask questions and share observations to develop an understanding of patterns and variations in local weather and the purpose of weather forecasting to prepare for and respond to severe weather.	**What can observations tell us about the effect of sunlight on Earth's surface?** Students apply an understanding of sunlight's effect on the Earth's surface to design solutions to reduce the sunlight's warming effect on an area.

Through the kindergarten standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: asking questions; developing and using models; planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; and engaging in argument from evidence. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; and systems and system models are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina kindergarten students will explore include the following **disciplinary core ideas** from the NRC Framework: Physical Science (PS2, PS3); Life Science (LS1); Earth and Space Science (ESS2, ESS3); and Engineering, Technology, and Applications of Science (ETS1, ETS2). The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Motion and Stability: Forces and interactions (PS2) K		
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, 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 Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. With guidance, plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	**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.

Motion and Stability: Forces and interactions (PS2)		
K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. ***Clarification Statement:*** *Emphasis on exploration-based play as a means to develop a designed solution and test the design. Examples of problems requiring a solution could include having a marble or other object move a certain distance, follow a particular path, and knock down other objects. Examples of solutions could include tools such as a ramp to increase the speed of the object and a structure that would cause an object such as a marble or ball to turn.* ***Assessment Boundary:*** *Assessment does not include friction as a mechanism for change in speed.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Analyze data from tests of an object or tool to determine if it works as intended.	**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. **ETS1.A: Defining Engineering Problems** A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** There are many types of tools produced by engineering that can be used in science to help answer these questions through observation or measurement. Observations and measurements are also used in engineering to help test and refine design ideas.	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Energy (PS3)		
K-PS3-1. Make observations to determine the effect of sunlight on Earth's surface. ***Clarification Statement:*** *Examples of Earth's surface could include sand, soil, rocks, and water.* ***Assessment Boundary:*** *Assessment of temperature is limited to relative measures such as warmer/cooler.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Make observations (firsthand or from media) to collect data that can be used to make comparisons.	**PS3.B: Conservation of Energy and Energy Transfer** Sunlight warms Earth's surface.	**Cause and Effect** Events have causes that generate observable patterns.

Energy (PS3)		
K-PS3-2. Use tools and materials to design and build a structure that will reduce the warming effect of sunlight on an area. ***Clarification Statement:*** *Examples of structures could include umbrellas, canopies, and tents that minimize the warming effect of the sun.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Use tools and materials provided to design and build a device that solves a specific problem or a solution to a specific problem.	**PS3.B: Conservation of Energy and Energy Transfer** Sunlight warms Earth's surface. **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** There are many types of tools produced by engineering that can be used in science to help answer these questions through observation or measurement.	**Cause and Effect** Events have causes that generate observable patterns.

Molecules to Organisms: Structures and Processes (LS1) K		
K-LS1-1. Use observations to describe patterns of what plants and animals (including humans) need to survive. ***Clarification Statement:*** *Examples of patterns could include that animals need to take in food, but plants make food; the different kinds of food needed by different types of animals; the requirement of plants to have light; and, that all living things need water. Patterns could be described using multiple modes of representation.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	**LS1.C: Organization for Matter and Energy Flow in Organisms** All animals need food in order to live and grow. They obtain their food from plants or from other animals. Plants need water and light to live and grow.	**Patterns** Patterns in the natural and human designed world can be observed and used as evidence.

Earth's Systems (ESS2)		
K-ESS2-1. Use and share observations of local weather conditions to describe patterns over time. ***Clarification Statement:*** *Examples of qualitative observations could include descriptions of the weather (sunny, cloudy, rainy, and warm). Examples of quantitative observations could include numbers of sunny, windy, and rainy days in a month. Examples of patterns could include that mornings are cooler than afternoons or the number of sunny days versus cloudy days during different months.* ***Assessment Boundary:*** *Assessment of quantitative observations limited to whole numbers and relative measures such as warmer/cooler.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	**ESS2.D: Weather and Climate** Weather is the combination of sunlight, wind, snow or rain, and temperature in a particular region at a particular time. People measure these conditions to describe and record the weather and to notice patterns over time.	**Patterns** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Earth's Systems (ESS2)		
K-ESS2-2. Construct an argument supported by evidence for how plants and animals (including humans) can change the environment to meet their needs. ***Clarification Statement:*** *Examples of plants and animals changing their environment could include beavers building dams, a squirrel digs in the ground to hide its food and tree roots can break concrete. Humans have developed means to heat and/or cool our homes and vehicles to protect ourselves from the elements.* ***Assessment Boundary:*** *Focus is on plant and animal impacts as a whole and not related to their parts.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). Construct an argument with evidence to support a claim.	**ESS2.E: Biogeology** Plants and animals depend on and can change their environment. **ESS3.C: Human Impacts on Earth Systems** Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. (*secondary*)	**Systems and System Models** Systems in the natural and designed world have parts that work together.

Earth and Human Activity (ESS3)		
K-ESS3-1. Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live. ***Clarification Statement:*** *Examples of relationships could include that deer eat buds and leaves; therefore, they usually live in forested areas, humans use soil and water to grow food, and grasses need sunlight so they often grow in meadows. Plants, animals, and their surroundings make up a system.* ***Assessment Boundary:*** *Specific habitats/biomes are not assessed.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e. diagram, drawing, physical replica, diorama, dramatization, storyboard) that represent concrete events or design solutions. Use a model to represent relationships in the natural world.	**ESS3.A: Natural Resources** Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	**Systems and System Models** Systems in the natural and designed world have parts that work together.

Earth and Human Activity (ESS3)		
K-ESS3-2. Ask questions to understand the purpose of weather forecasting to prepare for and respond to severe weather. ***Clarification Statement:*** *Emphasis is on weather forecasting of local weather and how weather forecasting can help people plan for and respond to specific types of local weather.* ***Assessment Boundary:*** *Assessment does not include how severe weather is formed.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in grades K–2 builds on prior experiences and progresses to simple descriptive questions that can be tested. Ask questions based on observations to find more information about the designed world.	**ESS3.B: Natural Hazards** Some kinds of severe weather are more likely than others in a given region. Weather scientists forecast severe weather so that the communities can prepare for and respond to these events. **ETS1.A: Defining and Delimiting an Engineering Problem** Asking questions, making observations, and gathering information are helpful in thinking about problems. (*secondary*) ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** People encounter questions about the natural world every day.	**Cause and Effect** Events have causes that generate observable patterns.

Earth and Human Activity (ESS3)		
K-ESS3-3. Plan and carry out an investigation that gives evidence of human impact on the land, water, air, and/or other living things in the local environment. ***Clarification Statement:*** *Examples of human impact on the land could include cutting trees to produce paper, using resources to produce bottles, mowed versus un-mowed plots in the schoolyard, and materials used in school cafeteria trays. Examples of investigations could include reusing and recycling materials.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. With guidance, plan and conduct an investigation in collaboration with peers.	**ESS3.C: Human Impacts on Earth Systems** Things that people do to live comfortably can affect the world around them, but they can make choices that reduce their impacts on the land, water, air, and other living things.	**Cause and Effect** Events have causes that generate observable patterns.

First Grade

South Carolina first grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experience are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in first grade help students engage in inquiry questions such as:

What happens when there is no light?
Students investigate the relationship between the presence or absence of light and the ability to see objects. The idea that light travels from place to place can be understood by students at this level through determining the effect of placing objects made with different materials in the path of a beam of light.

What are some ways plants and animals meet their needs in order to survive and grow?
Students develop an understanding of how plants and animals use their external parts to help them survive, grow, and meet their needs as well as how behaviors of parents and offspring help the offspring survive. Students also us mimicry to design solutions to a human problem.

What happens when materials vibrate?
Students plan and conduct investigations to develop an understanding of the relationship between sound and vibrating materials.

How are parents and their young similar and different?
Students make observations to support the understanding that young plants and animals are like, but not exactly the same as, their parents.

What objects are in the sky and how do they seem to move?
Students are able to observe, describe, and predict some patterns of the movement of objects in the sky.

Through the first grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; structure and function; and systems and system models are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina kindergarten students will explore include the following **disciplinary core ideas** from the NRC Framework: Physical Science (PS4); Life Science (LS1, LS3); Earth and Space Science (ESS1); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Waves and their Applications in Technologies for Information Transfer (PS4) 1		
1-PS4-1. Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can make materials vibrate. ***Clarification Statement:*** *Examples of vibrating materials that make sound could include tuning forks and plucking a stretched string. Examples of how sound can make matter vibrate could include holding a piece of paper near a speaker making sound and holding an object near a vibrating tuning fork.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question.	**PS4.A: Wave Properties** Sound can make matter vibrate and vibrating matter can make sound.	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Waves and their Applications in Technologies for Information Transfer (PS4)

1-PS4-2. Make observations to construct an evidence-based claim that objects in darkness can be seen only when illuminated by light sources.

Clarification Statement: *Examples of observations could include those made in a completely dark room, a pinhole box, and a video of a cave explorer with a flashlight. Illumination could be from an external light source or by an object giving off its own light.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	**PS4.B: Electromagnetic Radiation** Objects can only be seen if light is available to illuminate them or if they give off their own light.	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Waves and their Applications in Technologies for Information Transfer (PS4)		
1-PS4-3. **Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light.** ***Clarification Statement:*** *Examples of materials could include those that are transparent (such as clear plastic), translucent (such as wax paper), opaque (such as cardboard), and reflective (such as a mirror).* ***Assessment Boundary:*** *Assessment does not include the speed of light.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Plan and conduct investigations collaboratively to produce data to serve as the basis for evidence to answer a question	**PS4.B: Electromagnetic Radiation** Light travels from place to place. Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam. (The idea that light travels from place to place is developed through experiences with light sources, mirrors, and shadows, but no attempt is made to discuss the speed of light.)	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Waves and their Applications in Technologies for Information Transfer (PS4) 1		
1-PS4-4. Use tools and materials to design and build a device that uses light or sound to communicate over distance. ***Clarification Statement:*** *Examples of resources could include general household items to create light or sound signals and patterns.* ***Assessment Boundary:*** *Assessment does not include technological details for how communication devices work.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Use tools and materials provided to design a device that solves a specific problem.	**PS4.C: Information Technologies and Instrumentation** People also use a variety of devices to communicate (send and receive information) over long distances. **ETS1.B: Develop Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. To design something complicated, one may need to break the problem into parts and attend to each part separately, then bring the parts together to test the overall solution. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.	**Systems and System Models:** Systems in the natural and designed world have parts that work together.

From Molecules to Organisms: Structures and Processes (LS1)

1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Clarification Statement: *Examples of human problems that can be solved by mimicking plant or animal solutions could include designing clothing or equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales; stabilizing structures by mimicking animal tails and roots on plants; keeping out intruders by mimicking thorns on branches and animal quills; and, detecting intruders by mimicking eyes and ears.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Use materials to design a device that solves a specific problem or a solution to a specific problem.	**LS1.A: Structure and Function** All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. **LS1.D: Information Processing** Animals have body parts that capture and convey different kinds of information needed for growth and survival. Animals respond to these inputs with behaviors that help them survive. Plants also respond to some external inputs. **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	**Structure and Function** The shape and stability of structures and natural and designed objects are related to their function(s).

	Links Among Engineering, Technology, Science, and Society **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world.	

From Molecules to Organisms: Structures and Processes (LS1)		
1-LS1-2. Obtain information from multiple sources to determine patterns in behavior of parents and offspring that help offspring survive. ***Clarification Statement:*** *Examples of patterns of behaviors could include the signals that offspring make (such as crying, cheeping, and other vocalizations) and the responses of the parents (such as feeding, comforting, and protecting the offspring). Information may be obtained through observations, field study, text, media, etc.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. Read grade-appropriate texts and use media to obtain scientific information to determine patterns in the natural world.	**LS1.B: Growth and Development of Organisms** Adult plants and animals can have young. In many kinds of animals, parents and the offspring themselves engage in behaviors that help the offspring to survive.	**Patterns** Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.

Heredity: Inheritance and Variation of Traits (LS3)		
1-LS3-1. Make observations of plants and animals to support an evidence-based claim that most young are like, but not exactly like, their parents. ***Clarification Statement:*** *Emphasis is on identifying patterns of shared features between young and adult plants or animals. Examples of observations could include leaves from the same kind of plant are the same shape but can differ in size; and, a particular breed of dog looks like its parents but is not exactly the same.* ***Assessment Boundary:*** *Assessment does not include inheritance or animals that undergo metamorphosis or hybrids.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	**LS3.A: Inheritance of Traits** Young animals are very much, but not exactly like, their parents. Plants also are very much, but not exactly, like their parents. **LS3.B: Variation of Traits** Individuals of the same kind of plant or animal are recognizable as similar but can also vary in many ways.	**Patterns** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Earth's Place in the Universe (ESS1)		
1-ESS1-1. Use observations of the sun, moon, and stars to describe patterns that can be predicted. ***Clarification Statement:*** *Examples of patterns could include that the sun and moon appear to rise in one part of the sky, move across the sky, and set; and stars other than our sun are visible at night but not during the day.* ***Assessment Boundary:*** *Assessment of star patterns is limited to stars being seen at night and not during the day.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Use observations (firsthand or from media) to describe patterns in the natural world in order to answer scientific questions.	**ESS1.A: The Universe and Stars** Patterns in location of the sun, moon, and stars in the sky can be observed, described, and predicted. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** People encounter questions about the natural world every day. There are many types of tools produced by engineering that can be used in science to help answer these questions through observation or measurement. Observations and measurements are also used in engineering to help test and refine design ideas.	**Patterns** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Earth's Place in the Universe (ESS1)

1-ESS1-2. Make observations at different times of year to relate the amount of daylight to the time of year.

Clarification Statement: *Emphasis is on relative comparisons of the amount of daylight in the winter to the amount in the spring or fall.*
Assessment Boundary: *Assessment is limited to relative amounts of daylight, not quantifying the hours or time of daylight.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Make observations (firsthand or from media) to collect data that can be used to make comparisons.	**ESS1.B: Earth and the Solar System** Seasonal patterns of sunrise and sunset can be observed, described, and predicted.	**Patterns** Patterns in the natural world can be observed, used to describe phenomena, and used as evidence.

Second Grade

South Carolina second grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in second grade help students engage in inquiry questions such as:

How are materials similar and different from one another, and how do the properties of the materials relate to their use?
Students develop an understanding of observable properties of materials through the analysis and classification of different materials.

How does land change and what are some things that cause it to change?
Students apply their understanding of the idea that wind and water can change the shape of the land to compare design solutions to slow or prevent such change.

What do plants need to grow?
Students investigate and use models to develop an understanding of what plants need to grow and how plants depend on animals for seed dispersal and pollination.

What are the different kinds of land and bodies of water?
Students use information and models to identify and represent the shapes and kinds of land and bodies of water in an area and where water is found on Earth.

How many types of living things live in a place?
Students make observations and compare the diversity of life in different habitats.

Through the second grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices:** developing and using models; planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; energy and matter; structure and function; and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina second grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS1); Life Science (LS2, LS4); Earth and Space Science (ESS1, ESS2, ESS3); and Engineering, Technology, and Application of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Matter and Its Interactions (PS1)		
2-PS1-1. Plan and conduct an investigation to describe, identify patterns, and classify different kinds of materials by their observable properties. ***Clarification Statement:*** *Observations could include color, texture, hardness, and flexibility* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	**PS1.A: Structure and Properties of Matter** Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.	**Patterns** Patterns in the natural and human designed world can be observed.

Matter and its Interactions (PS1)		
2-PS1-2. Analyze data obtained from tests to determine which materials have the best properties for an intended purpose. ***Clarification Statement:*** *Examples of properties could include, strength, flexibility, hardness, texture, and absorbency* ***Assessment Boundary:*** *Assessment of quantitative measurements is limited to length.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in K–2 builds on prior experiences and progresses to collecting, recording, and sharing observations. Analyze data from tests of an object or tool to determine if it works as intended.	**PS1.A: Structure and Properties of Matter** Different properties are suited to different purposes.	**Cause and Effect** Simple tests can be designed to gather evidence to support or refute student ideas about causes.

Matter and its Interactions (PS1)

2-PS1-3. Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

Clarification Statement: *Examples of pieces could include manipulatives, or other assorted small objects. Provide students with the same number of objects to create a different object.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Make observations (firsthand or from media) to construct an evidence-based account for natural phenomena.	**PS1.A: Structure and Properties of Matter** Different properties are suited to different purposes. A great variety of objects can be built up from a small set of pieces.	**Energy and Matter** Objects may break into smaller pieces and be put together into larger pieces, or change shapes.

Matter and its Interactions (PS1) 2		
2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot. ***Clarification Statement:*** *Examples of reversible changes could include materials such as water, crayons and butter at different temperatures. Examples of irreversible changes could include cooking an egg, baking a cake, or preparing popcorn.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in K–2 builds on prior experiences and progresses to comparing ideas and representations about the natural and designed world(s). Construct an argument with evidence to support a claim.	**PS1.B: Chemical Reactions** Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.	**Cause and Effect** Events have causes that generate observable patterns.

Ecosystems: Interactions, Energy, and Dynamics (LS2)

2-LS2-1. Plan and conduct an investigation to determine if plants need sunlight and water to grow.

Clarification Statement: *Emphasis is on plants depending on water and light to grow.*
Assessment Boundary: *Assessment is limited to testing one variable at a time.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.	**LS2.A: Interdependent Relationships in Ecosystems** Plants depend on air, water, minerals (in the soil), and light to grow. Different plants survive better in different settings because they have varied needs for water, minerals, and sunlight.	**Cause and Effect** Events have causes that generate observable patterns.

Ecosystems: Interactions, Energy, and Dynamics (LS2) 2		
2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. Develop a simple model based on evidence to represent a proposed object or tool.	**LS2.A: Interdependent Relationships in Ecosystems** Plants depend on animals for pollination or to move their seeds around. **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people.	**Structure and Function** The shape and stability of structures of natural and designed objects are related to their function(s).

Biological Evolution: Unity and Diversity (LS4)		
2-LS4-1. Make observations of plants and animals to compare the diversity of life in different habitats. ***Clarification Statement:*** *Emphasis is on the diversity of living things in a variety of different habitats* ***Assessment Boundary:*** *Assessment does not include specific animal and plant names in specific habitats.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in K–2 builds on prior experiences and progresses to simple investigations, based on fair tests, which provide data to support explanations or design solutions. Make observations (firsthand or from media) to collect data which can be used to make comparisons.	**LS4.D: Biodiversity and Humans** There are many different kinds of living things in any area, and they exist in different places on land and in water.	**Structure and Function** The shape and stability of structures of natural and designed objects are related to their function(s).

Earth's Place in the Universe (ESS1)		
2-ESS1-1. Use information from several sources to provide evidence that Earth events can occur rapidly or slowly. ***Clarification Statement:*** *Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly and erosion of rocks, which occurs slowly.* ***Assessment Boundary:*** *Assessment does not include quantitative measurements of timescales.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Make observations from several sources to construct an evidence-based account for natural phenomena.	**ESS1.C: The History of Planet Earth** Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe.	**Stability and Change** Things may change slowly or rapidly.

Earth's Systems (ESS2)

2-ESS2-1. Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

Clarification Statement: *Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena and designing solutions. Compare multiple solutions to a problem.	**ESS2.A: Earth Materials and Systems** Wind and water can change the shape of the land. **ETS1.C: Optimizing the Design Solution** Because there is always more than one possible solution to a problem, it is useful to compare and test designs. *(secondary)* ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Developing and using technology has impacts on the natural world. *(secondary)*	**Stability and Change** Things may change slowly or rapidly.

Earth's Systems (ESS2)		
2-ESS2-2. Develop a model to represent the shapes and kinds of land and bodies of water in an area. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *Assessment does not include quantitative scaling in models.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in K–2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. Develop a model to represent patterns in the natural world.	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** Maps show where things are located. One can map the shapes and kinds of land and water in any area.	**Patterns** Patterns in the natural world can be observed.

Earth's Systems (ESS2)		
2-ESS2-3. Obtain information to identify where water is found on Earth and that it can be solid or liquid. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in K–2 builds on prior experiences and uses observations and texts to communicate new information. Obtain information using various texts, text features (e.g., headings, tables of contents, glossaries, electronic menus, icons), and other media that will be useful in answering a scientific question.	**ESS2.C: The Roles of Water in Earth's Surface Processes** Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form.	**Patterns** Patterns in the natural world can be observed.

Earth and Human Activity (ESS3)

2

2-ESS3-1. Design solutions to address human impacts on natural resources in the local environment.

Clarification Statement: *N/A*
Assessment Boundary: *Assessment does not include energy resources such as coal or other fuels.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in K–2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence based accounts of natural phenomena and designing solutions. Use tools and/or materials to design and/or build a device that solves a specific problem or a solution to a specific problem.	**ESS3.C: Human Impacts on Earth Systems** Things that people do to live can affect the world around them. But they can make choices that reduce their impacts on the land, water, air, and other living things. **ETS1.B: Developing Possible Solutions** Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Every human-made product is designed by applying some knowledge of the natural world and is built using materials derived from the natural world. Thus, developing and using technology has impacts on the natural world.	**Cause and Effect** Events have causes that generate observable patterns.

Third Grade

South Carolina third grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in third grade help students engage in inquiry questions such as:

How do equal and unequal forces on an object affect the object?
Students investigate the effects of balanced and unbalanced forces on the motion of an object and develop an understanding of the cause and effect relationships of electric and magnetic interactions between two objects not in contact with each other.

What happens to organisms when their environment changes?
Students construct arguments from evidence to develop an understanding of the idea that when the environment changes some organisms survive and reproduce, some move to new locations, some move into the transformed environment, and some die.

How can magnets be used?
Students apply their understanding of magnetic interactions to define a simple design problem that can be solved with magnets.

How can the impact of weather-related hazards be reduced?
Students make a claim about the effectiveness of a design solution that reduces the impacts of a weather-related hazard by applying their understanding of weather-related hazards.

How are plants, animals, and environments of the past similar or different from current plants, animals, and environments?
Students analyze and interpret data to develop an understanding of types of organisms that lived long ago and also about the nature of their environments.

What is typical weather in different parts of the world and during different times of the year?
Students organize and use data to describe typical weather conditions expected during a particular season. An exploration of weather patterns over time enables students to understand various climates found around the world.

How do organisms vary in their traits?
Students develop and use models to build an understanding of the similarities and differences of organisms' life cycles. An understanding that organisms have different inherited traits, and that the environment can also affect the traits that an organism develops, is developed by students at this level. In addition, students construct an explanation using evidence for how the variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing.

Through the third grad standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices:** asking questions and defining problems; developing and using models; planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion and quantity; and systems and system models are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina third grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS2); Life Science (LS1, LS2, LS3, LS4); Earth and Space Science (ESS2, ESS3); and Engineering, Technology and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Motion and Stability: Forces and interactions (PS2)		
3-PS2-1. Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. ***Clarification Statement:*** *Examples could include an unbalanced force on one side of a ball, which causes movement; and, balanced forces pushing on a box from both sides will not cause any motion.* ***Assessment Boundary:*** *Assessment does include gravity as a force that pulls objects down and investigates one variable at a time (number, size or direction of forces). Assessment does not include quantitative force size, only qualitative and relative.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**PS2.A: Forces and Motion** Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (Qualitative and conceptual, but not quantitative addition of forces are used at this level.) **PS2.B: Types of Interactions** Objects in contact exert forces on each other.	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

Motion and Stability: Forces and interactions (PS2)		
3-PS2-2. Make observations and measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. ***Clarification Statement:*** *Example could include a pattern of the number of times a pendulum swings at various lengths.* ***Assessment Boundary:*** *Assessment does include predictions based on patterns found in measurable data. Assessment does not include technical terms such as period and frequency.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.	**PS2.A: Forces and Motion** The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.)	**Patterns** Patterns of change can be used to make predictions.

Motion and Stability: Forces and interactions (PS2)		
3-PS2-3. Ask questions to determine cause and effect relationships of electric interactions and magnetic interactions between two objects not in contact with each other. ***Clarification Statement:*** *Examples could include the interactive force on hair from an electrically charged balloon or other instances of static electricity. Examples could include either the magnetic force between two permanent magnets or an electromagnet and steel paper clips. Examples of cause and effect relationships could include how the distance between objects affects strength of the force, how combining magnets affects the strength of the force, and how the orientation of magnets affects the direction of the force.* ***Assessment Boundary:*** *Assessment does include electric interactions and magnetic interactions produced by objects that can be manipulated by students. Assessment does not include electric interactions other than static electricity.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Ask questions that can be investigated based on patterns such as cause and effect relationships.	**PS2.B: Types of Interactions** Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other.	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

Motion and Stability: Forces and interactions (PS2)

3-PS2-4. Develop possible solutions to a simple design problem by applying scientific ideas about magnets.

Clarification Statement: *Examples could include latching a door to keep it shut or keeping objects apart so they do not touch.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**PS2.B: Types of Interactions** Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. **ETS1.B: Developing Possible Solutions** Testing a solution involves investigating how well it performs under a range of likely conditions. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Scientific discoveries about the natural world can often lead to new and improved technologies, which are developed through the engineering design process.	**Systems and System Models** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

From Molecules to Organisms: Structures and Processes (LS1)		3
3-LS1-1. Develop and use models to describe how organisms change in predictable patterns during their unique and diverse life cycles. ***Clarification Statement:*** *Changes organisms go through during their life cycles include birth/sprouting, growth, reproduction, and death.* ***Assessment Boundary:*** *Assessment does include animal life cycles and flowering plants. Assessment does not include details of reproduction beyond two ways animals are born: live from mother or hatched from eggs. Assessment is limited to non-human examples.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop models to describe phenomena.	**LS1.B: Growth and Development of Organisms** Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles.	**Patterns** Patterns of change can be used to make predictions.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
3-LS2-1. Construct an argument that some animals form groups that help members survive. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model.	**LS2.D: Social Interactions and Group Behavior** Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. Groups can be collections of equal individuals, hierarchies with dominant members, small families, groups of single or mixed gender, or groups composed of individuals similar in age. Some groups are stable over long periods of time; others are fluid, with members moving in and out. Some groups assign specialized tasks to each member; in others, all members perform the same or a similar range of functions.	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Heredity: Inheritance and Variation of Traits (LS3)		
3-LS3-1. Analyze and interpret data to provide evidence that plants and animals have inherited traits that vary within a group of similar organisms. ***Clarification Statement:*** *Similarities and differences in shared traits form patterns among parents, siblings, and offspring.* ***Assessment Boundary:*** *Assessment does not include genetic mechanisms of inheritance and prediction of traits. Assessment is limited to non-human examples.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning.	**LS3.A: Inheritance of Traits** Many characteristics of organisms are inherited from their parents. **LS3.B: Variation of Traits** Different organisms vary in how they look and function because they have different inherited information.	**Patterns** Similarities and differences in patterns can be used to sort and classify natural phenomena.

Heredity: Inheritance and Variation of Traits (LS3)		
3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment. ***Clarification Statement:*** *Examples could include stunted growth in plants due to insufficient resources or obesity in animals that eat too much and get little exercise.* ***Assessment Boundary:*** *Assessment is limited to non-human examples.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Use evidence (e.g., observations, patterns) to support an explanation.	**LS3.A: Inheritance of Traits** Some characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. **LS3.B: Variation of Traits** The environment affects the traits that an organism develops.	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Biological Evolution: Unity and Diversity (LS4)		
3-LS4-1. Analyze and interpret data from fossils to provide evidence of organisms and the environments in which they lived long ago. ***Clarification Statement:*** *Examples could include marine fossils found on dry land or tropical plant fossils found in cold regions.* ***Assessment Boundary:*** *Assessment is limited to major fossil types, relative ages, and fossils of extinct organisms, but does not include identification of specific fossils.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning.	**LS4.A: Evidence of Common Ancestry and Diversity** Some kinds of plants and animals that once lived on Earth are no longer found anywhere. Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**Scale, Proportion, and Quantity** Observable phenomena exist from very short to very long time periods.

Biological Evolution: Unity and Diversity (LS4)		
3-LS4-2. Use evidence to construct an explanation for how the variations in traits among individuals of the same species may provide advantages in surviving and producing offspring. ***Clarification Statement:*** *Examples could include plants that have larger thorns than other plants may be less likely to be eaten or animals that have better camouflage may be more likely to survive and produce offspring.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Use evidence (e.g., observations, patterns) to construct an explanation.	**LS4.B: Natural Selection** Sometimes the differences in characteristics between individuals of the same species provide advantages in surviving, finding mates, and reproducing.	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Biological Evolution: Unity and Diversity (LS4)		

3-LS4-3. Construct an argument with evidence that in a particular habitat some organisms can thrive, struggle to survive, or fail to survive.

Clarification Statement: *Examples could include needs and characteristics of the organisms and habitats involved. Changes in a habitat are sometimes beneficial, sometimes neutral, or sometimes harmful to an organism.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence.	**LS4.C: Adaptation** Adaptation can lead to organisms that are better suited for their environment. For any particular environment, some kinds of organisms survive well, some survive less well, and some cannot survive at all.	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Biological Evolution: Unity and Diversity (LS4)

3-LS4-4. Make a claim about the effectiveness of a solution to a problem caused when the environment changes and affects organisms living there.

Clarification Statement: *Examples could include changes within a system such as land characteristics, water distribution, temperature, food, or other organisms.*
Assessment Boundary: *Assessment is limited to a single environmental change. Assessment does not include the greenhouse effect or climate change.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. *(secondary)* **LS4.D: Biodiversity and Humans** Populations live in a variety of habitats, and change in those habitats affects the organisms living there. **ETS1.C: Optimizing the Design Solution** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. ***Links Among Engineering, Technology, Science, and Society***	**Systems and System Models** A system can be described in terms of its components and their interactions.

	ETS2.A: Interdependence of Science, Engineering, and Technology Knowledge of relevant scientific concepts and research findings is important in engineering.	

Earth's Systems (ESS2)		
3-ESS2-1. Represent data in tables and graphical displays of typical weather conditions during a particular season to identify patterns and make predictions. ***Clarification Statement:*** *Examples could include making predictions about weather conditions based on average temperature, precipitation, and wind direction.* ***Assessment Boundary:*** *Assessment does include tables and graphical displays (only pictographs and bar graphs). Assessment does not include climate change.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Represent data in tables and various graphical displays (bar graphs and pictographs) to reveal patterns that indicate relationships.	**ESS2.D: Weather and Climate** Weather, which varies from day to day and seasonally throughout the year, is the conditions of the atmosphere at a given place and time. Scientists record patterns of the weather across different times and areas so that they can make predictions about what kind of weather might happen next.	**Patterns** Patterns of change can be used to make predictions.

Earth's Systems (ESS2)		
3-ESS2-2. Obtain and combine information to describe climate patterns in different regions of the world. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. Obtain and combine information from books and other reliable media to explain phenomena.	**ESS2.D: Weather and Climate** Climate describes a range of an area's typical weather conditions and the extent to which those conditions vary over years.	**Patterns** Similarities and differences in patterns can be used to sort and classify natural phenomena.

Earth and Human Activity (ESS3)		
3-ESS3-1. Make a claim about the effectiveness of a design solution that reduces the impacts of a weather-related hazard. ***Clarification Statement:*** *Examples could include design solutions to a weather-related hazard such as barriers to prevent flooding, wind resistant roofs, or lightning rods.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.	**ESS3.B: Natural Hazards** A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. **ETS1.C: Optimizing the Design Solution** Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers improve existing technologies or develop new ones to increase their benefits (e.g., better artificial limbs), decrease known risks (e.g., seatbelts in cars), and meet societal demands (e.g., cell phones).	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

Fourth Grade

South Carolina fourth grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in fourth grade help students engage in inquiry questions such as:

What are waves and what are some things they can do?
Students use a model of waves to describe patterns of waves in terms of amplitude and wavelength, and that waves can cause objects to move.

What is energy and how is it related to motion?
Students use evidence to construct an explanation of the relationship between the speed of an object and the energy of that object.

What patterns of Earth's features can be determined with the use of maps?
Students analyze and interpret data from maps to describe patterns of Earth's features.

How can energy be used to solve a problem?
Students apply their understanding of energy to design, test, and refine a device that converts energy from one form to another.

How is energy transferred?
Students ask questions and make observations to develop an understanding that energy can be transferred from place to place by sound, light, heat, and electric currents or from object to object through collisions.

How can water, ice, wind and vegetation change the land?
Students develop an understanding of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. They apply their knowledge of natural Earth processes to generate and compare multiple solutions to reduce the impacts of such processes on humans.

How do internal and external structures support the survival, growth, behavior, and reproduction of plants and animals?
Students develop an understanding that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. By developing a model, they describe that an object can be seen when light reflected from its surface enters the eye.

Through the fourth grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices:** asking questions; developing and using models; planning and carrying out investigations;

analyzing and interpreting data; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; energy and matter; and systems and system models are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina fourth grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS3, PS4); Life Science (LS1); Earth and Space Science (ESS1, ESS2, ESS3); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Energy (PS3)

4

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Clarification Statement: *N/A*
Assessment Boundary: *Assessment does not include quantitative measurements of energy and speed. Assessment does include qualitative observations, such as: fast, slow, more than, further than, etc.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Use evidence (e.g., measurements, observations, patterns) to construct an explanation.	**PS3.A: Definitions of Energy** The faster a given object is moving, the more energy it possesses.	**Energy and Matter** Energy can be transferred in various ways and between objects.

Energy (PS3)

4

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Clarification Statement: *N/A*
Assessment Boundary: *Assessment does not include quantitative measurements of energy or the difference between transferring and transforming energy.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Decide what data are to be gathered, what tools are needed to do the gathering, and how measurements will be recorded.	**PS3.A: Definitions of Energy** Energy can be moved [transferred] from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and Energy Transfer** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. Light also transfers energy from place to place. Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light.	**Energy and Matter** Energy can be transferred in various ways and between objects.

Energy (PS3)

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Clarification Statement: *Emphasis is on the change in the energy due to the change in speed, not on the forces, as objects interact.*
Assessment Boundary: *Assessment does not include quantitative measures of changes in the speed of an object (acceleration) or quantitative measurements of energy.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.	**PS3.A: Definitions of Energy** Energy can be moved from place to place by moving objects or through sound, light, or electric currents. **PS3.B: Conservation of Energy and Energy Transfer** Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. **PS3.C: Relationship Between Energy and Forces** When objects collide, the contact forces transfer energy so as to change the objects' motions.	**Energy and Matter** Energy can be transferred in various ways and between objects.

Energy (PS3)

4

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Clarification Statement: *Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints include the materials, cost, or time to design the device.*

Assessment Boundary: *Devices should be limited to those that convert motion energy to electric energy or use stored energy (batteries) to cause motion or produce light or sound.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Apply scientific ideas to solve design problems.	**PS3.B: Conservation of Energy and Energy Transfer** Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by trans- forming the energy of motion into electrical energy. **PS3.D: Energy and Chemical Processes and Everyday Life** The expression "produce energy" typically refers to the conversion of stored energy (batteries) into a desired form for practical use. **ETS1.A: Defining Engineering Problems** Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria).	**Energy and Matter** Energy can be transferred in various ways and between objects.

	Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. *(secondary)* **ETS1.B: Developing Possible Solution** At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. *(secondary)* ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering and Technology on Society and the Natural World** Engineers improve existing technologies or develop new ones. *(secondary)*	

Waves and their Applications in Technologies for Information Transfer (PS4)

4

4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

Clarification Statement: *Examples of models include diagrams, analogies, and physical models using (but not limited to) stringed beads, rubber bands, wire, or yarn to illustrate wavelength and amplitude of waves.*
Assessment Boundary: *Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model using an analogy, example, or abstract representation to describe a scientific principle.	**PS4.A: Wave Properties** Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: This grade band endpoint was moved from K–2) Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).	**Patterns** Similarities and differences in patterns can be used to sort and classify natural phenomena.

Waves and their Applications in Technologies for Information Transfer (PS4)

4-PS4-2. Develop a model to describe that light reflecting from objects and entering the eye affects the object's appearance.

Clarification Statement: *Model constraints include components such as the source of the light, objects that are seen, the path of the light, and the eye. Models could be used to investigate what happens when one of the components changes.*
Assessment Boundary: *Assessment does not include knowledge of the visible light spectrum, the specific interaction of light and states of matter in refraction, the cellular mechanisms of vision, or how the retina works.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena. Use diagrams, maps, and other abstract models as tools that enable them to elaborate on their own ideas or findings and present them to others.	**PS4.B: Electromagnetic Radiation** An object can be seen when light reflected from its surface enters the eyes. The color people see depends on the color of the available light source (i.e. colored filter) as well as the properties of the surface.	**Cause and Effect** Cause and effect relationships are routinely identified.

Waves and their Applications in Technologies for Information Transfer (PS4)		
4-PS4-3. Generate and compare multiple solutions that use patterns to transmit information. ***Clarification Statement:*** *Examples of solutions include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, QR codes, barcodes, and using Morse code to send text. The coding method does not need to be electronic or digital, but the code should only be two possible values such as on/off, 1/0, black/white.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**PS4.C: Information Technologies and Instrumentation** Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. When in digitized form, information can be recorded, stored for future recovery, and transmitted over long distances without significant degradation of the wave. **ETS1.C: Optimizing the Designed Solution** Different solutions need to be tested in order to determine which of the best solves the problem, given the criteria and the constraints. *(secondary)* ***Links Among Engineering, Technology, Science, and Society***	**Patterns** Similarities and differences in patterns can be used to sort and classify designed products.

	ETS2.A: Interdependence of Science, Engineering, and Technology Knowledge of relevant scientific concepts and research findings is important in engineering.	

From Molecules to Organisms: Structures and Processes (LS1)		
4-LS1-1. Construct an argument that plants and animals have internal and external structures that function together in a system to support survival, growth, behavior, and reproduction. ***Clarification Statement:*** *Examples of structures include thorns, stems, roots, colored petals, heart, stomach, lung, brain, and skin. Emphasis on identifying structure design before naming its purpose or function. Reproduction refers specifically to the life cycle. Examples do not include reproductive organs.* ***Assessment Boundary:*** *Assessment does not include microscopic structures within plant and animal systems.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Construct an argument with evidence, data, and/or a model.	**LS1.A: Structure and Function** Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction.	**Systems and System Models** A system can be described in terms of its components and their interactions.

From Molecules to Organisms: Structures and Processes (LS1)		4
4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways. ***Clarification Statement:*** *Emphasis is on systems of information transfer.* ***Assessment Boundary:*** *Assessment does not include the mechanisms by which the brain stores and recalls information or the mechanisms of how sensory receptors function.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Use a model to test interactions concerning the functioning of a natural system.	**LS1.D: Information Processing** Different sense receptors are specialized for particular kinds of information, which may be then processed by the animal's brain. Animals are able to use their perceptions and memories to guide their actions.	**Systems and System Models** A system can be described in terms of its components and their interactions.

Earth's Place in the Universe (ESS1)		
4-ESS1-1. Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. ***Clarification Statement:*** *Examples of evidence from patterns could include rock layers with marine shell fossils above rock layers with plant fossils and no shells, indicating a change from land to water over time; and, a canyon with different rock layers in the walls and a river in the bottom, indicating that over time a river cut through the rock.* ***Assessment Boundary:*** *Assessment does not include specific knowledge of the mechanism of rock formation or memorization of specific rock formations and layers. Assessment is limited to relative time.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Identify the evidence that supports particular points in an explanation.	**ESS1.C: The History of Planet Earth** Local, regional, and global patterns of rock formations reveal changes over time due to Earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed.	**Patterns** Patterns can be used as evidence to support an explanation.

Earth's Systems (ESS2)		
4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. ***Clarification Statement:*** *Examples of variables to test include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.* ***Assessment Boundary:*** *Assessment is limited to a single form of weathering or erosion.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**ESS2.A: Earth Materials and Systems** Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. **ESS2.E: Biogeology** Living things affect the physical characteristics of their regions.	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

Earth's Systems (ESS2)		4
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features. ***Clarification Statement:*** *Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes. Emphasis on analyzing quantitative data to include longitude, latitude, elevation and sea levels; digital tools such as Google Maps or Google Earth can be used when possible.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Analyze and interpret data to make sense of phenomena using logical reasoning.	**ESS2.B: Plate Tectonics and Large Scale System Interactions** The locations of mountain ranges, deep ocean trenches, ocean floor structures, earthquakes, and volcanoes occur in patterns. Most earthquakes and volcanoes occur in bands that are often along the boundaries between continents and oceans. Major mountain chains form inside continents or near their edges. Maps can help locate the different land and water features areas of Earth.	**Patterns** Patterns can be used as evidence to support an explanation.

Earth and Human Activity (ESS3)		
4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and how their uses affect the environment. ***Clarification Statement:*** *Examples of renewable resources could include wind energy, water behind dams, and sunlight; non-renewable resources are fossil and nuclear fuels.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the merit and accuracy of ideas and methods. Obtain and combine information from books and other reliable media to explain phenomena.	**ESS3.A: Natural Resources** All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Knowledge of relevant scientific concepts and research findings is important in engineering. *(secondary)* **ETS2.B: Influence of Science, Engineering and Technology on Society and the Natural World** Over time, people's needs and wants change, as do their demands for new and improved technologies. *(secondary)*	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Earth and Human Activity (ESS3)

4

4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Clarification Statement: *Examples of solutions include designing hurricane or earthquake resistant buildings, improving monitoring of volcanic and tectonic activity, and constructing waterways for floodwaters.*
Assessment Boundary: *Assessment does include earthquakes, floods, tsunamis, hurricanes, coastal erosion, and volcanic eruptions. Assessment does not include making predictions based on patterns of data or the specifics of plate tectonics.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Use evidence in creating multiple solutions to design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution.	**ESS3.B Natural Hazards** A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. **ETS1.B: Designing Solutions to Engineering Problems** Testing a solution involves investigating how well it performs under a range of likely conditions. Communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering and Technology on Society and the Natural World** Engineers improve existing technologies or	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

	develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.	

Fifth Grade

South Carolina fifth grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning students engage in is built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in fifth grade help students engage in inquiry questions such as:

When matter changes, does its weight change?
Students describe that matter is made of particles too small to be seen through the development of a model. Students also measure and graph quantities to develop an understanding of the idea that regardless of the type of change that matter undergoes, the total weight of matter is conserved.

How does matter cycle through ecosystems and where does the energy in food come from and what is it used for?
Students develop an understanding of the idea that plants get the materials they need for growth chiefly from air and water. Using models, students can describe the movement of matter among plants, animals, decomposers, and the environment and that energy in animals' food was once energy from the sun.

How do lengths and directions of shadows or relative lengths of day and night change from day to day, and how does the appearance of some stars change in different seasons?
Students support an argument with evidence and represent data in graphical displays to develop an understanding of patterns of daily changes in length and direction of shadows, day and night, and the seasonal appearance of some stars in the night sky.

How much water can be found in different places on Earth?
Students describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact through the development of a model. They describe and graph data to provide evidence about the distribution of water on Earth.

Can new substances be created by combining other substances?
Students make observations and measurements to determine whether the mixing of two or more substances results in new substances.

How can we protect the Earth's resources and environment?
Students evaluate solutions for local communities to protect the Earth's resources and environment.

Through the fifth grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices:** developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; energy and matter; and systems and system models are emphasized to help organize concepts for student thinking, sense making, and understanding of the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina fifth grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS1, PS2, PS3); Life Science (LS1, LS2); Earth and Space Science (ESS1, ESS2, ESS3); and Engineering, Technology, and Application of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Matter and Its Interactions (PS1)

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.

Clarification Statement: *Examples of evidence supporting a model could include adding air to expand a basketball, dissolving and evaporating salt water, effects of air particles on larger objects such as leaves.*
Assessment Boundary: *Assessment does not include the atomic-scale mechanism of evaporation and condensation or defining the unseen particles.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena.	**PS1.A: Structure and Properties of Matter** Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space (and can be detected by their impact on other objects) can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.	**Scale, Proportion, and Quantity** Natural objects exist from the very small to the immensely large.

Matter and Its Interactions (PS1) 5		
5-PS1-2. 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. ***Clarification Statement:*** *Examples of reactions or changes could include phase changes over time, dissolving, mixing that form new substance, and weighing substances before and after changes.* ***Assessment Boundary:*** *Assessment does not include distinguishing mass and weight.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. Measure quantities such as weight to address scientific and engineering questions and problems.	**PS1.A: Structure and Properties of Matter** The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. **PS1.B: Chemical Reactions** No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Mass and weight are not distinguished at this grade level.) ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Tools and instruments (e.g., balances, thermometers, graduated cylinders) are used in scientific exploration to gather data and help answer questions about the natural world.	**Scale, Proportion, and Quantity** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Matter and Its Interactions (PS1)		
5-PS1-3. Make observations and measurements to identify materials based on their properties. ***Clarification Statement:*** *Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, and reflectivity; density is not intended as an identifiable property.* ***Assessment Boundary:*** *Assessment does not include density or distinguishing mass and weight.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon.	**PS1.A: Structure and Properties of Matter** Measurements of a variety of properties can be used to identify materials. At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Tools and instruments (e.g., balances, thermometers, graduated cylinders) are used in scientific exploration to gather data and help answer questions about the natural world.	**Scale, Proportion, and Quantity** Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume.

Matter and Its Interactions (PS1)

5

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Clarification Statement: *Examples of interactions forming new substances can include mixing baking soda and vinegar. Examples of interactions not forming new substances can include mixing chocolate and milk.*
Assessment Boundary: *Mass and weight are not distinguished.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.	**PS1.B: Chemical Reactions** When two or more different substances are mixed, a new substance with different properties may be formed.	**Cause and Effect** Cause and effect relationships are routinely identified, tested, and used to explain change.

Motion and Stability: Forces and Interactions (PS2) 5		
5-PS2-1. Support an argument that the gravitational force exerted by Earth on objects is directed down. ***Clarification Statement:*** *"Down" is a local description of the direction that points toward the center of the spherical Earth.* ***Assessment Boundary:*** *Assessment does not include mathematical representation of gravitational force.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Support an argument with evidence, data, or a model.	**PS2.B: Types of Interactions** The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.	**Cause and Effect** Cause and effect relationships are routinely identified and used to explain change.

Energy (PS3)		
5-PS3-1. 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. ***Clarification Statement:*** *Examples of models could include food webs, diagrams and flowcharts to illustrate the flow of energy.* ***Assessment Boundary:*** *Assessment does not include cellular mechanisms of digestive absorption.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Use models to describe phenomena.	**PS3.D: Energy in Chemical Processes and Everyday Life** The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). **LS1.C: Organization for Matter and Energy Flow in Organisms** Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. *(secondary)*	**Energy and Matter** Energy can be transferred in various ways and between objects.

From Molecules to Organisms: Structures and Processes (LS1)		
5-LS1-1. Support an argument with evidence that plants obtain materials they need for growth mainly from air and water. ***Clarification Statement:*** *Without inputs of energy (sunlight) and matter (carbon dioxide and water), a plant cannot grow. Evidence could be drawn from diagrams, models, and data that are gathered from investigations.* ***Assessment Boundary:*** *Assessment does not include molecular explanations of photosynthesis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K– 2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Support an argument with evidence, data, or a model.	**LS1.C: Organization for Matter and Energy Flow in Organisms** Plants acquire their material for growth chiefly from air and water.	**Energy and Matter** Matter is transported into, out of, and within systems.

Ecosystems: Interactions, Energy, and Dynamics (LS2) 5		
5-LS2-1. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. ***Clarification Statement:*** *Emphasis is on the idea that matter that is not food (such as air, water, decomposed materials in soil) is changed by plants into matter that is food. Examples of systems could include organisms, ecosystems, and the Earth.* ***Assessment Boundary:*** *Assessment does not include molecular explanations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 3–5 builds on K–2 models and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model to describe phenomena.	**LS2.A: Interdependent Relationships in Ecosystems** The food of almost any kind of animal can be traced back to plants (producers). Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants (either way they are consumers). Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as “decomposers.” Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. **LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Matter cycles between the air and soil and among plants, animals, and microbes as these	**Systems and System Models** A system can be described in terms of its components and their interactions.

	organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment.	

Earth's Place in the Universe (ESS1)

5-ESS1-1. Support an argument with evidence that the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

Clarification Statement: *Evidence could be drawn from various media, diagrams, models, and data that are gathered from investigations.*
Assessment Boundary: *Assessment is limited to relative distances, not sizes, of stars. Assessment does not include other factors that affect apparent brightness (such as stellar masses, age, stage).*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). Support an argument with evidence, data, or a model.	**ESS1.A: The Universe and its Stars** The sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.	**Scale, Proportion, and Quantity** Natural objects exist from the very small to the immensely large.

Earth's Place in the Universe (ESS1)		
5-ESS1-2. 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. ***Clarification Statement:*** *Patterns could be revealed from graphical interpretations, various media, diagrams, models, and graphs constructed from data gathered from investigations. Examples of patterns could include the position and motion of Earth with respect to the sun and selected stars that are visible only in particular months.* ***Assessment Boundary:*** *Assessment does not include causes of seasons or labeling specific phases of the moon.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 3–5 builds on K–2 experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships.	**ESS1.B: Earth and the Solar System** The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.	**Patterns** Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

Earth's Systems (ESS2)		
5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. ***Clarification Statement:*** *Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.* ***Assessment Boundary:*** *Assessment is limited to the interactions of two systems at a time.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions. Develop a model using an example to describe a scientific principle.	**ESS2.A: Earth Materials and Systems** Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather.	**Systems and System Models** A system can be described in terms of its components and their interactions.

Earth's Systems (ESS2)		
5-ESS2-2. Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 3–5 builds on K–2 experiences and progresses to extending quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. Describe and graph quantities such as area and volume to address scientific questions.	**ESS2.C: The Roles of Water in Earth's Surface Processes** Nearly all of Earth's available water is in the ocean. Most freshwater is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.	**Scale, Proportion, and Quantity** Standard units are used to measure and describe physical quantities such as weight and volume.

Earth and Human Activity (ESS3)

5

5-ESS3-1. Evaluate potential solutions to problems that individual communities face in protecting the Earth's resources and environment.

Clarification Statement: *N/A*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluating the merit and accuracy of ideas and methods. Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.	**ESS3.C: Human Impacts on Earth Systems** Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. **ETS1.B: Developing Possible Solutions** Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers improve existing technologies or develop new ones to increase their benefits, to decrease known risks, and to meet societal demands.	**Systems and System Models** A system can be described in terms of its components and their interactions.

Sixth Grade

South Carolina sixth grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in sixth grade help students engage in inquiry questions such as:

How do we know that the Earth and life on Earth have changed through time?
Students construct explanations based on geoscience data (locations and prevalence of specific rock types, fossils, continental features, ocean floor features, and earthquake events) to support that Earth and life on Earth has changed over time.

How do waves behave?
Students describe how mechanical and light waves behave when interacting with matter.

How do cells contribute to the function of living organisms and the organism's response to its environment?
Students investigate that all organisms are made of cell(s), describe that special cells or structures are responsible for particular functions in organisms, and explain with evidence that for many organisms the body is a system of multiple interacting subsystems that form a hierarchy from cells to the body. Students synthesize information that sensory receptors respond to stimuli for behaviors or memory storage.

How can a substance be changed by energy and how can energy be transferred from one object or system to another?
Students predict and investigate the relationship between energy (kinetic energy of moving objects) and temperature (average kinetic energy of particles in matter). Students also apply the engineering design process to develop a device that controls energy transfer.

How do the materials in and on Earth's crust change over time?	What factors interact and influence weather and climate?
Students describe how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data.	Students use models and explore with evidence factors that control weather and climate.

How do natural hazards and technologies impact Earth's systems and people?
Students analyze and interpret natural hazards data for patterns to predict and reduce their impact on humans through use and development of new technologies.

Through the sixth grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: asking questions; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina sixth grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS1, PS3); Life Science (LS1); Earth and Space Science (ESS1, ESS2, ESS3); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Matter and Its Interactions (PS1) 6		

6-PS1-4. Develop and use 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 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: *The use of mathematical formulas is not required.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to 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	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

	for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (*secondary*) 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. (*secondary*) 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. (*secondary*)	

Energy (PS3)		
6-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. ***Clarification Statement:*** *Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.* ***Assessment Boundary:*** *Assessment does not include calculating the total amount of thermal energy transferred.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system.	**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 energy transfers by convection, conduction, and radiation (particularly infrared and light). **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. Energy is spontaneously transferred out of hotter regions or objects and into colder ones by the processes of conduction, convection, and radiation. **ETS1.A: Defining and Delimiting an Engineering Problem** 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.	**Energy and Matter** The transfer of energy can be tracked as energy flows through a designed or natural system.

	Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (*secondary*) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (*secondary*)	

Energy (PS3) 6

6-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 Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. 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.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
6-PS4-2. **Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** ***Clarification Statement:*** *Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.* ***Assessment Boundary:*** *Assessment is limited to qualitative applications pertaining to light and mechanical waves.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**PS4.A: Wave Properties** A sound wave needs a medium through which it is transmitted. **PS4.B: Electromagnetic Radiation** When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves.	**Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

From Molecules to Organisms: Structures and Processes (LS1) 6		
6-LS1-1. Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. ***Clarification Statement:*** *Emphasis is on developing evidence that living things are made of at least one cell, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.* ***Assessment Boundary:*** *Assessment does not include identification of specific cell types and should emphasize the use of evidence from investigations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation.	**LS1.A: Structure and Function** All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.	**Scale, Proportion, and Quantity** Phenomena that can be observed at one scale may not be observable at another scale.

From Molecules to Organisms: Structures and Processes (LS1) 6		
6-LS1-2. Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function. ***Clarification Statement:*** *Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall.* ***Assessment Boundary:*** *Assessment of organelle structure/function relationships is limited to the cell wall and cell membrane. Assessment of the function of the other organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**LS1.A: Structure and Function** Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell.	**Structure and Function** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

From Molecules to Organisms: Structures and Processes (LS1) 6		
6-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 or individual organs and structures. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, skeletal and nervous systems and is limited to the interdependence of the body systems.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). 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.

From Molecules to Organisms: Structures and Processes (LS1) 6		

6-LS1-8. Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Clarification Statement: *Examples of stimulus and sensory receptor pairings include: electromagnetic stimuli (light intensity and color) are received by the eye; mechanical stimuli (sound waves) are received by the hair cells of the inner ear; mechanical stimuli (pressure) are received by the skin; and chemical stimuli (foods) are received by the various taste buds.*
Assessment Boundary: *Assessment does not include identifying specific structures of the brain or mechanisms for the transmission of this information.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	**LS1.D: Information Processing** Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. Changes in the structure and functioning of many millions of interconnected nerve cells allow combined inputs to be stored as memories for long periods of time.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural systems.

Earth's Place in the Universe (ESS1)		
6-ESS1-4. Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history. ***Clarification Statement:*** *Emphasis is on analyses of rock formations and the fossils they contain to establish relative ages of major events in Earth's history. Scientific explanations can include models to study the geologic time scale.* ***Assessment Boundary:*** *Assessment does not include recalling the names of specific periods or epochs and events within them.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**ESS1.C: The History of Planet Earth** The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. Major historical events include the formation of mountain chains and ocean basins, the adaptation and extinction of particular living organisms, volcanic eruptions, periods of massive glaciation, and development of watersheds and rivers through glaciation and water erosion.	**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.

Earth's Systems (ESS2)		
6-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. ***Clarification Statement:*** *Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.* ***Assessment Boundary:*** *Assessment does not include the identification and naming of minerals.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**ESS2.A: Earth's Materials and Systems** All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.	**Energy and Matter** Within a natural or designed system, the transfer of energy drives the motion/and or cycling of matter.

Earth's Systems (ESS2)		

6-ESS2-2. Construct an explanation based on evidence for how 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 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 by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.*
Assessment Boundary: *Assessment does not include identification or naming of specific events.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe 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.	**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.

Earth's Systems (ESS2)		
6-ESS2-3. Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions. ***Clarification Statement:*** *Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), the locations of ocean structures (such as ridges, fracture zones, and trenches), and the prevalence of earthquakes and volcanoes along plate boundaries.* ***Assessment Boundary:*** *Paleomagnetic anomalies in oceanic and continental crust are not assessed.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to provide evidence for phenomena.	**ESS2.B: Plate Tectonics and Large-Scale System Interactions** Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geological history. Plate movements are responsible for most continental and ocean floor features and for the distribution of most rocks and minerals within Earth's crust. 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. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology**	**Patterns** Patterns in rates of change and other numerical relationships can provide information about natural systems.

	Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	

Earth's Systems (ESS2) 6		
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 Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to 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.

Earth's Systems (ESS2)		
6-ESS2-5. Analyze and interpret data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions. ***Clarification Statement:*** *Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).* ***Assessment Boundary:*** *Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to provide evidence for phenomena.	**ESS2.C: The Roles of Water in Earth's Surface Processes** The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. **ESS2.D: Weather and Climate** Because these patterns are so complex, weather can only be predicted probabilistically.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Earth's Systems (ESS2)		
6-ESS2-6. Develop and use models to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. ***Clarification Statement:*** *Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the unequal heating of the Earth by the sun at different latitudes, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.* ***Assessment Boundary:*** *Assessment does not include the dynamics of the Coriolis Force and should be focused on the patterns that drive Earth's climate systems.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**ESS2.C: The Roles of Water in Earth's Surface Processes** Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. **ESS2.D: Weather and Climate** The tilt of the earth's rotational axis causes a pattern of uneven heating and cooling that changes seasonally and establishes global patterns of climate and weather. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. The ocean exerts a major influence on weather	**Systems and System Models** Models can be used to represent systems and their interactions—such as inputs, processes and outputs— and energy, matter, and information flows within systems.

	and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents.	

Earth and Human Activity (ESS3)		
6-ESS3-2. Analyze and interpret data on natural hazards to identify patterns which help forecast future catastrophic events and inform the development of technologies to mitigate their effects. ***Clarification Statement:*** *Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado- prone regions or reservoirs to mitigate droughts).* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings.	**ESS3.B: Natural Hazards** Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the	**Patterns** Graphs, charts, and images can be used to identify patterns in data.

	findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Seventh Grade

South Carolina seventh grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in seventh grade help students engage in inquiry questions such as:

How do atomic and molecular interactions explain the properties of matter that we see and feel?
Students develop models to describe atomic composition of simple molecules and complex extended molecules.

How are synthetic materials made from natural resources important to people?
Students use information to make sense of and evaluate how synthetic materials are made from natural resources and how society has been influenced by these materials.

How do mass, speed and position affect kinetic and potential energy of objects, and how is energy transferred from one object to another?
Students use evidence to support a claim that energy is transferred between objects, and that the relationship of mass and speed on kinetic energy, and position on potential energy of objects interact in a system.

How does matter and energy move through an ecosystem?
Students explain with evidence how matter and energy cycle in an ecosystem, and describe the interaction of organisms to obtain food to survive and grow.

How do organisms interact with other organisms in the physical environment to obtain matter and energy?
Students analyze and interpret data as evidence that organisms and populations of organisms are dependent on their environmental resources, explain patterns of interactions with other organisms, and describe cycling of matter and energy flow in an ecosystem.

How is the health of an ecosystem determined?
Students construct an argument and evaluate solutions of how biodiversity, ecosystem services and environmental changes can impact the integrity of an ecosystem.

How does surface processes and human activity affect Earth temperature and systems?
Students ask questions, apply scientific principles, and explain how human use and of Earth's resources due to geoscience processes have impacted global temperatures and systems.

Through the seventh grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices:** asking questions; developing and using models; analyzing and interpreting data; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina seventh grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS1, PS3); Life Science (LS1, LS2); Earth and Space Science (ESS3); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Matter and Its Interactions (PS1)		
7-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. ***Clarification Statement:*** *Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended atomic structures will assist students in making sense of different phenomena such as how diamonds and granite can both be made of pure carbon. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.* ***Assessment Boundary:*** *Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to predict and/or describe phenomena.	**PS1.A: Structure and Properties of Matter** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	**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.

Matter and Its Interactions (PS1)		7
7-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. ***Clarification Statement:*** *Examples of reactions could include burning sugar or steel wool, milk curdling, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.* ***Assessment Boundary:*** *Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings.	**PS1.A: Structure and Properties of Matter** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Matter and Its Interactions (PS1)

7

7-PS1-3. Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Clarification Statement: *Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, plastic made from petroleum, and alternative fuels.*
Assessment Boundary: *Assessment is limited to qualitative data.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communication Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	**PS1.A: Structure and Properties of Matter** Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. **PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems**.**	**Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

	ETS2.B: Influence of Science, Engineering and Technology on Society and the Natural World The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Matter and Its Interactions (PS1)		

7-PS1-5. 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.

Clarification Statement: *Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.*
Assessment Boundary: *Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to describe unobservable mechanisms.	**PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. The total number of each type of atom is conserved, and thus the mass does not change. The total number of each atom is conserved, and thus the mass does not change. Some chemical reactions release energy, others store energy.	**Energy and Matter** Matter is conserved because atoms are conserved in physical and chemical processes.

Matter and Its Interactions (PS1)

7

7-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Clarification Statement: *Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride, baking soda and vinegar, sodium bicarbonate tablets and water).*
Assessment Boundary: *Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.	**PS1.B: Chemical Reactions** Some chemical reactions release energy, others store energy. **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. **ETS1.C: Optimizing the Design Solution** Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of the characteristics may be incorporated into the new design. The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	**Energy and Matter** The transfer of energy can be tracked as energy flows through a designed or natural system.

Energy (PS3)		
7-PS3-1. Construct and interpret graphical displays of data to describe the proportional relationships of kinetic energy to the mass of an object and to the speed of an object. ***Clarification Statement:*** *Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.* ***Assessment Boundary:*** *Assessment does not include mathematical calculations of kinetic energy.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	**PS3.A: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	**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.

Energy (PS3)

7-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

Clarification Statement: *Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.*
Assessment Boundary: *Assessment is limited to two objects and electric, magnetic, and gravitational interactions.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to describe unobservable mechanisms.	**PS3.A: Definitions of Energy** A system of objects may also contain stored (potential) energy, depending on their relative positions. **PS3.C: Relationship Between Energy and Forces** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.	**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.

Energy (PS3)		
7-PS3-5. 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. ***Clarification Statement:*** *Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of the object.* ***Assessment Boundary:*** *Assessment does not include calculations of energy.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds. Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.	**PS3.B: Conservation of Energy and Energy Transfer** When the motion energy of an object changes, there is inevitably some other change in energy at the same time.	**Energy and Matter** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

From Molecules to Organisms: Structures and Processes (LS1) 7		
7-LS1-6. 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. ***Clarification Statement:*** *Emphasis is on tracing movement of matter and flow of energy.* ***Assessment Boundary:*** *Assessment does not include details of the chemical reactions of photosynthesis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.C: Organization for Matter and Energy Flow in Organisms** Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. In most animals and plants, oxygen reacts with carbon- containing molecules (sugars) to provide energy and produce carbon dioxide; anaerobic bacteria achieve their energy needs in other chemical processes that do not require oxygen. **PS3.D: Energy in Chemical Processes and Everyday Life** The chemical reaction by which plants	**Energy and Matter** Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

	produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (*secondary*)	

From Molecules to Organisms: Structures and Processes (LS1) 7		
7-LS1-7. Develop a model to describe how food molecules in plants and animals are rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. ***Clarification Statement:*** *Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released.* ***Assessment Boundary:*** *Assessment does not include the biochemical mechanisms of photosynthesis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to describe unobservable mechanisms.	**LS1.C: Organization for Matter and Energy Flow in Organisms** Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. **PS3.D: Energy in Chemical Processes and Everyday Life** Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary)*	**Energy and Matter** Matter is conserved because atoms are conserved in physical and chemical processes.

Ecosystems: Interactions, Energy, and Dynamics (LS2) 7		
7-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 and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.* ***Assessment Boundary:*** *Assessment does not include determining the carrying capacity of ecosystems.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze 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 nonliving 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. 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.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		7
7-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. ***Clarification Statement:*** *Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena.	**LS2.A: Interdependent Relationships in Ecosystems** Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	**Patterns** Patterns can be used to identify cause and effect relationships.

Ecosystems: Interactions, Energy, and Dynamics (LS2) 7		
7-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. ***Clarification Statement:*** *Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.* ***Assessment Boundary:*** *Assessment does not include the use of chemical reactions to describe the processes.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop a model to describe phenomena.	**LS2.B: Cycle of Matter and Energy Transfer in Ecosystems** Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	**Energy and Matter** The transfer of energy can be tracked as energy flows through a natural system.

Ecosystems: Interactions, Energy, and Dynamics (LS2) 7		
7-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. ***Clarification Statement:*** *Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems. Disruptions to any physical or biological component of an ecosystem can lead to shifts in its populations.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds. Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.	**Stability and Change** Small changes in one part of a system might cause large changes in another part.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		

7-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

Clarification Statement: Humans can benefit from services that are provided by healthy ecosystems. These ecosystem services could include climate stabilization, water purification, nutrient recycling, pollination, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K– 5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D: Biodiversity and Humans** Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. *(secondary)* **ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary)*	**Stability and Change** Small changes in one part of a system might cause large changes in another part.

	Links Among Engineering, Technology, Science, and Society **ETS2B: Influence of Science, Engineering, and Technology on Society and the Natural World** The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Earth and Human Activity (ESS3)

7

7-ESS3-1. 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.

Clarification Statement: *Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**ESS3.A: Natural Resources** Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Earth and Human Activity (ESS3)

7

7-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Clarification Statement: *Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles to design an object, tool, process or system.	**ESS3.C: Human Impacts on Earth Systems** Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural	**Cause and Effect** Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.

	resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Earth and Human Activity (ESS3)

7-ESS3-4. Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Clarification Statement: *Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**ESS3.C: Human Impacts on Earth Systems** Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Earth and Human Activity (ESS3)

7-ESS3-5. Ask questions to clarify evidence of the factors that have impacted global temperatures over the past century.

Clarification Statement: *Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models. Ask questions to identify and clarify evidence of an argument.	**ESS3.D: Global Climate Change** Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature. Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural	**Stability and Change** Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

	resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Eighth Grade

South Carolina eighth grade students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in eighth grade help students engage in inquiry questions such as:

How can one describe physical interactions between objects and within systems of objects?
Students apply Newton's third law of motion to related forces to explain the motion of objects colliding. Students also construct arguments, and analyze and interpret data on 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 investigate and evaluate evidence that objects exert force even without contact.

How does the energy of an object change related to its mass, speed, and position in a system?
Students investigate for evidence that an object's motion depends on mass and sum of forces.

What are the characteristic properties of waves and how can they be used?
Students describe characteristic properties of a wave and the behavior related to energy. Students communicate evidence that digital devices use waves to transmit information.

How do organisms grow, develop, and reproduce?
Students explain based on evidence and reasoning how genetic factors, the environment, and an organism's behaviors and structures influence its growth, development, and reproduction.

How do changes to genes affect an organism?
Students describe how genetic changes can affect the structure and function of an organism.

How has life changed throughout Earth's history?
Students analyze and interpret data for patterns in how the fossil record documents Earth's history with existence, diversity, extinction and changing of life forms as well as construct an explanation for similarities and differences in modern day and ancestral organisms.

How does genetic variation among organisms in a species affect survival and reproduction? How does the environment and humans influence genetic traits in populations over multiple generations?
Students use information and begin constructing an explanation of genetic variation in natural selection and how this leads to traits in a population changing.

What is Earth's place in the Universe? What makes up our solar system and how can the motion of Earth explain seasons and eclipses?
Students describe Earth's place in relation to the solar system, Milky Way galaxy and universe, and evaluate information on scale properties of objects.

Through the eighth grade standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; structure and function and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina eighth grade students will explore include **disciplinary core ideas** from the NRC Framework: Physical Science (PS2, PS4); Life Science (LS1, LS2, LS3); Earth and Space Science (ESS1); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Motion and Stability: Forces and Interactions (PS2)

8

8-PS2-1. Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.

Clarification Statement*: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.*
Assessment Boundary*: Assessment is limited to vertical or horizontal interactions in one dimension.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific ideas, 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). **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. *(secondary)* ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World**	**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.

	The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. *(secondary)*	

Motion and Stability: Forces and Interactions (PS2)		
8-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. ***Clarification Statement:*** *Emphasis is on balanced (Newton's first law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's second law), frame of reference, and specification of units.* ***Assessment Boundary:*** *Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. 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 examples of 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 (inertia). 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. The positions of objects and the directions of forces and motions must be described using a qualitative comparison and scalar quantities. In order to share information with other people, a reference frame 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.

Motion and Stability: Forces and Interactions (PS2)		
8-PS2-3. Analyze and interpret data to determine the factors that affect the strength of electric and magnetic forces.		
Clarification Statement: *Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.* ***Assessment Boundary:*** *Assessment is limited to data examples using proportional reasoning and algebraic thinking, rather than mathematical computations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze displays of data to identify linear and nonlinear relationships.	**PS2.B: Types of Interactions** Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Motion and Stability: Forces and Interactions (PS2) 8		
8-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. ***Clarification Statement:*** *Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance between objects, and orbital periods of objects within the solar system.* ***Assessment Boundary:*** *Assessment does not include Newton's law of gravitation or Kepler's laws.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**PS2.B: Types of Interactions** Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.	**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.

Motion and Stability: Forces and Interactions (PS2)		8
8-PS2-5. Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. ***Clarification Statement****: Examples of this phenomenon could include the interactions of magnets and electrically charged objects. Examples of investigations could include first-hand experiences or simulations.* ***Assessment Boundary:*** *Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation.	**PS2.B: Types of Interactions** Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be illustrated by their effect on a test object (a charged object, or a ball, respectively).	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Waves and Their Applications in Technologies for Information Transfer (PS4) 8		
8-PS4-1. Using mathematical representations, describe a simple model for waves, that includes how the amplitude of a wave is related to the energy in a wave. ***Clarification Statement:*** *Emphasis is on describing waves with both qualitative and quantitative thinking.* ***Assessment Boundary:*** *Assessment does not include electromagnetic waves and is limited to standard repeating waves. Assessment does not include relationships between the speed of waves and their frequency or wavelength.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking at the 6–8 level builds on K–5 and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. Use mathematical representations to describe and/or support scientific conclusions and design solutions.	**PS4.A: Wave Properties** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	**Patterns** Graphs and charts can be used to identify patterns in data.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
8-PS4-3. Communicate information to support the claim that digital devices are used to improve our understanding of how waves transmit information. ***Clarification Statement:*** *Emphasis is on a basic understanding that waves can be used for communication purposes and digitized signals are a more reliable way to encode and transmit information than analog. When in digitized form, information can be recorded, stored for future recovery, and transmitted over long distances without significant degradation. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.* ***Assessment Boundary:*** *Assessment does not include binary counting and does not include the specific mechanism of any given device.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods. Integrate qualitative scientific and technical information in different forms of text that are contained in media and visual displays to clarify claims and findings.	**PS4.C: Information Technologies and Instrumentation** Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. ***Links Among Engineering, Technology, Science, and Society*** **ETS2B: Influence of Science, Engineering, and Technology on Society and the Natural World** Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.	**Structure and Function** Structures can be designed to serve particular functions.

From Molecules to Organisms: Structures and Processes (LS1) 8		
8-LS1-4. Use arguments, 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. ***Clarification Statement:*** *Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer pollen, flower nectar and odors that attract insects that transfer pollen, and hard shells on nuts that squirrels bury.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s). Use an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.	**LS1.B: Growth and Development of Organisms** Animals engage in characteristic behaviors that increase the odds of reproduction. Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.	**Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

From Molecules to Organisms: Structures and Processes (LS1)		
8-LS1-5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. ***Clarification Statement:*** *Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include how drought or flooding affects plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.* ***Assessment Boundary:*** *Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.B: Growth and Development of Organisms** Genetic factors as well as local conditions affect the growth of the adult plant. The growth of an animal is controlled by genetic factors, food intake, and interactions with other organisms, and each species has a typical adult size range.	**Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Heredity: Inheritance and Variation of Traits (LS3)		
8-LS3-1. Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. ***Clarification Statement:*** *Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.* ***Assessment Boundary:*** *Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**LS3.A: Inheritance of Traits** Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. **LS3.B: Variation of Traits** In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism.	**Structure and Function** Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function.

Heredity: Inheritance and Variation of Traits (LS3) 8		
8-LS3-2. 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. ***Clarification Statement:*** *Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.* ***Assessment Boundary:*** *Assessment should be limited to Punnett squares of monohybrid cross.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**LS1.B: Growth and Development of Organisms** Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary)* **LS3.A: Inheritance of Traits** Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. **LS3.B: Variation of Traits** In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. In asexual reproduction, an organism's DNA is replicated and passed to its offspring creating a genetic copy of the parent.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural systems.

Biological Evolution: Unity and Diversity (LS4) 8		
8-LS4-1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operated in the past as they do today. ***Clarification Statement:*** *Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.* ***Assessment Boundary:*** *Assessment does not include the names of individual species or geological eras in the fossil record.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings.	**LS4.A: Evidence of Common Ancestry and Diversity** The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. **ESS2.E: Biogeology** Sudden changes in conditions (e.g., meteor impacts, major volcanic eruptions) have caused mass extinctions, but these changes, as well as more gradual ones, have ultimately allowed other life forms to flourish. *(secondary)*	**Patterns** Graphs, charts, and images can be used to identify patterns in data.

Biological Evolution: Unity and Diversity (LS4)		
8-LS4-2. **Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer their ancestral relationships.** ***Clarification Statement:*** *Emphasis is on explanations of the ancestral relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.* ***Assessment Boundary:*** *Assessment of comparisons is limited to gross appearance of anatomical structures.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events.	**LS4.A: Evidence of Common Ancestry and Diversity** Anatomical similarities and differences among modern organisms and between modern and fossil organisms in the fossil record enable the reconstruction of the history and the inference of lines of ancestral relationships.	**Patterns** Patterns can be used to identify cause and effect relationships.

Biological Evolution: Unity and Diversity (LS4)		
8-LS4-4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individual's probability of surviving and reproducing in a specific environment. ***Clarification statement:*** *In a specific environment impacted by different factors, some traits provide advantages that make it more probable that an organism will be able to survive and reproduce there.* ***Assessment boundary:*** *Assessment is limited to using simple probability statements and proportional reasoning to construct explanations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena.	**LS4.B: Natural Selection** Natural selection leads to the predominance of certain traits in a population, and the suppression of others.	**Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Biological Evolution: Unity and Diversity (LS4) 8

8-LS4-5. Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

Clarification Statement: *Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and on the impacts these technologies have on society and scientific discoveries.*
Assessment Boundary: *Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence.	**LS4.B: Natural Selection** In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed onto offspring. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems.	**Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Biological Evolution: Unity and Diversity (LS4)		
8-LS4-6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. ***Clarification Statement:*** *Emphasis on student explanation of trends in data using mathematical models, probability statements, and proportional reasoning to support explanations of trends of population changes.* ***Assessment Boundary:*** *Assessment does not include Hardy Weinberg calculations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments. Use mathematical representations to support scientific conclusions and design solutions.	**LS4.C: Adaptation** Adaptation by natural selection occurring over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not, become less common. Thus, the distribution of traits in a population changes.	**Cause and Effect** Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.

Earth’s Place in the Universe (ESS1)		
8-ESS1-1. Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, tides, and seasons. ***Clarification Statement:*** *Examples of models can be physical, graphical, or conceptual.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**ESS1.A: The Universe and Its Stars** Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. **ESS1.B: Earth and the Solar System** This model of the solar system can explain tides (including spring and neap), eclipses of the sun and the moon. Earth’s spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.	**Patterns** Patterns can be used to identify cause-and-effect relationships.

Earth’s Place in the Universe (ESS1)

8-ESS1-2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

Clarification Statement: *Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students’ school or state).*
Assessment Boundary: *Assessment does not include Kepler’s laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. Develop and use a model to describe phenomena.	**ESS1.A: The Universe and Its Stars** Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. **ESS1.B: Earth and the Solar System** The solar system consists of the sun, planets, their moons, and other celestial objects that are held in orbit around the sun by its gravitational pull on them. The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.	**Systems and System Models** Models can be used to represent systems and their interactions.

Earth’s Place in the Universe (ESS1)

8

8-ESS1-3. Evaluate information to determine scale properties of objects in the solar system.

Clarification Statement: *Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of a celestial object’s layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.*
Assessment Boundary*: Assessment does not include recalling facts about properties of the planets and other solar system bodies.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods. Integrate qualitative and/or quantitative scientific and/or technical information in text with that contained in media and visual displays to clarify claims and findings.	**ESS1.B: Earth and the Solar System** The solar system consists of the sun, planets, their moons, and other celestial objects that are held in orbit around the sun by its gravitational pull on them. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.	**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.

Biology

South Carolina Biology students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in Biology help students engage in inquiry questions such as:

How do the structures of organisms enable life's functions?
Students explain how cells are the basic units of life and the role specialized cells play in maintenance and growth. Students develop models that illustrate the hierarchical system of organizations and how cell division allows for growth, repair, and maintenance of complex organisms. Students design experiments to illustrate how systems of cells function together to support life processes.

How do organisms obtain and use energy they need to live and grow? How do matter and energy move through ecosystems?
Students explain interactions among organisms and their environment and how organisms obtain and use resources. Students use mathematical concepts to construct explanations for the role of energy in the cycling of matter. Students examine complex interactions among all organisms and design solutions to lessen the effects of changes to ecosystems.

How do organisms interact with the living and non-living environment to obtain matter and energy?
Students use evidence to evaluate the role of biodiversity in ecosystems and the role of animal behavior on survival of individuals and species. Students evaluate interactions among organisms, including humans, and how those interactions influence the dynamics and health of ecosystems, and biodiversity.

How are the characteristics from one generation related to the previous generation?
Students ask questions to clarify the relationship of DNA and chromosomes in the processes of cellular division that pass traits from one generation to the next. Students also use data and mathematical evidence to explain why individuals of the same species vary in how they look, function, and behave.

How can there be so many similarities among organisms yet so many different plants, animals, and microorganisms? How do humans affect biodiversity?
Students explain with evidence factors causing natural selection, the process of evolution of species over time, and how multiple lines of evidence contribute to the strength of scientific theories of natural selection and evolution. Students engage in the engineering design process to investigate and test solutions to reduce the human impact on biodiversity.

Through the Biology standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: asking questions; developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; and engaging in argument from evidence. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina Biology students will explore include the following **disciplinary core ideas** from the NRC Framework: Life Science (LS1, LS2, LS3, LS4); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

From Molecules to Organisms: Structures and Processes (LS1)

B-LS1-1. 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.

Clarification Statement: *N/A*
Assessment Boundary: *Assessment does not include identification of specific cell or tissue types, whole body systems, specific protein structures and functions, or the biochemistry of protein synthesis.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.A: Structure and Function** Systems of specialized cells within organisms help them perform the essential functions of life. All cells contain genetic information, in the form of DNA. Genes are specific regions within the extremely large DNA molecules that form the chromosomes. Genes contain the instructions that code for the formation of molecules called proteins, which carry out most of the work of cells to perform the essential functions of life. Proteins provide structural components, serve as signaling devices, regulate cell activities, and determine the performance of cells through their enzymatic actions **LS3.A: Inheritance of Traits** The sequence of nucleotides spells out the information in a gene.	**Structure and Function** The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.

	DNA controls the expression of proteins by being transcribed into a “messenger” RNA, which is translated in turn by the cellular machinery into a protein.	

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-2. Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms. ***Clarification Statement:*** *Emphasis is on the conceptual level of understanding of the interactions among systems to maintain life, not rote memorization of organ systems.* ***Assessment Boundary:*** *Assessment does not include interactions and functions at the molecular or chemical reaction level.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.A: Structure and Function** Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level.	**Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-3. **Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.** ***Clarification Statement:*** *Examples of investigations could include heart rate response to exercise, stomata response to moisture and temperature, and root development in response to water levels.* ***Assessment Boundary:*** *Assessment does not include the cellular and chemical processes involved in the feedback mechanism.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**LS1.A: Structure and Function** Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system.	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-4. Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing, and maintaining complex organisms. ***Clarification Statement:*** *Emphasis is on normal cell division as well as instances in which cell division is uncontrolled (e.g. cancer).* ***Assessment Boundary:*** *Assessment does not include specific gene control mechanisms or rote memorization of the steps of mitosis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system	**LS1.B: Growth and Development of Organisms** In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow (and repair). The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism.	**Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. ***Clarification Statement:*** *Emphasis is on explaining inputs and outputs of matter and the transfer and transformation of energy in photosynthesis by plants and other photosynthesizing organisms. Examples of models could include diagrams, chemical equations, and conceptual models.* ***Assessment Boundary:*** *Assessment does not include specific biochemical steps.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.C: Organization for Matter and Energy Flow in Organisms** The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen.	**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-6. 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 other large carbon-based molecules necessary for essential life processes. ***Clarification Statement:*** *Emphasis is on using evidence from models and simulations to support explanations of how the products of photosynthesis can be used to form the molecules of life.* ***Assessment Boundary:*** *Assessment does not include the details of the specific chemical reactions or molecular identification of macromolecules.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS1.C: Organization for Matter and Energy Flow in Organisms** The sugar molecules thus formed contain carbon, hydrogen, and oxygen: the hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins or DNA), used for essential life functions. As matter and energy flow through organizational levels of living systems, chemical elements are recombined to form different products.	**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

From Molecules to Organisms: Structures and Processes (LS1)		
B-LS1-7. Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy. ***Clarification Statement:*** *Emphasis is on the conceptual understanding of the inputs and outputs of the processes of aerobic and anaerobic cellular respiration.* ***Assessment Boundary:*** *Assessment should not include identification of the steps or specific processes involved in cellular respiration nor specific types of fermentation. Assessment should be limited to comparing efficiency of aerobic and anaerobic cellular respiration.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds. Use a model based on evidence to illustrate the relationships between systems or between components of a system.	**LS1.C: Organization for Matter and Energy Flow in Organisms** As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. Anaerobic cellular respiration follows a	**Energy and Matter** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

	different and less efficient chemical pathway to provide energy in cells.	

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-1. Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales. ***Clarification Statement:*** *Emphasis is on quantitative analysis and comparison of the relationships among interdependent factors including boundaries, resources, climate, and challenges. Examples of mathematical comparisons could include graphs, charts, histograms, and population changes gathered from simulations or historical data sets. Examples of scales could be a pond versus an ocean.* ***Assessment Boundary:*** *Assessment does not include deriving mathematical equations to make comparisons.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical and/or computational representations of phenomena or design solutions to support explanations.	**LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem.	**Scale, Proportion, and Quantity** The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-2. **Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.** ***Clarification Statement:*** *Examples of mathematical representations include finding the average, determining trends, and using graphical comparisons of multiple sets of data.* ***Assessment Boundary:*** *Assessment is limited to provided data.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena or design solutions to support and revise explanations.	**LS2.A: Interdependent Relationships in Ecosystems** Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is	**Scale, Proportion, and Quantity** Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.

	resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	

Ecosystems: Interactions, Energy, and Dynamics (LS2) B		
B-LS2-3. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. ***Clarification Statement:*** *Emphasis is on conceptual understanding of the role of aerobic and anaerobic respiration in the conservation of matter and flow of energy into, out of, and within various ecosystems.* ***Assessment Boundary:*** *Assessment focuses on the conceptual understanding and does not include the specific chemical processes of either aerobic or anaerobic respiration.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes.	**Energy and Matter** Energy drives the cycling of matter within and between systems.

B-LS2-4. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.

Clarification Statement: *Emphasis is on using a mathematical model of stored energy in biomass to describe the transfer of energy from one trophic level to another and that matter and energy are conserved as matter cycles and energy flows through ecosystems. Emphasis is on conservation of carbon, oxygen, hydrogen and nitrogen as they move through an ecosystem.*
Assessment Boundary: *Assessment is limited to proportional reasoning to describe the cycling of matter and flow of energy.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena or design solutions to support claims.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved.	**Energy and Matter** Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-5. Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *Assessment does not include the specific chemical steps of photosynthesis and respiration.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show how relationships among variables between systems and their components in the natural and designed worlds. Develop a model based on evidence to illustrate the relationships between systems or components of a system.	**LS2.B: Cycles of Matter and Energy Transfer in Ecosystems** Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. **PS3.D: Energy in Chemical Processes** The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (*secondary*)	**Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-6. Evaluate 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. ***Clarification Statement:*** *Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health. ***Clarification Statement:*** *N/A* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. **LS4.D: Biodiversity and Humans** Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). *(secondary)* Humans depend on the living world for the resources and other benefits provided by biodiversity. Human activity is having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. These problems have the potential to cause biological extinctions which result in decreased biodiversity and the effects may be harmful to	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

	humans and other living things. Sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. *(secondary)* **ETS1.B: Developing Possible Solutions** When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. *(secondary)*	

Ecosystems: Interactions, Energy, and Dynamics (LS2)		
B-LS2-8. Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce. ***Clarification Statement:*** *Emphasis is on: (1) distinguishing between group and individual behavior, (2) identifying evidence supporting the outcomes of group behavior, and (3) developing logical and reasonable arguments based on evidence. Examples of group behaviors could include flocking, schooling, herding, and cooperative behaviors such as hunting, migrating, and swarming.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate the evidence behind currently accepted explanations to determine the merits of arguments.	**LS2.D: Social Interactions and Group Behavior** Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Heredity: Inheritance and Variation of Traits (LS3)		

B-LS3-1. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

Clarification Statement: *N/A*
Assessment Boundary: *Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process (including gene regulation).*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems Asking questions and defining problems in 9–12 builds on K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations. Ask questions that arise from examining models or a theory to clarify relationships.	**LS1.A: Structure and Function** All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins. *(secondary)* **LS3.A: Inheritance of Traits** Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Heredity: Inheritance and Variation of Traits (LS3)

B-LS3-2. 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.

Clarification Statement: *Emphasis is on using data to support arguments for the way genetic variation occurs.*
Assessment Boundary: *Assessment does not include the phases of meiosis or the biochemical mechanism of specific steps in the process.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student-generated evidence.	**LS3.B: Variation of Traits** In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Heredity: Inheritance and Variation of Traits (LS3)		
B-LS3-3. Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population. ***Clarification Statement:*** *Emphasis is on the use of mathematics to describe the probability of traits as it relates to genetic and environmental factors in the expression of traits.* ***Assessment Boundary:*** *Assessment does not include Hardy-Weinberg or Chi-square analysis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**LS3.B: Variation of Traits** Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors.	**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Biological Evolution: Unity and Diversity (LS4)		
B-LS4-1. Construct an explanation of how multiple lines of evidence support common ancestry and biological evolution. ***Clarification Statement:*** *Emphasis is on students' conceptual understanding of the role each line of evidence has relating to common ancestry and biological evolution. Examples of evidence could include similarities in DNA sequences, anatomical structures, and order of appearance of structures in embryological development.* ***Assessment Boundary:*** *Assessment is limited to conceptual explanations of the evidence for biological evolution and is not extended to the lines of evidence for specific species (e.g. Homo sapiens). Assessment does not include classification of organisms.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS4.A: Evidence of Common Ancestry and Diversity** Genetic information, like the fossil record, provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; notably, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. The study of evolutionary biology communicates the characteristics that set humans apart from other primates and helps to define what it means to be human. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering,**	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

	Technology, and Science on Society and the Natural World The understanding of evolutionary relationships has recently been greatly accelerated by using new molecular tools to study biology.	

Biological Evolution: Unity and Diversity (LS4)		
B-LS4-2. 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. ***Clarification Statement:*** *Emphasis is on using evidence to explain the influence each of the four factors has on the number of organisms, behaviors, morphology, or physiology in terms of ability to compete for limited resources and subsequent survival of individuals and adaptation of species. Examples of evidence could include mathematical models such as simple distribution graphs and proportional reasoning.* ***Assessment Boundary:*** *Assessment does not include other mechanisms of evolution, such as genetic drift, gene flow through migration, and co-evolution.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS4.B: Natural Selection** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. **LS4.C: Adaptation** Evolution is driven by the interaction of four factors: (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Biological Evolution: Unity and Diversity (LS4)

B-LS4-3. 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.

Clarification Statement: *Emphasis is on analyzing shifts in numerical distribution of traits and using these shifts as evidence to support explanations.*
Assessment Boundary: *Assessment is limited to basic statistical and graphical analysis. Assessment does not include allele frequency calculations.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**LS4.B: Natural Selection** Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **LS4.C: Adaptation** Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

	future generations that have the trait and to a decrease in the proportion of individuals that do not. Adaptation also means that the distribution of traits in a population can change when conditions change.	

Biological Evolution: Unity and Diversity (LS4)		
B-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations. ***Clarification Statement:*** *Emphasis is on using data to provide evidence for how specific biotic and abiotic differences in ecosystems (such as ranges of seasonal temperature, long-term climate change, acidity, light, geographic barriers, or evolution of other organisms) contribute to a change in gene frequency over time, leading to adaptation of populations.* ***Assessment Boundary:*** *Assessment does not include allele frequency calculations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**LS4.C: Adaptation** Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Biological Evolution: Unity and Diversity (LS4)		
B-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. ***Clarification Statement:*** *Emphasis is on determining cause and effect relationships for how changes to the environment such as deforestation, fishing, application of fertilizers, drought, flood, and the rate of change of the environment affect distribution or disappearance of traits in species.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current or historical episodes in science. Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**LS4.C: Adaptation** Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the extinction–of some species. Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Biological Evolution: Unity and Diversity (LS4)

B-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Clarification Statement: *Emphasis is on testing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Create or revise a simulation of a phenomenon, designed device, process, or system.	**LS4.C: Adaptation** Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline — and sometimes the extinction — of some species. **LS4.D: Biodiversity and Humans** Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

	ETS1.B: Developing Possible Solutions When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (*secondary*) Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (*secondary*) ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems, including those related to agriculture, health, water, energy, transportation (e.g. wildlife corridors), manufacturing, construction, and communications. *(secondary)* Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. *(secondary)*	

Chemistry

South Carolina Chemistry students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in Chemistry help students engage in inquiry questions such as:

How can one explain the structure and properties of matter?
Using the patterns in the periodic table, students predict properties of elements, substructure of atoms and trends.

How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?
Students explain simple chemical reactions and patterns of chemical properties. Using chemical reactions, students conduct substance structure and particle force investigations, illustrate energy changes, explain reaction rates, refine a chemical system in equilibrium, support a claim of energy conservation and illustrate changes to nuclei composition.

How can one explain and predict interactions between objects and within systems of objects?
Students build an understanding of attraction and repulsion between electric charges at the atomic scale explaining the structure, properties and transformations of matter as well as electrostatic forces between objects.

How is energy transferred and conserved?
Students investigations concerning macroscopic and the subatomic energy can account for either motions of particles or energy associated with the configuration (relative positions) of particles.

How are waves/particles used to transfer energy and send and store information?
Students evaluate and communicate how wave/particle properties and the interactions of electromagnetic radiation with matter can transmit and capture information and energy.

Through the Chemistry standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: developing and using models; planning and carrying out investigations; using mathematics and computational thinking; constructing explanations and designing solutions; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; structure and function and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina Chemistry students will explore include the following **disciplinary core ideas** from the NRC Framework: Physical Science (PS1, PS2, PS3, PS4); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Matter and Its Interactions (PS1)		
C-PS1-1. 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. ***Clarification Statement:*** *Examples of properties that could be predicted from patterns could include reactivity of metals, types of bonds formed, numbers of bonds formed, and reactions with oxygen.* ***Assessment Boundary:*** *Assessment is limited to main group elements. Assessment does not include quantitative understanding of ionization energy beyond relative trends.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Use a model to predict the relationships between systems or between components of a system.	**PS1.A: Structure and Properties of Matter** Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.	**Patterns** Different patterns may be observed at which a system is studied and can provide evidence for causality in explanations of phenomena.

Matter and Its Interactions (PS1)		
C-PS1-2. 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. ***Clarification Statement:*** *Examples of chemical reactions could include the reaction of sodium and chlorine, carbon and oxygen, carbon and hydrogen, or biochemical reactions.* ***Assessment Boundary:*** *Assessment is limited to chemical reactions involving main group elements and combustion reactions.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**PS1.A: Structure and Properties of Matter** The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. **PS1.B: Chemical Reactions** The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	**Patterns** Different patterns may be observed at which a system is studied and can provide evidence for causality in explanations of phenomena.

Matter and Its Interactions (PS1)		
C-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at a bulk scale to infer the strength of various forces between particles. ***Clarification Statement:*** *Emphasis is on understanding the strengths of forces between particles, NOT on naming specific intermolecular forces (such as dipole-dipole). Examples of particles could include ions, atoms, molecules, and networked materials (such as graphite). Macroscopic properties of substances at the bulk scale could include the melting point and boiling point, vapor pressure, and surface tension.* ***Assessment Boundary:*** *Assessment does not include Raoult's law calculations of vapor pressure.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the broader level are determined by various forces within and between atoms. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects.	**Patterns** Different patterns may be observed at which a system is studied and can provide evidence for causality in explanations of phenomena.

Matter and Its Interactions (PS1)		
C-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. ***Clarification Statement:*** *Emphasis is on the idea that a chemical reaction is a system that affects the energy change and is due to the absorption of energy when bonds are broken and the release of energy when new bonds are formed. Examples of models could include molecular-level drawings and diagrams of reactions, graphs showing the relative energies of reactants and products, and representations showing energy is conserved. Examples could include photosynthesis and cell respiration.* ***Assessment Boundary:*** *Assessment does not include calculating the total bond energy changes during a chemical reaction from the bond energies of reactants and products.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Model Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**PS1.A: Structure and Properties of Matter** A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart. **PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

Matter and Its Interactions (PS1)		
C-PS1-5. **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.** ***Clarification Statement:*** *Emphasis is on student reasoning that focuses on the number and energy of collisions between molecules. Examples could include enzymes or biocatalytic reactions.* ***Assessment Boundary:*** *Assessment is limited to simple reactions in which there are only two reactants; evidence from temperature, concentration, and rate data; and qualitative relationships between rate and temperature.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	**PS1.B: Chemical Reactions** Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.	**Patterns** Different patterns may be observed at which a system is studied and can provide evidence for causality in explanations of phenomena.

Matter and Its Interactions (PS1)		
C-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium. ***Clarification Statement:*** *Emphasis is on the application of Le Chatelier's Principle and on refining designs of chemical reaction systems, including descriptions of the connection between changes made at the macroscopic level and what happens at the molecular level. Examples of designs could include different ways to increase product formation including adding reactants, removing products, or chemical kinetics.* ***Assessment Boundary:*** *Assessment is limited to specifying the change in only one variable at a time. Assessment does not include calculating equilibrium constants and concentrations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	**PS1.B: Chemical Reactions** In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present. **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary)*	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

Matter and Its Interactions (PS1)		
C-PS1-7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. ***Clarification Statement:*** *Emphasis is on using mathematical ideas to communicate the proportional relationships between masses of atoms in the reactants and the products, and the translation of these relationships to the macroscopic scale using the mole as the conversion from the atomic to the macroscopic scale (stoichiometry). Emphasis is on assessing students' use of mathematical thinking and not on memorization and rote application of problem- solving techniques.* ***Assessment Boundary:*** *Assessment does not include complex chemical reactions.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena to support claims.	**PS1.B: Chemical Reactions** The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved.

Matter and Its Interactions (PS1)		
C-PS1-8. 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. ***Clarification Statement:*** *Emphasis is on simple qualitative models, such as pictures or diagrams, and on the scale of energy released in nuclear processes relative to other kinds of transformations.* ***Assessment Boundary:*** *Assessment does not include quantitative calculation of energy released. Assessment is limited to alpha, beta, and gamma radioactive decays.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Model Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate the relationships between systems or between components of a system.	**PS1.C: Nuclear Processes** Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.	**Energy and Matter** In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.

Motion and Stability: Forces and Interactions (PS2)

C-PS2-6. Communicate scientific and technical information about why the molecular structure determines the functioning of designed materials.

Clarification Statement: *Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.*
Assessment Boundary: *Assessment is limited to provided molecular structures of specific designed materials.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats.(including orally, graphically, textually, and mathematically.	**PS1.A: Structure and Properties of Matter** The structure and interactions of matter at the broader level are determined by various forces within and between atoms. **PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. **ETS1.C: Optimizing the Design Solution** Determining what constitutes “best,” however, requires value judgments, given that one person’s view of the optimal solution may differ from another’s. *(secondary)*	**Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

Energy (PS3)		
C-PS3-4. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperatures are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). ***Clarification Statement:*** *Emphasis is on analyzing data from student investigations and using mathematical thinking to describe the energy changes both quantitatively and conceptually. Examples of investigations could include mixing liquids at different initial temperatures or adding objects at different temperatures to water.* ***Assessment Boundary:*** *Assessment is limited to investigations based on materials and tools provided to students.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	**PS3.B: Conservation of Energy and Energy Transfer** Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems. Uncontrolled systems always evolve toward more stable states— that is, toward more uniform energy distribution (e.g., water flows downhill, objects hotter than their surrounding environment cool down). **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment.	**Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
C-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. ***Clarification Statement:*** *Emphasis is on the idea that particles associated with different frequencies of light have different energies, and the damage to living tissue from electromagnetic radiation depends on the energy of the radiation. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.* ***Assessment Boundary:*** *Assessment is limited to qualitative descriptions.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.	**PS4.B: Electromagnetic Radiation** When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells. Atoms of each element emit and absorb characteristic frequencies of light and nuclear transitions have distinctive gamma ray wavelengths, which allows identification of the presence of an element.	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Waves and Their Applications in Technologies for Information Transfer (PS4)

C-PS4-5. Communicate technical information about how some technological devices use the principles of the electromagnetic spectrum to cause matter to transmit and capture information and energy.

Clarification Statement: *Examples could include medical imaging; and communications technology.*
Assessment Boundary: *Assessments are limited to qualitative information. Assessments do not include band theory.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**PS4.B: Electromagnetic Radiation** Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.C: Information Technologies and Instrumentation** Multiple technologies based on the understanding of energy and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). *(secondary)*	**Cause and Effect** Systems can be designed to cause a desired effect of energy interactions of matter.

	ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World Modern civilization depends on major technological systems. *(secondary)*	

Physics

South Carolina Physics students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in Physics help students engage in inquiry questions such a:

How can one explain and predict interactions between objects and within systems of objects?
Students build an understanding of forces and interactions, as well as total momentum of a system of objects. Students also predict the gravitational and electrostatic forces between objects. Students apply scientific and engineering ideas to design, evaluate as well as investigate the relationship between electric current and magnetic fields.

How is energy transferred and conserved?
Students illustrate that energy at the macroscopic level can be explained by motion of particles or energy associated with the configuration (relative positions) of particles at the atomic scale. Students apply scientific and engineering ideas to design, build, and refine a device that converts one form of energy into another.

How are waves/particles used to transfer energy and send and store information?
Students support a claim that wave/particle properties are related, and evaluate the interactions of electromagnetic radiation with matter in transmission and capture of information and energy.

Through the Physics standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: developing and using models; planning and carrying out investigations; analyzing and interpreting data; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; systems and system models; energy and matter; structure and function; and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina Physics students will explore include the following **disciplinary core ideas** from the NRC Framework: Physical Science (PS2, PS3, PS4); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Motion and Stability: Forces and Interactions (PS2)		
P-PS2-1. 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. ***Clarification Statement:*** *Examples of data could include tables or graphs of position or velocity of an object as a function of time. Examples of objects subjected to a net force could include objects in free-fall, objects sliding down a ramp, or moving objects pulled by a constant force.* ***Assessment Boundary:*** *Assessment is limited to macroscopic objects moving in one-dimensional motion, at non-relativistic speeds.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**PS2.A: Forces and Motion** Newton's second law accurately predicts changes in the motion of macroscopic objects (Fnet=ma).	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.

Motion and Stability: Forces and Interactions (PS2)		
P-PS2-2. 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. ***Clarification Statement:*** *Emphasis is on the quantitative conservation of momentum in interactions and the qualitative meaning of this principle.* ***Assessment Boundary:*** *Assessment is limited to systems of two macroscopic bodies moving in one dimension.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematical and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical, computational, and/or algorithmic representations of phenomena to describe and/or support claims and/or explanations.	**PS2.A: Forces and Motion** Momentum is defined for a particular frame of reference; it is the mass times the velocity of the object. If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system.	**Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined.

Motion and Stability: Forces and Interactions (PS2)

P-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the effect of a force on a macroscopic object during a collision.

Clarification Statement: *An example of evaluation could include determining the success of the device at protecting an object from damage. Examples of devices could include football helmets, parachutes, and car restraint systems, such as seatbelts and airbags. Refinement of the device could include modifying one or more parts or all of the device to improve performance of the device.*
Assessment Boundary: *Assessment is limited to qualitative evaluations, algebraic manipulations, or both.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations.	**PS2.A: Forces and Motion** If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. **ETS1:A: Defining and Delimiting Engineering Problems** Criteria may include satisfying cost, safety, reliability, aesthetics requirements and taking into account constraints regarding social, cultural, and environmental impacts. **ETS1.B: Developing Possible Solutions** The aim of engineering is to design the best solution under clearly defined constraints and criteria, but there is often no one best solution. **ETS1.C: Optimize the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically. Trade-offs among the criteria will need to be analyzed, and certain criteria may need to be prioritized over others.	**Cause and Effect** Systems can be designed to cause a desired effect.

Motion and Stability: Forces and Interactions (PS2)		
P-PS2-4. Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects. ***Clarification Statement:*** *Emphasis is on both quantitative and conceptual descriptions of interactions between masses in gravitational fields and electrical charges in electric fields.* ***Assessment Boundary:*** *Assessment is limited to systems with two objects.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical, computational, and/or algorithmic representations of phenomena to describe and/or support claims and/or explanations.	**PS2.B: Types of Interactions** Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.	**Patterns** Different patterns may be observed at each of the scales at which a system is studied and can provide for causality in explanations of phenomena.

Motion and Stability: Forces and Interactions (PS2)		
P-PS2-5. 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. ***Clarification Statement:*** *Examples could include current carrying wires and electromagnets/solenoids in motors, anti-shoplifting devices, junkyard magnets, metal detectors, and magnetic levitation in high-speed trains.* ***Assessment Boundary:*** *Assessment is limited to planning and conducting investigations with provided materials and tools.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying out Investigations Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence. During the planning process: decide on types, how much, and accuracy of data needed to produce reliable measurements, consider limitations on the precision of the data (such as number of trials, cost, risk, time), and refine the design accordingly.	**PS2.B: Types of Interactions** Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. **PS3.A: Definitions of Energy** "Electrical Energy" may mean energy stored in battery or energy transmitted by electric current.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.

Motion and Stability: Forces and Interactions (PS2)

P-PS2-6. Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

Clarification Statement: *Emphasis is on the attractive and repulsive forces that determine the functioning of the material, and transfer of electric charge. Examples of designed conductive materials could include wiring in phone chargers, wiring in car speakers, or computer chips. Examples of designed insulating materials could include Styrofoam and fiberglass.*
Assessment Boundary: *Assessment is limited to molecular structures that are given or provided to students during instruction.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate scientific and/or technical information about phenomena and performance of a proposed process or system. Communication can be in multiple formats including orally, graphically, textually, and mathematically.	**PS2.B: Types of Interactions** Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineers continuously modify these technological systems by applying scientific knowledge. *(secondary)* **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World**	**Structure and Function** Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

	Modern civilization depends on major technological systems which can have deep impacts on society and the environment. *(secondary)*	

Energy (PS3)		
P-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the following are known: 1) the change in energy of the other component(s) and 2) the energy flowing in and out of the system. ***Clarification Statement:*** *Emphasis is on explaining the calculations in the computational model. Examples of computational models could include diagrams, drawings, descriptions, mathematical equations, and computer simulations.* ***Assessment Boundary:*** *Assessment is limited to basic algebraic equations; to systems of two or three components; and to thermal energy, kinetic energy, and/or the energies in gravitational, magnetic, or electric fields.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Create a computational model or simulation of a phenomenon, designed device, process, or system. Analyze relationships and quantities in appropriate mathematical or algorithmic forms for scientific modeling and investigations.	**PS3.A: Definitions of Energy** Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. A system's total energy is 1) conserved as energy is transferred within the system from one object to another and between its various possible forms and 2) always equal to the energy transferred into or out of the system. **PS3.B: Conservation of Energy and Energy Transfer** Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.	**Systems and System Models** Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.

	Mathematical expressions allow the concept of conservation of energy to be used to predict and describe system behavior. Mathematical expressions quantify how the stored energy in a system depends on its configurations (such as relative positions of charged particles or compression of a spring) and how kinetic energy depends on mass and speed. The availability of energy limits what can occur in any system.	

Energy (PS3)		
P-PS3-2. Develop and use models to illustrate that energy can be explained by the combination of motion and position of objects at the macroscopic scale and the motion and position of particles at the microscopic scale ***Clarification Statement:*** *Examples of phenomena at the macroscopic scale could include the conversion of kinetic energy to thermal energy, the energy stored due to position of an object above the Earth (as stored in fields), and the energy stored between two electrically-charged plates. Examples of models could include diagrams, drawings, descriptions, and computer simulations.* ***Assessment Boundary:*** *Assessment does not include quantitative calculations.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**PS3.A: Definitions of Energy** Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. Energy at the macroscopic level can be better understood, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields	**Energy and Matter** Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

	(which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.	

Energy (PS3)		

P-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Clarification Statement: *Emphasis is on both qualitative and quantitative evaluations of devices. Examples of devices could include Rube Goldberg devices, wind turbines, solar cells, solar ovens, speakers, and generators. Examples of constraints placed on a device could include the cost of materials, types of materials available, having to use renewable energy, an efficiency threshold, and time to build and/or operate the device.*

Assessment Boundary: *Assessment for quantitative evaluations is limited to total output for a given input. Assessment is limited to devices constructed with materials provided to students.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	**PS3.A: Definitions of Energy** At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. **PS3.D: Energy in Chemical Processes** Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. **ETS1.A: Defining and Delimiting Engineering Problems** Criteria may include satisfying cost, safety, reliability, aesthetics requirements and taking into account constraints regarding social, cultural, and environmental impacts. **ETS1.B: Developing Possible Solutions** The aim of engineering is to design the best solution under clearly defined constraints and	**Energy and Matter** Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.

	criteria, but there is often no one best solution. **ETS1.C: Optimizing the Design Solution** Criteria may need to be broken down into simpler ones that can be approached systematically. Trade-offs among the criteria will need to be analyzed, and certain criteria may need to be prioritized over others. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology.** Engineers continuously modify these technological systems by applying scientific knowledge. **ETS2.B: Influence of Science, Engineering, and Technology on Society and the Natural World** Modern civilization depends on major technological systems which can have deep impacts on society and the environment. *(secondary)*	

Energy (PS3)		
P-PS3-5. Develop and use a model to illustrate the forces between two objects and the changes in energy of the objects due to their interaction through electric or magnetic fields. ***Clarification Statement:*** *Examples of models could include drawings, diagrams, descriptions, or computer simulations.* ***Assessment Boundary:*** *Assessment is limited to systems containing two objects.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**PS3.C: Relationship Between Energy and Forces** When two objects interacting through a field change relative position, the energy stored in the field is changed. Each force between the two interacting objects acts in the direction such that the motion in that direction would reduce the energy in the force field between the objects.	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
P-PS4-1. Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media. ***Clarification Statement:*** *Examples of different media that could be explored include electromagnetic radiation traveling in a vacuum or glass, sound waves traveling through air or water, or seismic waves traveling through Earth.* ***Assessment Boundary:*** *Assessment is limited to algebraic relationships and describing relationships qualitatively.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 and experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical representations of phenomena or design solutions to describe and/or support claims and/or explanations.	**PS4.A: Wave Properties** The wavelength and frequency of a wave are related to one another by the speed of travel of the wave, which depends on the type of wave and the medium through which it is passing. The reflection, refraction, and transmission of waves at an interface between two media can be modeled on the bases of wave properties.	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

Waves and Their Applications in Technologies for Information Transfer (PS4)		

P-PS4-2. Design, evaluate, and refine a solution for improving how digital devices store and transmit information

Clarification Statement: *Examples of design problems could include poor signal strength in rural areas with satellite radio or internet connections; lack of security on social media applications (reducing personal data theft); or low quality images (pixelated/fuzzy images, small size). Examples of evaluating the stability of the solution could include determining how successful the solution is at improving signal strength, preventing hacking, or improving image quality.*
Assessment Boundary: *Assessment is limited to designed solutions with qualitative analysis of wave properties through drawings, diagrams, or computer simulations.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade-off considerations.	**PS4.A: Wave Properties** Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this stable form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. Combining waves of different frequencies can make a wide variety of patterns and thereby encode and transmit information. **ETS1.B: Developing Possible Solutions** The aim of engineering is to design the best solution under clearly defined constraints and criteria, but there is often no one best solution. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology**	**Stability and Change** Systems can be designed for greater or lesser stability.

	Engineers continuously modify these technological systems by applying scientific knowledge. **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems, which can have deep impacts on society and the environment.	

Waves and Their Applications in Technologies for Information Transfer (PS4)		
P-PS4-3. Evaluate the claims, evidence, and reasoning about how electromagnetic radiation can be described either by a wave model or a particle model, and in some situations one model is more useful than the other. ***Clarification Statement:*** *Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect.* ***Assessment Boundary:*** *Assessment does not include using quantum theory.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments.	**PS4.A: Wave Properties** Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other. **PS4.B: Electromagnetic Radiation** Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electric and magnetic fields or as particles called photons. The wave model is useful for explaining many features of electromagnetic radiation, and the particle model explains other features.	**Systems and System Models** Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
P-PS4-4. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter. ***Clarification Statement:*** *Examples of technology applications could include medical imaging devices, tanning beds, radiation cancer treatments, or potential health concerns related to digital signals. Examples of published materials could include trade books, magazines, web resources, videos, and other passages that may reflect bias.* ***Assessment Boundary:*** *Assessment is limited to qualitative descriptions.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Evaluate the validity and reliability of multiple claims that appear in scientific and technical texts or media reports, verifying the data when possible.	**PS4.B: Electromagnetic Radiation** When light or longer wavelength electromagnetic radiation is absorbed in matter, it is generally converted into thermal energy (heat). Shorter wavelength electromagnetic radiation (ultraviolet, X-rays, gamma rays) can ionize atoms and cause damage to living cells.	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

Waves and Their Applications in Technologies for Information Transfer (PS4)		
P-PS-4-5. 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. ***Clarification Statement:*** *Examples could include solar cells capturing light and converting it to electricity, medical imaging, and communications technology.* ***Assessment Boundary:*** *Assessments are limited to qualitative information. Assessments do not include band theory.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Communicate scientific and/or technical information or ideas (e.g. about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically).	**PS4.A: Wave Properties** Information can be digitized (e.g., a picture stored as the values of an array of pixels); in this form, it can be stored reliably in computer memory and sent over long distances as a series of wave pulses. **PS4.B: Electromagnetic Radiation** Photoelectric materials emit electrons when they absorb light of a high-enough frequency. **PS4.C: Information Technologies and Instrumentation** Multiple technologies based on the understanding of waves and their interactions with matter are part of everyday experiences in the modern world (e.g., medical imaging, communications, scanners) and in scientific research. They are essential tools for producing, transmitting, and capturing signals and for storing and interpreting the information contained in them.	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

	Links Among Engineering, Technology, Science, and Society **ETS2.A: Interdependence of Science, Engineering, and Technology** Engineers continuously modify these technological systems by applying scientific knowledge. *(secondary)* **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems which can have deep impacts on society and the environment. *(secondary)*	

Earth and Space Science

South Carolina Earth and Space Science students engage in thinking and solving problems the way scientists and engineers do to help them better see how science is relevant to their lives. To capitalize on the natural curiosity all students have about the world around them, the learning experiences are built around the three major dimensions of science: **science and engineering practices (SEPs)**, **crosscutting concepts (CCCs)**, and **disciplinary core ideas (DCIs)**. This three-dimensional approach to teaching and learning science helps educators provide meaningful learning experiences that offer varied entry points for students from diverse backgrounds.

The standards (performance expectations) in Earth and Space Science help students engage in inquiry questions such as:

What is the universe and what goes on in stars? What are the predictable patterns caused by Earth's movement in the solar system?
Students use evidence to explain the processes governing the formation, evolution, and workings of the solar system and universe in order to understand how matter in the universe formed and how changes in the behavior of the sun directly affect humans.

How do people reconstruct and date events in Earth's planetary history?
Students construct explanations based on data and evidence for the scales of time over which Earth's processes operate. An important aspect of the Earth and space sciences involves making inferences about events in Earth's history.

How do chemical cycles impact Earth's systems?
Students investigate and describe how water and carbon cycles impact Earth's systems. Students also communicate information on how Earth's systems and life change and influence each other.

What affects climate change and what are the effects?
Students forecast climate changes by analyzing data from models and evaluating the implications on Earth's systems. Students also describe how variations in energy flow in Earth's systems result in climate change and use evidence to create an argument that climate change affects human activity.

How do Earth's systems and humans influence each other?
Students construct explanations of the complex and significant interdependencies between humans and Earth's systems, and evaluate solutions for natural hazards, natural resources, and environmental factors.

Through the Earth and Space Science standards (performance expectations), students demonstrate grade-appropriate proficiency in the following **science and engineering practices**: developing and using models; planning and carrying out investigations; analyzing and interpreting data; using mathematics and computational thinking; constructing explanations and designing solutions; engaging in argument from evidence; and obtaining, evaluating, and communicating information. Students use these practices to demonstrate understanding of the **disciplinary core ideas**. The following **crosscutting concepts:** patterns; cause and effect; scale, proportion, and quantity; systems and system models; energy and matter; and stability and change are used by students to understand the **disciplinary core ideas** and related phenomena. The standards (performance expectations) that South Carolina Earth and Space Science students will explore include the following **disciplinary core ideas** from the NRC Framework: Earth and Space Science (ESS1, ESS2, ESS3); and Engineering, Technology, and Applications of Science (ETS1, ETS2).

The standards represent the performance expectation goals for the end of instruction. Teachers have the flexibility to make instructional decisions that incorporate additional science and engineering practices and crosscutting concepts that align to their students' needs and supports the learning that leads up to the end of instruction goal.

Earth's Place in the Universe (ESS1)

E-ESS1-1. Develop a model based on evidence to illustrate that energy generated by nuclear fusion within the Sun (and other stars) radiates to and influences orbiting planets.

Clarification Statement: *Emphasis should be on the energy from nuclear fusion in a star's core (relative to the star's mass and age) radiating to nearby planets as seen in the Earth-Sun system. This energy varies in cyclic and non-cyclic ways over the lifespan of the star. Examples of evidence could include observations of other solar systems, surface fluctuations, electromagnetic radiation emissions, atmospheric interactions, solar incidence, and albedo.*
Assessment Boundary: *Assessment does not include details of the mechanism of nuclear fusion. Assessment does not include details of the atomic and subatomic processes involved with the sun's nuclear fusion.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Use a Model Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.	**ESS1.A: The Universe and Its Stars** Nuclear fusion within stars releases electromagnetic energy (seen as starlight). Stars go through a sequence of developmental stages--they are formed; evolve in size, mass, and brightness; and eventually burn out. The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. The sun is just one of more than 200 billion stars in the Milky Way galaxy, and the Milky Way is just one of hundreds of billions of galaxies in the universe. The sun is a medium-sized star about halfway through its predicted life span of about 10 billion years. **PS3.D: Energy in Chemical Processes and Everyday Life** Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. *(secondary)*	**Energy and Matter** Energy cannot be created or destroyed—only moves between one place and another place, between objects and/or fields, or between systems.

Earth's Place in the Universe (ESS1)		
E-ESS1-2. Construct an explanation of the Big Bang Theory based on evidence to show that the universe is changing over time. ***Clarification Statement:*** *Emphasis is on astronomical evidence that shows the expansion, cooling, and observed composition of the universe. Examples of supporting data include red shift of light from receding galaxies, cosmic microwave background radiation, and spectra of electromagnetic radiation from stars and interstellar gases that match predictions from models of the Big Bang theory.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**ESS1.A: The Universe and Its Stars** The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Stars' radiation of visible light and other forms of energy can be measured and studied to develop explanations about the formation, age, and composition of the universe. The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

	PS4.B: Electromagnetic Radiation Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. *(secondary)* ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. *(secondary)*	

Earth's Place in the Universe (ESS1)		
E-ESS1-3. Construct an explanation using evidence to explain the ways elements are produced over the life cycle of a star. ***Clarification Statement:*** *Emphasis is on the way nucleosynthesis, and therefore the different elements created, varies as a function of the mass of a star and the stage of its lifetime. Emphasis is on the concept that the matter found in our solar system originated from the deaths of other stars. Examples of evidence include data from stars such as composition, temperature, size, mass, and luminosity.* ***Assessment Boundary:*** *Assessment does not include details of the atomic and subatomic processes involved with nucleosynthesis.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	**ESS1.A: The Universe and Its Stars** The study of stars' light spectra and brightness is used to identify compositional elements of stars. Stars go through a sequence of developmental stages--they are formed; evolve in size, mass, and brightness; and eventually burn out. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. Material from earlier stars that explode as supernovas is recycled to form younger stars and their planetary systems.	**Energy and Matter** Energy and matter cannot be created nor destroyed - only moved between one place and another place between objects and/or fields, or between systems.

Earth's Place in the Universe (ESS1)		
E-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the universe due to gravity. ***Clarification Statement:*** *Emphasis is on predicting orbital motion of naturally occurring or human-made objects using Kepler's laws and Newton's law of gravity.* ***Assessment Boundary:*** *Mathematical representations for the gravitational attraction of bodies and Kepler's laws of orbital motions should not deal with more than two bodies, nor involve calculus.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematical and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical, computational, and/or algorithmic representations of phenomena to describe and/or support claims and/or explanations.	**ESS1.B: Earth and the Solar System** Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. *(secondary)*	**Scale, Proportion, and Quantity** Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

Earth's Place in the Universe (ESS1)		
E-ESS1-5. 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. ***Clarification Statement:*** *Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate evidence behind currently accepted explanations or solutions to determine the merits of arguments.	**ESS1.C: The History of Planet Earth** Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** The theory of plate tectonics is supported by evidence of ocean floor spreading over time given by tracking magnetic patterns in undersea rocks and coordinating them with changes to Earth's magnetic axis data. Earth's history is still being written. Continents are continually being shaped and reshaped by competing constructive and destructive geological processes. North America, for example, has gradually grown in size over the past 4 billion years through a	**Patterns** Empirical evidence is needed to identify patterns.

	complex set of interactions with other continents, including the addition of many new crustal segments.	

Earth's Place in the Universe (ESS1)		
E-ESS1-6. 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. ***Clarification Statement:*** *Emphasis is on using available evidence within the solar system to reconstruct the early history of Earth, which formed simultaneously along with the rest of the solar system. Examples of evidence include the absolute ages of ancient materials (obtained by radiometric dating of meteorites, moon rocks, and Earth's oldest minerals), the sizes and compositions of solar system objects, and the impact cratering record of planetary surfaces.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion.	**ESS1.B: The Earth and the Solar System** The Solar System consists of the Sun and a collection of objects of varying sizes and conditions. This system appears to have formed from a disk of dust and gas, drawn together by gravity approximately 4.6 billion years ago. **ESS1.C: The History of Planet Earth** Radioactive decay lifetimes and isotopic content in rocks provide a way of dating rock formations and thereby fixing the scale of geological time. Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the Solar System, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

	early history. Study of other planets and their moons, many of which exhibit features such as volcanism and meteor impacts similar to those found on Earth, also help illuminate aspects of Earth's history and changes. **PS1.C: Nuclear Processes** Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials thereby fixing the scale of geological time. *(secondary)*	

Earth's Systems (ESS2)		
E-ESS2-1. Use evidence to argue how Earth's internal and external processes operate to form and modify continental and ocean-floor features throughout Earth's history. ***Clarification Statement:*** *Emphasis is on the core idea that convection leads to the creation and destruction of surface features. Plate movements and many crustal features and events are a result of this phenomena, but there are other surface processes which shape Earth's surface as well. The appearance of land features (such as mountains, valleys, coastlines, and plateaus) and sea-floor features (such as trenches, ridges, and seamounts) are a result of both constructive forces (such as volcanism, tectonic uplift, and orogeny) and destructive mechanisms (such as weathering, mass wasting, and coastal erosion). Examples include seafloor spreading at ridges (evidenced by paleomagnetic data and radiometric dating of rocks), subduction at trenches (evidenced by seismic data and volcanoes), and weathering and erosion among mountains (evidenced by weathering, erosion, and deposition patterns of streams).* ***Assessment Boundary:*** *Assessment does not include memorization of the details of the formation of specific geographic features of Earth's surface.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engage in argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.	**ESS2.A: Earth Materials and Systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. A deep knowledge of how feedback works within and among Earth's systems is still lacking, thus limiting scientists ability to predict some changes and their impacts. The top part of the mantle, along with the crust, forms structures known as tectonic plates. These changes can occur on a variety of time scales from sudden (e.g., volcanic ash clouds) to intermediate (ice ages) to long-term tectonic cycles.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

	ESS2.B: Plate Tectonics and Large-Scale System Interactions The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. The plates move across Earth's surface, carrying the continents, creating and destroying ocean basins, producing earthquakes and volcanoes, and forming mountain ranges and plateaus. Most continental and ocean floor features are the result of geological activity and earthquakes along plate boundaries. The exact patterns depend on whether the plates are being pushed together to create mountains or deep ocean trenches, being pulled apart to form new ocean floor at mid-ocean ridges, or sliding past each other along surface faults.	

Earth's Systems (ESS2)		

E-ESS2-2. Analyze data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Clarification Statement: *Examples should include climate feedback, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth's surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyze and Interpret Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	**ESS2.A: Earth Materials and Systems** Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. Transfers of energy and the movements of matter can cause chemical and physical changes among Earth's materials and living organisms. **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space.	**Stability and Change** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

	Links Among Engineering, Technology, Science, and Society **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. *(secondary)*	

Earth's Systems (ESS2)		
E-ESS2-3. Develop a model based on evidence of Earth's interior that describes cycling of matter through convection processes. ***Clarification Statement:*** *Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth's three-dimensional structure obtained from seismic waves, records of the rate of change of Earth's magnetic field (as constraints on convection in the outer core), volcanoes, and identification of the composition of Earth's layers from high-pressure laboratory experiments.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**ESS2.A Earth's Materials and Systems** Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle, and crust. **ESS2.B: Plate Tectonics and Large-Scale System Interactions** Plate tectonics can be viewed as the surface expression of mantle convection. Tectonic plates are the top parts of giant convection cells that bring matter from the hot inner mantle up to the cool surface. These movements are driven by the release of energy (from radioactive decay of unstable isotopes within Earth's interior) and by the cooling and gravitational downward motion of the dense material of the plates after subduction (one plate being drawn under	**Energy and Matter** Energy and matter cannot be created nor destroyed - only moved between one place and another place between objects and/or fields, or between systems. The total amount of energy and matter in closed systems is conserved.

	another). The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle providing the primary source of the heat that drives mantle convection. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.A: Interdependence of Science, Engineering, and Technology** Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. *(secondary)*	

Earth's Systems (ESS2)

E-ESS2-4. Use a model to describe how causes of short and long-term variations in the flow of energy into and out of Earth's systems result in changes to climate.

Clarification Statement: *Emphasis is on the relationships between components that affect the input, output, storage and redistribution of energy on Earth. Emphasis is on specific cause and effect relationships between the factors that affect energy flow (into and out of Earth's systems) and their effects on climate over different timescales.*

Assessment Boundary: *Assessment is limited to one example of a climate change and its associated impacts; Assessment of the results of changes in climate is limited to direct changes in climate such as surface temperatures and precipitation patterns.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Use a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**ESS1.B: Earth and the Solar System** Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the orientation of the planet's axis of rotation, both occurring over tens to hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on Earth. These phenomena cause cycles of ice ages and other gradual climate changes. *(secondary)* **ESS2.D: Weather and Climate** The foundation for Earth's global climate systems is the electromagnetic radiation from the Sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. Climate changes, which are defined as significant and persistent changes in an area's average or extreme weather	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.

	conditions, can occur if any of Earth's systems change. Scientists can infer these changes from geological evidence. Some climate changes in Earth's history were rapid shifts (caused by natural events, such as volcanic eruptions and meteoric impacts, which suddenly put a large amount of particulate matter into the atmosphere or by abrupt changes in ocean currents, or variations in solar output). Other climate changes were gradual and longer term - due, for example, to solar output variations, or atmospheric changes due to the rise of plants and other life forms that modified the atmosphere via photosynthesis. The timescale of these changes varies from a few to millions of years. Cumulative increases in the atmospheric concentrations of carbon dioxide and other greenhouse gases, whether arising from natural sources or human industrial activity, increase the capacity of Earth to retain energy. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	

Earth's Systems (ESS2)		
E-ESS2-5. Investigate the ways that water (given its unique physical and chemical properties) impacts various Earth systems. ***Clarification Statement:*** *Emphasis should be on water's ability to absorb/store and release energy, transmit sunlight, expand when freezing, and dissolve/transport materials. Examples of system interactions could include the hydrogeologic system (weathering, erosion, deposition, soil formation, groundwater formation, and the rock cycle), energy transfer system (weather and climate), and ecosystems (coral reefs and hydrothermal vents).* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying out Investigations Planning and carrying out investigations in 9–12 builds on K–8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence.	**ESS2.C: The Roles of Water in Earth's Surface Processes** The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy as it changes state; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of the material when mixed with fluid rocks within the mantle. Each of these properties plays a role in how water affects other Earth systems (e.g., ice expansion contributes to rock erosion, or ocean thermal capacity contributes to moderating temperature variations).	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. Systems can be designed to cause a desired effect.

Earth’s Systems (ESS2)		
E-ESS2-6. Develop a quantitative model to describe the cycling of carbon through the hydrosphere, atmosphere, geosphere, and biosphere. ***Clarification Statement:*** *Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (photosynthesis, chemosynthesis, cellular respiration), providing the foundation for living organisms.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s). Develop a model based on evidence to illustrate and/or predict the relationships between systems or between components.	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate.	**Energy and Matter** The total amount of energy and matter in closed systems is conserved.

Earth's Systems (ESS2)		
E-ESS2-7. Communicate scientific information that illustrates how Earth's systems and life on Earth change and influence each other over time. ***Clarification Statement:*** *Emphasis is on the dynamic causes, effects, and feedbacks between the biosphere and Earth's other systems, whereby geoscience factors control the evolution of life, which in turn continuously alters Earth's surface. Examples include how photosynthetic life altered the atmosphere through the production of oxygen, which in turn increased weathering rates and allowed for the evolution of animal life; how microbial life on land increased the formation of soil, which in turn allowed for the evolution of land plants; or how the evolution of corals created reefs that altered patterns of erosion and deposition along coastlines and provided habitats for the evolution of new life forms.* ***Assessment Boundary:*** *Assessment does not include a comprehensive understanding of the mechanisms of how the biosphere interacts with all of Earth's other systems.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Obtaining, Evaluating, and Communicating Information Obtaining, evaluating, and communicating information in 9–12 builds on K–8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs. Use words, tables, diagrams, and graphs, as well as mathematical expressions to communicate their understanding or to ask questions about a system under study.	**ESS2.D: Weather and Climate** Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. The time scales of these changes varied from a few to millions of years. **ESS2.E: Biogeology** As Earth changes, life on Earth adapts and evolves to those changes, so just as life influences other Earth systems, other Earth systems influence life. Life and the planet's nonliving systems can be said to co-evolve. The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it.	**Stability and Change** Much of science deals with constructing explanations of how things change and how they remain stable.

Earth and Human Activity (ESS3)		
E-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources and occurrence of natural hazards have influenced human activity. ***Clarification Statement:*** *Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting, and soil erosion), and severe weather (such as hurricanes, floods, and droughts).* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations.	**ESS3.A: Natural Resources** Resource availability has guided the development of human society. **ESS3.B: Natural Hazards** Natural hazards and other geologic events have shaped the course of human history by destroying buildings and cities, eroding land, changing the course of rivers, and reducing the amount of arable land. These have significantly altered the sizes of human populations and have driven human migrations. Natural hazards can be local, regional, or global in origin, and their risks increase as populations grow. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems. *(secondary)*	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.

Earth and Human Activity (ESS3)

E-ESS3-2. Evaluate competing design solutions that address the impacts of developing, managing, and using Earth's energy and mineral resources.

Clarification Statement: *Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining, forestry, and risk/benefit analysis of the production of conventional, unconventional, or renewable energy resources.*
Assessment Boundary: *N/A*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student generated sources of evidence, prioritized criteria, and trade off considerations.	**ESS3.A: Natural Resources** All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. **ETS1.A: Engineering Design** Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities. **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural,	**Cause and Effect** Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.

	and environmental impacts. Testing should lead to improvements in the design through an iterative procedure. *(secondary)* ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology. *(secondary)*	

Earth and Human Activity (ESS3)

E-ESS3-3. Use computational representation to illustrate the relationships among the management of Earth's resources, the sustainability of human populations, and biodiversity.

Clarification Statement: *Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, urban planning, as well as local and international policies.*
Assessment Boundary: *Assessment for computational thinking is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**ESS3.C: Human Impacts on Earth Systems** The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts (e.g., acid rain and the ozone hole near Antarctica). ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems. *(secondary)*	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.

	New technologies can have deep impacts on society and the environment, including some that were not anticipated. *(secondary)*	

Earth and Human Activity (ESS3)		
E-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Clarification Statement: *Examples of data on the impacts of human activities could include the quantities and types of pollutants released, changes to biomass and species diversity, or areal changes in land surface use (such as for urban development, agriculture and livestock, or surface mining). Examples for limiting future impacts could range from local efforts (such as reducing, reusing, and recycling resources) to large-scale geoengineering design solutions (such as altering global temperatures by making large changes to the atmosphere or ocean).* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	**ESS3.C: Human Impacts on Earth Systems** Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. **ETS1.B: Developing Possible Solutions** When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. Testing should lead to improvements in the design through an iterative procedure. ***Links Among Engineering, Technology, Science, and Society*** **EST2.B: Influence of Engineering, Technology, and Science on Society and the Natural World**	**Stability and Change** Feedback (negative or positive) can stabilize or destabilize a system.

	Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks.	

Earth and Human Activity (ESS3)		
E-ESS3-5. Analyze data and the results from global climate models to make an evidence-based forecast of the current rate of regional or global climate change and associated future impacts to Earth's systems. ***Clarification Statement:*** *Examples of evidence, for both data and climate model outputs, are for climate changes (such as precipitation and temperature) and their associated impacts (such as on sea level, glacial ice volumes, or atmosphere and ocean composition).* ***Assessment Boundary:*** *Assessment is limited to one example of a climate change and its associated impacts.*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Analyzing data in 9–12 builds on K–8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. Analyze data using computational models in order to make valid and reliable scientific claims.	**ESS3.D: Global Climate Change** Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts.	**Stability and Change** Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible.

Earth and Human Activity (ESS3)

E-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Clarification Statement: *Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. One example of this relationship is how human activities can create changes in the atmosphere including an increase in carbon dioxide that has many far-reaching effects, including changes in photosynthetic biomass on land, ocean acidification, and storm intensity.*
Assessment Boundary: *Assessment does not include running computational representations, but is limited to using the published results of scientific computational models.*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	**ESS2.D: Weather and Climate** Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. Hence the outcomes depend on human behaviors as well as on natural factors that involve complex feedback among Earth's systems. *(secondary)* **ESS3.D: Global Climate Change** Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	**Systems and System Models** When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

	ESS3.B: Natural Hazards Human activities can contribute to the frequency and intensity of some natural hazards.	

Earth and Human Activity (ESS3)		
E-ESS3-7. Create an argument, based on evidence, that describes how changes in climate on Earth have affected human activity. ***Clarification Statement:*** *Emphasis is on changes in climate that influence past, modern, or future human activities. Examples of key changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.* ***Assessment Boundary:*** *N/A*		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence Engaging in argument from evidence in 9–12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments; Construct a scientific argument based on data and evidence.	**ESS3.D: Global Climate Change** Impacts of climate change--for example, increased frequency of severe storms due to ocean warming-- have begun to influence human activities. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences - for humanity as well as for the rest of the planet. The impacts of climate change are uneven and may affect some regions, species, of human populations more severely than others. By using science-based predictive models, humans can anticipate long-term	**Cause and Effect** Empirical evidence is required to differentiate between cause and correlations and make claims about specific causes and effects.

	change more effectively than ever and plan accordingly. ***Links Among Engineering, Technology, Science, and Society*** **ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World** Modern civilization depends on major technological systems. *(secondary)*	

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Appendix A: Acknowledgements

South Carolina owes a debt of gratitude to the hundreds of science educators, informal science educators, representatives of higher education, business and industry representatives, community members and leaders, parents, national science education leaders, as well as recent SC graduates who collaborated to produce the *South Carolina College- and Career-Ready Science Standards 2021*.

SC Education Oversight Committee (EOC) Science Standards National Review Panel

The five members of the SC EOC science standards national review panel recommended revisions to the *South Carolina Academic Standards and Performance Indicators for Science 2014.*

EOC National Review Panel Members		
Mr. Randy LaCross, Vice President for Outreach and Research, South Carolina Governor's School for Science and Mathematics	Dr. Christine Lotter, Associate Professor, University of South Carolina	Mr. Peter McLaren, Executive Director, Next Gen Education, Rhode Island
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SC Education Oversight Committee (EOC) Science Standards Review Panel

The 43 members of the SC EOC science standards state review panel recommended revisions to the *South Carolina Academic Standards and Performance Indicators for Science 2014.*

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SCDE Science Standards Review Panel

The 54 members of the SCDE science standards review panel recommended revisions to the *South Carolina Academic Standards and Performance Indicators for Science 2014.*

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Informal education representation: SC State Museum, EdVenture, the Greenwood Genetics Center, the Riverbanks Zoo, the STEM centers, and SC Forestry Division

Business and Industry representation: McCall Farms, Boeing, Milliken, Santee Cooper, Clergy, DHEC, and Proterra Engineering.

IHE Representation: Clemson University, College of Charleston, USC Upstate, Piedmont Technical College, and Duke University (student)

SCDE Office representation: Office of Career and Technology, Office of Assessment, Office of Virtual Education, and Office of Standards and Learning

SCDE Writing Team

The 48 members of the SCDE science standards writing team wrote the *South Carolina College- and Career-Ready Science Standards 2021*.

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Informal education representation: S2TEM Center, South Carolina State Museum
IHE Representation: Clemson University, Francis Marion University, Claflin University, Coastal University
SCDE Office representation: Office of Assessment, Office of Standards and Learning

SCDE Local Writing Advisory Team

The 28 members of the SCDE local advisory writing team provided recommendations to the *South Carolina College- and Career-Ready Science Standards 2021 LINK to APPENDIX*

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Informal education representation: Museum of York County, Spring Island Trust / Low Country Institute, South Carolina Sea Grant Consortium, South Carolina Aquarium, Spartanburg Science Center, SC Forestry Commission & SC Project Learning Tree, Riverbanks Zoo and Garden, South Carolina Wildlife Federation

Business and Industry representation: SC Department of Health and Environmental Control, Santee Cooper, Hemphill Consulting Group, LLC, SC chapter of the American Academy of Pediatrics, South Carolina Department of Natural Resources, Westminster Presbyterian Church, Greenwood Genetics Center, The Boeing Company

IHE Representation: University of North Dakota, Clemson University, Duke University**,** University of South Carolina, College of Charleston

SCDE National Advisory Writing Team

The ten members of the SCDE national advisory writing team provided recommendations to the *South Carolina College- and Career-Ready Science Standards 2021*

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Business and Industry representation: US Air Force Reserve, NASA Langley Research Center Science System Applications Incorporated, Department of Defense, Advanced Technology International,

SCDE Standards Design Team

The 13 members of the SCDE design team produced the engineering design process for the *South Carolina College- and Career-Ready Science Standards 2021*.

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Informal educator representation: the NASA Langley Research Center

Business and Industry representation: Boeing, Advanced Technology Institute, Hemphill Consulting Engineering Group, LLC, Intelligence for Air Force Global Strike Command

IHE representation: Clemson University (student Engineering candidate), College of Charleston, USC Honors College (student Pre-Law candidate), University of North Dakota