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MISSISSIPPI DEPARTMENT OF EDUCATION

Ensuring a bright future for every child

2018 Mississippi College- and Career-Readiness Standards for Science

Effective Date: 2018-2019 School Year

2018 Mississippi College- and Career-Readiness Standards for Science

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Introduction

Mission Statement

The Mississippi Department of Education is dedicated to student success, which includes improving student achievement in science, equipping citizens to solve complex problems, and establishing fluent communication skills within a technological environment. The Mississippi College- and Career-Readiness Standards provide a consistent, clear understanding of what students are expected to know and be able to do by the end of each grade level or course. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that students need for success in college and careers and allowing students to compete in the global economy.

Purpose

In an effort to closely align instruction for students who are progressing toward postsecondary study and the workforce, the *2018 Mississippi College- and Career-Readiness Standards for Science* includes grade- and course-specific standards for K-12 science.

This document is designed to provide K-12 science teachers with a basis for curriculum development. In order to prepare students for careers and college, it outlines what knowledge students should obtain, and the types of skills students must master upon successful completion of each grade level. The *2018 Mississippi College- and Career-Readiness Standards (MS CCRS) for Science* replaces the *2010 Mississippi Science Framework*. These new standards reflect national expectations while focusing on postsecondary success, but they are unique to Mississippi in addressing the needs of our students and teachers. The standards' content centers around three basic content strands of science: life science, physical science, and Earth and space science. Instruction in these areas is designed for a greater balance between content and process. Teachers are encouraged to transfer more ownership of the learning process to students, who can then direct their own learning and develop a deeper understanding of science and engineering practices, critical analysis, and knowledge. Doing so will produce students that will become more capable, independent, and scientifically literate adults.

Implementation

The *2018 Mississippi College- and Career-Readiness Standards (MS CCRS) for Science* will be implemented during the 2018-2019 school year.

2018 Mississippi College- and Career-Readiness Standards for Science Overview

Research and Background Information

In today's modern world and complex society, our students are required to possess sufficient knowledge of science and engineering to become vigilant consumers of scientific and technological information. To meet the growing challenges facing our future workforce, the National Research Council (NRC) published a research-based report on teaching and learning science in a 2012 document titled *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012). This document proposes a new approach to K-12 science education through the integration of science and engineering practices (SEPs), crosscutting concepts, disciplinary core ideas, and engineering design within the context of science instruction.

Core Elements in the Use and Design of the *MS CCRS for Science*

The *MS CCRS for Science* are goals that reflect what a student should know and be able to do. This document does not dictate a manner or methods of teaching. The standards in this document are not sequenced for instruction and do not prescribe classroom activities, materials, or instruction strategies. These standards are end-of year expectations for each grade or course. The standards are intended to drive relevant and rigorous instruction that emphasizes student mastery of both disciplinary core ideas (concepts) and application of science and engineering practices (skills) to support student readiness for citizenship, college, and careers.

The *MS CCRS for Science* document was built by adapting and extending information from *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012) and combining with Mississippi's previous science framework process strands (i.e., science as inquiry, unifying concepts and processes, science and technology, science in personal and social perspectives, and the history and nature of science). These concepts connect information across the science content strands (i.e., life science, physical science, and Earth and space science) with the disciplinary core ideas (e.g., ecology and interdependence, motions, forces, and energy, Earth systems and cycles) and are essential to both scientists and engineers because they identify common properties and processes found in practice.

The core elements are integrated across standards and performance objectives in each grade and course. A brief description of each core element is presented below.

1. Nature of Science: Science and Engineering Practices (SEPs) replaced the Inquiry Strand included in the *2010 Mississippi Science Framework*. Beyond integration within the standards, these practices must be mastered by students to produce a more scientifically literate citizenry and to develop students that are more excited about STEM (Science, Technology, Engineering, and Mathematics) topics and careers. Inquiry verbs, along with the SEPs, are woven throughout the standards, especially in the performance objectives. Each has a deliberate placement to indicate the depth of understanding expected of students.

   The practices describe the behaviors that scientists engage in as they investigate and build models and theories about the natural world. They also describe the key set of engineering practices that engineers use as they design and build models and systems. These practices work together (overlap and interconnect) and are not separated in the study and investigation of science concepts. For example, the practice of *mathematical and computational thinking* may include some aspects of *analyzing and interpreting data*. The data often come from *planning and carrying out an investigation*. The writing task force for the *MS CCRS for Science* incorporated this language into the performance objectives to emphasize the importance of a student-centered science classroom and not a teacher-centered classroom. A list of these eight practices is listed below.

- a. **Ask Questions (science) and Define Problems (engineering)**
- b. **Develop and Use Models**
- c. **Plan and Conduct Investigations**
- d. **Analyze and Interpret Data**
- e. **Use Mathematical and Computational Thinking**
- f. **Construct Explanations (science) and Design Solutions (engineering)**
- g. **Engage in Scientific Argument from Evidence**
- h. **Obtain, Evaluate, and Communicate Information**

2. Crosscutting concepts: These seven, binding concepts were adopted directly from the National Research Council's *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* (2012) and should be woven into instruction for every grade and course. Crosscutting concepts are designed to help students see the unity of the sciences. Students often are confused when they study ecosystems for three weeks, then weather for two weeks, and finally motion and forces for several weeks. A concept is crosscutting if it communicates a scientific way of thinking about a subject and it applies to many different disciplines of science and engineering. Crosscutting concepts are sometimes called "the ties that bind." The seven concepts are listed below.

   - a. **Patterns**
   - b. **Cause and effect: Mechanism and explanation**
   - c. **Scale, proportion, and quantity**
   - d. **Systems and system models**
   - e. **Energy and matter: Flows, cycles, and conservation**
   - f. **Structure and function**
   - g. **Stability and change**

3. Technology: If Mississippi students are to compete on a global stage and exit high school prepared for college, career, and life, technology should be used in the classroom in a way that suits 21st-century learners and reflects the modern workplace. Technology is essential in teaching and learning of science; it influences and enhances students' learning. Flexible access, customized delivery, and increased convenience for the user are core tenets. K-12 learners have fundamentally changed over the past few decades, and our classrooms should adapt to accommodate them. Dr. Ruben Puentedura's SAMR (Substitution, Augmentation, Modification, and Redefinition) model is a resource that can be considered by teachers, administrators, and technology staff as they integrate meaningful and appropriate digital learning experiences into the classroom. At the basic level, technology enhances instruction.

4. Science and society: This core element assures exploration of science's impacts on society and the feedback loop that must be cultivated and sustained to continue improvement of systems.

5. History of science: Because most modern-day scientific advancement derives from past discoveries, it is essential that students understand the breakthroughs that make today's work possible.

6. Engineering design process (EDP) is the method of devising a system, component, or process to meet desired needs. Engineering standards are represented in some performance objectives with grade-banded, specific wording that prompts educators to approach learning and exploration using the engineering process. These performance objectives are marked with an *. It is important to

note that the EDP is flexible. Most students will approach the process in various ways. The EDP is also a cycle—there is no official start or end point. Students can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle. Professional development and teacher resources will be developed for Mississippi teachers as EDP is incorporated into Mississippi standards.

Students should be provided a safe environment for failure without consequence, which is one of the most powerful drivers in learning. Providing many opportunities for students to fail, learn, and try again, with appropriate levels of support, fosters a deeper level of understanding and greater student interest and engagement.

Other Important Core Elements

Mathematics is integrated throughout the science standards document because it is essential to the scientific process, requiring students to quantify, analyze, and present results. Students must be familiar with data analysis, critical thinking, and recording their own data; students must organize and analyze it before presenting their findings. Analysis of scientific studies and publications from a quantitative perspective is also very important.

English/language arts skills are also integrated into the science standards. Students will be required to read informational text for understanding as well as process and critique information. Students must be able to articulate a critical point of view using proper terminology. In addition, the K-4 science curriculum should be increasingly tied to language arts to lay the foundation for students to have access to science before fifth grade.

Content Strands and Disciplinary Core Ideas

Science (and engineering) fields can be divided into three content-strand domains based on relative content presented in strands, extending from kindergarten to eighth grade. Grouping content in this way allows for vertical alignment of competencies and objectives to better organize content distribution. Content strands are not included in the Grades 9-12 course organization, which allows for a more logical, sequential placement and flow of content. Content strands are subdivided into 10 disciplinary core ideas in which standards and performance objectives for science content can be placed in grades K-8.

K-8 content strands with the 10 disciplinary core ideas include:

Life Science

1. Hierarchical Organization
2. Reproduction and Heredity
3. Ecology and Interdependence
4. Adaptations and Diversity

Physical Science

5. Organization of Matter and Chemical Interactions
6. Motions, Forces, and Energy

Earth and Space Science

7. Earth's Structure and History
8. Earth and the Universe
9. Earth Systems and Cycles
10. Earth's Resources

Structure of the Standards Document

The organization and structure of this standards document are as follows:

- Grade-band overview: An overview that describes the general content and themes for the grade-level band or the high school courses. Outputs and outcomes are provided along with examples of, and references to, science and engineering practices and connecting concepts.

- Grade-level or course overview: An overview that describes the specific content and themes for each grade level and/or high school course. The K-8 standards are presented with each grade focused on a grade-level theme. High school courses provide an overview of the major ideas and strategies to use when planning instruction for the course.

- Content strand: Domains into which science fields can be divided based on relative content extending from kindergarten to eighth grade. In grades K through 8, the content strands are organized into three distinct areas: (1) life science, (2) physical science, and (3) Earth and space science. For the Grade 9-12 courses, the content areas are organized around the core ideas of each course.

- Disciplinary core ideas: Subdivision of the main content strands providing recurring ideas from the three content strands. The core ideas are the key organizing principles for the development of learning units. The K-8 vertical alignment is designed in a spiral arrangement, which places emphasis on one of the three content strands in each grade level. All content strands will be found in each grade level, but all disciplinary core ideas will not be found in every grade level in K-8 due to the spiral arrangement of content.

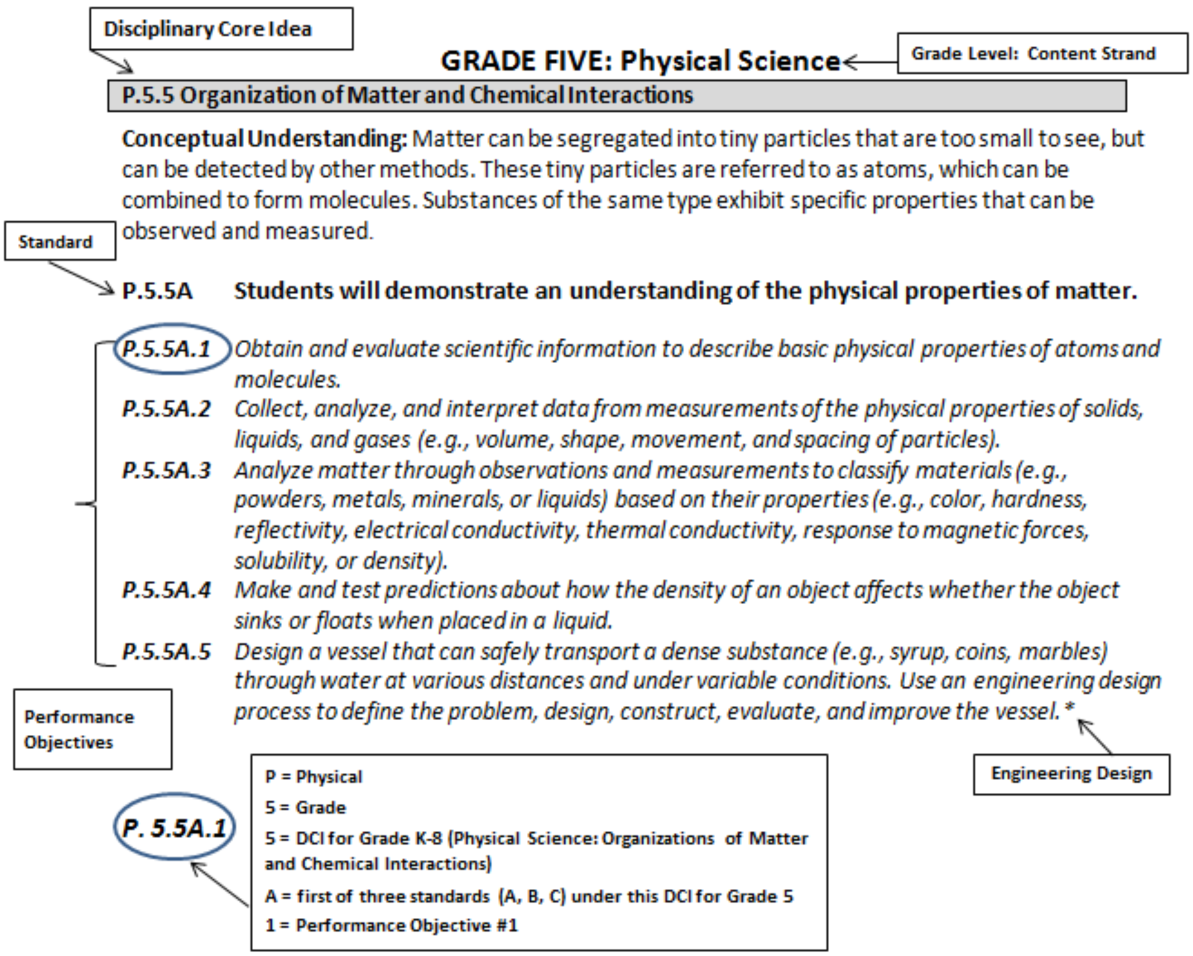
- Conceptual understanding: Statements of the core ideas for which student should demonstrate an understanding. Some grade level and/or course topics include more than one conceptual understanding with each guiding the intent of the standards.

- Content standards: Written below each disciplinary core ideas and conceptual understanding, the standards are a general statement of what students should know and be able to do because of instruction.

- Performance objectives: Detailed statements of content and skills to be mastered by the students. Performance objectives are specific statements of what students know and can do because of the science instruction at that level. These statements contain SEP and inquiry verb language.

Standards will appear in the following format:

Grade-Band Overview
Grade Level Theme (K-8)
Grade Level (K-8) or Course Overview (9-12)
Grade Level: Content Strand (K-8); Course Name (9-12)
  Disciplinary Core Idea (DCI)
  Conceptual Understanding
  Standard
  Performance Objectives



GRADE FIVE: Physical Science

P.5.5 Organization of Matter and Chemical Interactions

Conceptual Understanding: Matter can be segregated into tiny particles that are too small to see, but can be detected by other methods. These tiny particles are referred to as atoms, which can be combined to form molecules. Substances of the same type exhibit specific properties that can be observed and measured.

P.5.5A Students will demonstrate an understanding of the physical properties of matter.

P.5.5A.1 Obtain and evaluate scientific information to describe basic physical properties of atoms and molecules.

P.5.5A.2 Collect, analyze, and interpret data from measurements of the physical properties of solids, liquids, and gases (e.g., volume, shape, movement, and spacing of particles).

P.5.5A.3 Analyze matter through observations and measurements to classify materials (e.g., powders, metals, minerals, or liquids) based on their properties (e.g., color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, solubility, or density).

P.5.5A.4 Make and test predictions about how the density of an object affects whether the object sinks or floats when placed in a liquid.

*P.5.5A.5 Design a vessel that can safely transport a dense substance (e.g., syrup, coins, marbles) through water at various distances and under variable conditions. Use an engineering design process to define the problem, design, construct, evaluate, and improve the vessel. **

Safety in the Science Classroom

The National Science Teachers Association (NSTA) encourages K–12 school leaders and teachers to promote and support the use of science activities in science instruction and work to avoid and reduce injury. NSTA provides the following guidelines for school leaders and teachers to develop safety programs that include the effective management of chemicals, implement safety training for teachers and others, and create school environments that are as safe as possible (NSTA 2013).

1) National Science Teacher Association's *Safety in the Science Classroom*, accessible at http://www.nsta.org/docs/SafetyInTheScienceClassroom.pdf.
2) An extensive list of safety resources is available at http://www.nsta.org/safety/.

Support Documents and Resources

The MDE will develop support documents after these standards have been approved by the State Board of Education. Local districts, schools, and teachers may use these documents to construct standards-based science curriculum, allowing them to customize content to fit their students' needs and match available instructional materials. The support documents will include suggested resources, instructional strategies, essential knowledge, and detailed information about the core elements (e.g., SEPs, crosscutting concepts).

Professional development efforts will be aligned with the standards and delivered in accord with teacher resources to help expand expertise in delivering student-centered lessons (e.g., inquiry-based learning, 5-E instructional models, or other best practices in STEM teaching). The most successful national models and programs will be referenced for a capacity-building effort that can develop a more effective culture of science education in Mississippi.

Investigate, Apply, and Understand

It is important that the pedagogical paradigm of Mississippi's science classroom reflects the nature of the content being learned. The essence of science is natural to children and includes discovery, observation, questioning, design, testing, failure, iteration, and hands-on application. Research-based approaches such as inquiry-based (IB), project-based, and discovery learning are all pedagogical pathways that make sense, especially in the science classroom. Mississippi's science teachers are encouraged to embrace the growth mindset and constantly seek to upgrade classroom approaches by experimenting and adopting methods that excite students to learn and become functional, autonomous learners and contributors. Students should be provided increased maneuverability in the classroom to formulate their own ideas to investigate and understand the scientific and engineering design processes.

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GRADES 3-5 OVERVIEW

Upper elementary is a pivotal time to enhance students' scientific literacy and active engagement in science and engineering practices. Students use their experiences from structured investigations in kindergarten through Grade 2 to begin planning their own investigations to answer scientific questions. Because science foundations created at this level are key in developing students for college and career readiness, the cultivation of opportunities for inquiry-based activities and experiences that emphasize the problem solving and the engineering design process is critical.

The standards for Grades 3-5 have been developed around the following crosscutting concepts or themes:

- Grade 3 – Interactions Within an Environment
- Grade 4 – Energy and Change
- Grade 5 – Interdependence of Systems

In Grade 3, students are expected to engage in the engineering design process and conduct research and communicate their understanding of each standard in a variety of ways. In Grade 4, students will observe, research, and conduct investigations to discover patterns related to energy and change in the world around them. In Grade 5, students will model, provide evidence to support arguments, and obtain and display data about relationships among a variety of systems. Because of this yearlong study, students will gain content knowledge and tools to provide evidence and support arguments about the ways systems across content areas are interconnected and interdependent.

The core science content utilizes hands-on classroom instruction to reinforce the seven crosscutting concepts (i.e., patterns; cause and effect; scale, portion, and quantity; systems and system models; energy and matter; structure and function; and stability and change.

SEPs are in life science, physical science, and Earth and space science. The SEPs are designed so that students may develop skills and apply knowledge to solve real-life problems. While presented as distinct skill sets, the eight practices intentionally overlap and interconnect as students explore the science concepts. Some examples of specific skills students should develop in Grades 3-5 are listed below.

1. Ask questions to predict how natural or man-made changes in a habitat cause plants and animals to respond in different ways, including hibernating, migrating, responding to light, death, or extinction (e.g., sea turtles, the dodo bird, or nocturnal species).
2. Develop and use models to explain the unique and diverse life cycles of organisms other than humans (e.g., flowering plants, frogs, or butterflies) including commonalities (e.g., birth, growth, reproduction, or death).
3. Plan and conduct scientific investigations to classify different materials as either an insulator or conductor of electricity.
4. Analyze and interpret data to describe and predict how natural processes (e.g., weathering, erosion, deposition, earthquakes, tsunamis, hurricanes, or storms) affect Earth's surface.
5. Collect, analyze, and interpret data from measurements of the physical properties of solids, liquids, and gases (e.g., volume, shape, movement, and spacing of particles).
6. Construct explanations about regional climate differences using maps and long-term data from various regions.
7. Construct scientific arguments to support claims about the importance of astronomy in navigation and exploration, including the use of telescopes, compasses, and star charts.

8. Obtain and evaluate scientific information regarding the characteristics of different ecosystems and the organisms they support (e.g., salt and fresh water, deserts, grasslands, forests, rain forests, or polar tundra lands).

Curricula and instructions that integrate science and engineering practices should reflect the skills outlined above.

The Engineering Design Process (EDP) is a step-by-step method of devising a system, component, or process to meet desired needs. This is similar to the “scientific method” which is taught to young scientists. However, the EDP is a flexible process. Students can begin at any step, focus on just one step, move back and forth between steps, or repeat the cycle. Engineering standards are represented in some performance objectives with grade-banded, specific wording that will prompt students to approach learning and exploration using the engineering process. **These performance objectives are marked with an * at the end of the statement.** Professional development and teacher resources will be developed for teachers as EDP is incorporated into Mississippi standards.

Each standard in Grades 3, 4, and 5 allows students to be active doers of science rather than passive observers of science. This approach creates an opportunity for student learning and engages the pupil in the scientific investigation process. Therefore, students need to be supplied with the appropriate resources and materials to complete scientific investigations.

Conceptual Understanding: Earth's oceans and landforms can be affected in various ways by natural processes in one or more of Earth's spheres (i.e., atmosphere, biosphere, geosphere, and hydrosphere). Humans cannot eliminate natural hazards caused by these processes but can take steps to reduce their impacts. Human activities can affect the land and oceans in positive and negative ways.

E.4.9C Students will demonstrate an understanding of how natural processes and human activities affect the features of Earth's landforms and oceans.

E.4.9C.1 *Analyze and interpret data to describe and predict how natural processes (e.g., weathering, erosion, deposition, earthquakes, tsunamis, hurricanes, or storms) affect Earth's surface.*
E.4.9C.2 *Develop and use models of natural processes to explain the effect of the movement of water on the ocean shore zone, including beaches, barrier islands, estuaries, and inlets (e.g., marshes, bays, lagoons, fjord, or sound).*
E.4.9C.3 *Construct scientific arguments from evidence to support claims that human activities, such as conservation efforts or pollution, affect the land, oceans, and atmosphere of Earth.*
E.4.9C.4 *Research and explain how systems (i.e., the atmosphere, geosphere, and/or hydrosphere), interact and support life in the biosphere.*
E.4.9C.5 *Obtain and communicate information about severe weather phenomena (e.g., thunderstorms, hurricanes, or tornadoes) to explain steps humans can take to reduce the impact of severe weather events.*

GRADE FOUR: Earth and Space Science

E.4.10 Earth's Resources

Conceptual Understanding: Energy and fuels are derived from natural sources and human use of these materials affects the environment in multiple ways. Due to limited natural resources, humans are exploring the use of abundant solar, water, wind, and geothermal energy resources to develop innovative, high-tech renewable energy systems.

E.4.10 Students will demonstrate an understanding of the various sources of energy used for human needs along with their effectiveness and possible impacts.

E.4.10.1 *Organize simple data sets to compare energy and pollution output of various traditional, non-renewable resources (e.g. coal, crude oil, wood).*
E.4.10.2 *Use technology or informational text to investigate, evaluate, and communicate various forms of clean energy generation.*

GRADE FIVE

Theme: Interdependence of Systems

In Grade 5, students will model processes, provide evidence to support arguments, and obtain and display data about relationships among a variety of systems. The crosscutting concept can be seen in life science through the transfer of energy from the sun into all parts of a food web and ecosystem. In physical science, the concept is developed through a study of matter and an examination of forces and motion through the lens of gravity's effect on an object. The study of Earth and space science in fifth grade investigates the Earth in the universe, relationships between the bodies of our solar system, and human interaction with the Earth. Students are expected to engage in the engineering design process and conduct research to communicate their understanding of each standard in a variety of ways, including ELA connections to speaking and writing and mathematics connections to measurements using the metric system. Because of this yearlong study, students will gain content knowledge and tools to provide evidence and support arguments about the ways systems across content areas are interconnected and interdependent.

GRADE FIVE: Life Science

L.5.3 Ecology and Interdependence

Conceptual Understanding: All organisms need energy to live and grow. Energy is obtained from the sun. Cells transform the energy that organisms need to perform essential life functions through a complex sequence of reactions in which chemical energy is transferred from one system of interacting molecules to another.

L.5.3A Students will demonstrate an understanding of photosynthesis and the transfer of energy from the sun into chemical energy necessary for plant growth and survival.

L.5.3A.1 *Research and communicate the basic process of photosynthesis that is used by plants to convert light energy into chemical energy that can be stored and released to fuel an organism's activities.*

L.5.3A.2 *Analyze environments that do not receive direct sunlight and devise explanations as to how photosynthesis occurs, either naturally or artificially.*

Conceptual Understanding: A major role an organism serves in an ecosystem can be described by the way in which it obtains its energy. Energy is transferred within an ecosystem by producers, consumers, or decomposers. A healthy ecosystem is one in which a diverse population of life forms can meet their needs in a relatively stable web of life.

L.5.3B Students will demonstrate an understanding of a healthy ecosystem with a stable web of life and the roles of living things within a food chain and/or food web, including producers, primary and secondary consumers, and decomposers.

L.5.3B.1 *Obtain and evaluate scientific information regarding the characteristics of different ecosystems and the organisms they support (e.g., salt and fresh water, deserts, grasslands, forests, rain forests, or polar tundra lands).*

L.5.3B.2 *Develop and use a food chain model to classify organisms as producers, consumers, or decomposers. Trace the energy flow to explain how each group of organisms obtains energy.*

L.5.3B.3 *Design and interpret models of food webs to justify what effects the removal or the addition of a species (i.e., introduced or invasive) would have on a specific population and/or the ecosystem as a whole.*

L.5.3B.4 *Communicate scientific or technical information that explains human positions in food webs and our potential impacts on these systems.*

GRADE FIVE: Physical Science

P.5.5 Organization of Matter and Chemical Interactions

Conceptual Understanding: Matter can be segregated into tiny particles that are too small to see, but can be detected by other methods. These tiny particles are referred to as atoms, which can be combined to form molecules. Substances exhibit specific properties that can be observed and measured.

P.5.5A Students will demonstrate an understanding of the physical properties of matter.

P.5.5A.1 *Obtain and evaluate scientific information to describe basic physical properties of atoms and molecules.*

P.5.5A.2 *Collect, analyze, and interpret data from measurements of the physical properties of solids, liquids, and gases (e.g., volume, shape, movement, and spacing of particles).*

P.5.5A.3 *Analyze matter through observations and measurements to classify materials (e.g., powders, metals, minerals, or liquids) based on their properties (e.g., color, hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, solubility, or density).*

P.5.5A.4 *Make and test predictions about how the density of an object affects whether the object sinks or floats when placed in a liquid.*

P.5.5A.5 *Design a vessel that can safely transport a dense substance (e.g., syrup, coins, marbles) through water at various distances and under variable conditions. Use an engineering design process to define the problem, design, construct, evaluate, and improve the vessel.**

Conceptual Understanding: Substances of the same type can be classified by their similar, observable properties. Substances can be combined in a variety of ways. A mixture is formed when two or more kinds of matter are physically combined. Solutions are a special type of mixture in which one substance is distributed evenly into another substance. When the physical properties of the components in a mixture are not changed, they can be separated in different physical ways.

P.5.5B Students will demonstrate an understanding of mixtures and solutions.

P.5.5B.1 *Obtain and evaluate scientific information to describe what happens to the properties of substances in mixtures and solutions.*

P.5.5B.2 *Analyze and interpret data to communicate that the concentration of a solution is determined by the relative amount of solute versus solvent in various mixtures.*

P.5.5B.3 *Investigate how different variables (e.g., temperature change, stirring, particle size, or surface area) affect the rate at which a solute will dissolve.*

P.5.5B.4 *Design an effective system (e.g., sifting, filtration, evaporation, magnetic attraction, or floatation) for separating various mixtures. Use an engineering design process to define the problem, design, construct, evaluate, and improve the system.**

Conceptual Understanding: Physical properties can be observed and measured without changing the composition of matter. A physical change occurs when the matter's physical appearance is altered while leaving the composition of the matter unchanged. When two or more substances are mixed together, a new substance with different properties can sometimes be formed, but the total amount (i.e., mass) of the substances is conserved (i.e., total mass stays the same). In a chemical change, the composition of the original matter is altered to create a new substance. A different compound is present at the completion of the chemical change.

P.5.5C Students will demonstrate an understanding of the difference between physical and chemical changes.

P.5.5C.1 *Analyze and communicate the results of chemical changes that result in the formation of new materials (e.g., decaying, burning, rusting, or cooking).*
P.5.5C.2 *Analyze and communicate the results of physical changes to a substance that results in a reversible change (e.g., changes in states of matter with the addition or removal of energy, changes in size or shape, or combining/separating mixtures or solutions).*
P.5.5C.3 *Analyze and interpret data to support claims that when two substances are mixed, the total weight of matter is conserved.*

GRADE FIVE: Physical Science

P.5.6 Motions, Forces, and Energy

Conceptual Understanding: Gravity is a force that draws objects to Earth. This force acting on an object near Earth's surface pulls that object toward the planet's center. The motion of an object can be described in terms of its position, direction, and speed. Multiple factors determine the rate and motion of an object. Other than Earth, any celestial objects will exert varying gravitational pulls on other objects according to their mass and density.

P.5.6 Students will demonstrate an understanding of the factors that affect the motion of an object through a study of Newton's Laws of Motion.

P.5.6.1 *Obtain and communicate information describing gravity's effect on an object.*
P.5.6.2 *Predict the future motion of various objects based on past observation and measurement of position, direction, and speed.*
P.5.6.3 *Develop and use models to explain how the amount or type of force, both contact and non-contact, affects the motion of an object.*
P.5.6.4 *Plan and conduct scientific investigations to test the effects of balanced and unbalanced forces on the speed and/or direction of objects in motion.*
P.5.6.5 *Predict how a change of force, mass, and/or friction affects the motion of an object to convert potential energy into kinetic energy.*
P.5.6.6 *Design a system to increase the effects of friction on the motion of an object (e.g., non-slip surfaces or vehicle braking systems or flaps on aircraft wings). Use an engineering design process to define the problem, design, construct, evaluate, and improve the system.**

GRADE FIVE: Earth and Space Science

E.5.8 Earth and the Universe

Conceptual Understanding: Astronomy is the study of celestial objects in our solar system and beyond. A solar system includes one or more suns (stars) and all other objects orbiting in that system. Planets in our night sky change positions and are not always visible from Earth as they orbit our sun. Stars that can be seen in the night sky lie beyond our solar system and appear in patterns called constellations. Constellations can be used for navigation and appear to move together across the sky because of Earth’s rotation and revolution around the sun.

E.5.8A Students will demonstrate an understanding of the locations of objects in the universe.

E.5.8A.1 *Develop and use scaled models of Earth's solar system to demonstrate the size, composition (i.e., rock or gas), location, and order of the planets as they orbit the Sun.*

E.5.8A.2 *Use evidence to argue why the sun appears brighter than other stars.*

E.5.8A.3 *Describe how constellations appear to move from Earth's perspective throughout the seasons (e.g., Ursa Major, Ursa Minor, and Orion).*

E.5.8A.4 *Construct scientific arguments to support claims about the importance of astronomy in navigation and exploration, including the use of telescopes, compasses, and star charts.*

Conceptual Understanding: Earth orbits around the sun as the moon orbits around Earth. The revolution and rotation of Earth on a tilted axis provide evidence of patterns that can be observed, studied, and predicted.

E.5.8B Students will demonstrate an understanding of the principles that govern moon phases, day and night, appearance of objects in the sky, and seasonal changes.

E.5.8B.1 *Analyze and interpret data from observations and research (e.g., from NASA, NOAA, or the USGS) to explain patterns in the location, movement, and appearance of the moon throughout a month and over the course of a year.*

E.5.8B.2 *Develop and use a model of the Earth-Sun-Moon system to analyze the cyclic patterns of lunar phases, solar and lunar eclipses, and seasons.*

E.5.8B.3 *Develop and use models to explain the factors (e.g., tilt, revolution, and angle of sunlight) that result in Earth's seasonal changes.*

E.5.8B.4 *Obtain information and analyze how our understanding of the solar system has evolved over time (e.g., Earth-centered model of Aristotle and Ptolemy compared to the Sun-centered model of Copernicus and Galileo).*

GRADE FIVE: Earth and Space Science

E.5.10 Earth's Resources

Conceptual Understanding: Human activities can impact natural processes and availability of resources. To reduce impacts on the environment (including humans), various best practices can be used. New and improved conservation practices are constantly being developed and tested.

E.5.10 Students will demonstrate an understanding of the effects of human interaction with Earth and how Earth's natural resources can be protected and conserved.

E.5.10.1 *Collect and organize scientific ideas that individuals and communities can use to conserve Earth's natural resources and systems (e.g., implementing watershed management practices to conserve water resources, utilizing no-till farming to improve soil fertility, reducing emissions to abate air pollution, or recycling to reduce landfill waste).*

E.5.10.2 *Design a process for better preparing communities to withstand manmade or natural disasters (e.g., removing oil from water or soil, systems that reduce the impact of floods, structures that resist hurricane forces). Use an engineering design process to define the problem, design, construct, evaluate, and improve the disaster plan.**