Alabama Curriculum Guide to the Standards: Science Grades K-12

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CURRICULUM GUIDE TO THE ALABAMA COURSE OF STUDY: SCIENCE K-12

Table of Contents

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Introduction

The *Curriculum Guide to the Alabama Course of Study: Science* is a companion document to the *2015 Alabama Course of Study: Science*, for Grades K-12. Content standards contained within the course of study document may be accessed on the Alabama State Department of Education (ALSDE) Web site at www.alsde.edu. On the home page, click on Sections, scroll down to select Curriculum and Instruction. Click on Publications, scroll down to Courses of Study, and click on Science.

Educators are reminded that content standards indicate minimum content—what all students should know and be able to do by the end of each grade level or course. Local school systems may have additional instructional or achievement expectations and may provide instructional guidelines that address content sequence, review, and remediation.

The *Curriculum Guide to the Alabama Course of Study: Science* prepares students for study of the grade-level and course content standards through the teaching of prerequisite and enabling skills necessary for learning each content standard. This allows students to work toward grade-level and course content standards while working at individual ability levels. By identifying the prerequisites and enabling skills for each standard, teachers may plan instruction to address the achievement gap experienced by some students while still working with all students toward achievement of the grade-level standards. It should be noted that the *Curriculum Guide to the Alabama Course of Study: Science* is not a chronological list of learning targets nor a sequence of instruction, but rather a guide to assist students in learning content in smaller increments, catching up on content they may have missed in previous years, and/or reviewing content related to grade-level academic standards.

The *Curriculum Guide to the Alabama Course of Study: Science* may be accessed at alex.state.al.us/specialed/curriculum.html.

Educators are encouraged to use the curriculum guide to:

- Allow for Problem Solving Teams (PSTs) to plan for response to intervention/instructional strategies
- Assist in development of Individual Educational Programs (IEPs) annual goals and services
- Prepare for collaborative teaching
- Design tutorial programs
- Plan for instructional groupings
- Plan for parent information and conferences
- Develop curriculum-based assessments for use in determining mastery of needed prerequisite skills
- Prepare for state assessments by building prerequisite and enabling skills
- Develop lesson plans for differentiated instruction

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Organization of the Curriculum Guide

The organizational components of this guide include content standards and instructional objectives. Examples may be embedded within certain content standards and objectives to provide clarification.

Content Standards are statements found in the *Alabama Course of Study: Science* that define what all students should know and be able to do at the conclusion of a grade level or course. Content Standards contain minimum required content and complete the phrase "*Students will*." Content standards are also found in the *Curriculum Guide to the Alabama Course of Study: Science* to indicate the standard for which each objective is a prerequisite or enabling skill.

Content Standards for a grade level or course are clearly written, reasonable, measurable, developmentally appropriate, and sufficiently rigorous to enable Alabama students to achieve at levels comparable to other students in the nation and the world. They also provide proportional emphasis to the essential knowledge, skills, and processes of a given grade level or course.

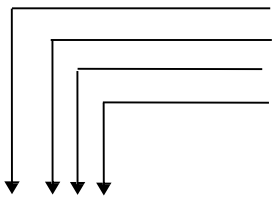
Instructional Objectives divide the standards into smaller instructional units that are prerequisite and enabling skills for the standards. Instructional objectives are useful for facilitating the ability to have all students working toward grade-level standards while also working at individual ability levels.

Instructional objectives within this document are numbered according to grade level, content standard number, and the order in which the instructional objective is listed. Objectives always start with any needed definitions, and then work down from skills closest to the standard (higher skills) to skills the furthest from the standard (lower skills). The instructional objectives are not a chronological list of learning targets, nor a sequence of instruction, but rather identified prerequisite or enabling skills.

The system for numbering the objectives for **Science Standard 2.9,** for example, is based upon the following:

Standard 2.9

9. Create models to identify physical features of Earth (e.g., mountains, valleys, plains, deserts, lakes, rivers, oceans).



Subject Grade Level Content Standard Objective

SCI.2.9.1: Define mountain, valleys, plains, deserts, lakes, rivers, and oceans.

SCI 2.9.2: Identify patterns of physical features on Earth.

Essentials Courses

The *Curriculum Guide to the Alabama Course of Study: Science* contains the course content for the *Essentials* course credits for the Alabama High School Diploma. The courses provide students with foundational skills for content standards identified in the general education Science courses.

Instructional objectives in Grades 9-12 preceded by a diamond shape (♦) indicate content required for earning course credit for the *Essentials* courses.

The courses include essential concepts to equip students with the Science skills necessary for employment and independent living.

- Essentials: Physical Science (750101)
- Essentials: Biology (750201)
- Essentials: Earth and Space Science (750301)
- Essentials: Environmental Science (750401)
- Essentials: Human Anatomy and Physiology (750501)

It should be noted that the committee decided not to develop objectives for the Physics course, as they felt that it was not a course that would typically be taken by students receiving special education services or accommodations/modifications.

Additional Resource

An additional resource for teachers, the Alabama Insight Tool, can be found at http://alex.state.al.us/ccrs/node/309. The Alabama Insight Tool was developed to give educators a tool for in-depth investigation of the College- and Career-Ready Standards (CCRS). Within the tool, the standards are unpacked, or dissected, identifying specific knowledge, skills, vocabulary, understandings, and evidence of student attainment for each standard.

GRADE K

Kindergarten students enter school with an eagerness to explore the world around them. Although their experiences and background knowledge may be limited, science instruction provides ample opportunities to develop investigative thinking, argumentation, and reasoning in the context of familiar surroundings. Students develop the foundational skills necessary for future learning in science.

Students in kindergarten learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students investigate forces and interactions. In Life Science, students explore interactions, energy, and dynamics of ecosystems. In Earth and Space Science, students become familiar with Earth's systems while observing the effects of sunlight and studying weather patterns. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three scientific domains and are denoted with an asterisk (*).

Grade K content standards provide students with opportunities for appropriate investigation and observation of the world around them. Through guided participation in specific engineering design projects, they find answers regarding how to use force to change the speed or direction of an object, how to reduce the human impact on the local environment, how to reduce the effects of sunlight, and how to use weather forecasts to prepare for severe weather.

Students will:

Motion and Stability: Forces and Interactions

1. Investigate the resulting motion of objects when forces of different strengths and directions act upon them (e.g., object being pushed, object being pulled, two objects colliding).

   Objective SCI.K.1.1: Define force.
   Objective SCI.K.1.2: Demonstrate that applying a force to an object changes the way it moves.
   Objective SCI.K.1.3: Predict the amount of force needed to move an object (e.g., it takes more force to move the ball and less force to move the paper).
   Objective SCI.K.1.4: Demonstrate force on an object (e.g., students will move objects) and its cause and effect.
   Objective SCI.K.1.5: Investigate the motion of different objects.

2. Use observations and data from investigations to determine if a design solution (e.g., designing a ramp to increase the speed of an object in order to move a stationary object) solves the problem of using force to change the speed or direction of an object.*

   Objective SCI.K.2.1: Chart the results of investigations.
   Objective SCI.K.2.2: Create a ramp or incline (e.g., stack books or blocks to make a ramp or incline).
   Objective SCI.K.2.3: Create possible solutions for moving objects.
   Objective SCI.K.2.4: Observe the change of speed of an object.
   Objective SCI.K.2.5: Observe the direction of an object.

Ecosystems: Interactions, Energy, and Dynamics

3. Distinguish between living and nonliving things and verify what living things need to survive (e.g., animals needing food, water, and air; plants needing nutrients, water, sunlight, and air).

Objective SCI.K.3.1: **Define living and non-living things.**
Objective SCI.K.3.2: **Record in words and pictures what living things need to survive.**
Objective SCI.K.3.3: **Distinguish patterns between living and non-living things using examples.**
Objective SCI.K.3.4: **Use pictures to discuss living and non-living things.**

4. Gather evidence to support how plants and animals provide for their needs by altering their environment (e.g., tree roots breaking a sidewalk to provide space, red fox burrowing to create a den to raise young, humans growing gardens for food, and building roads for transportation).

Objective SCI.K.4.1: **Define alter and environment.**
Objective SCI.K.4.2: **Create a project that demonstrates how people, animals or plants alter their environments to meet their needs.**
Objective SCI.K.4.3: **Explain how people change their environments to provide for their needs.**
Objective SCI.K.4.4: **Explain how animals change their environments to provide for their needs.**

5. Construct a model of a natural habitat (e.g., terrarium, ant farm, diorama) conducive to meeting the needs of plants and animals native to Alabama.

Objective SCI.K.5.1: **Define habitat and native.**
Objective SCI.K.5.2: **Create a model of a natural habitat for a plant or an animal.**
Objective SCI.K.5.3: **Discuss animals native to Alabama.**
Objective SCI.K.5.4: **Describe plants native to Alabama.**

6. Identify and plan possible solutions (e.g., reducing, reusing, recycling) to lessen the human impact on the local environment.*

Objective SCI.K.6.1: **Define reduce, reuse, recycle, and impact.**
Objective SCI.K.6.2: **Make a reasonable plan of possible solutions to lessen the human impact on the local environment (e.g., pick up trash around the school, create a reduced littering environment).**
Objective SCI.K.6.3: **Describe ways to lessen the human impact on the local environment.**

Earth's Systems

1. Observe and describe the effects of sunlight on Earth's surface (e.g., heat from the sun causing evaporation of water or increased temperature of soil, rocks, sand, and water).

Objective SCI.K.7.1: **Define evaporation and temperature.**
Objective SCI.K.7.2: **Compare the differences between soil, sand, rocks, and water that have been in sunlight and have not been in sunlight.**

2. Design and construct a device (e.g., hat, canopy, umbrella, tent) to reduce the effects of sunlight.*

Objective SCI.K.8.1: Design a structure that will shield areas from the warmth of the sun.
Objective SCI.K.8.2: Demonstrate how objects can reduce the effects of sunlight.
Objective SCI.K.8.3: Identify how objects reduce the effects of sunlight.

3. Observe, record, and share findings of local weather patterns over a period of time (e.g., increase in daily temperature from morning to afternoon, typical rain and storm patterns from season to season).

Objective SCI.K.9.1: Define seasons.
Objective SCI.K.9.2: Create a weather report and share with the class (e.g., daily, weekly, monthly).
Objective SCI.K.9.3: Use collected data to create drawings or other visual displays relating to weather.
Objective SCI.K.9.4: Observe local weather conditions to describe patterns over time (e.g., sunny, cloudy, rainy, warm or cold).

Earth and Human Activity

4. Ask questions to obtain information about the purpose of weather forecasts in planning for, preparing for, and responding to severe weather.*

Objective SCI.K.10.1: Define forecast and severe weather.
Objective SCI.K.10.2: Design a simple safety plan for school in the event of severe weather.
Objective SCI.K.10.3: Design a simple safety plan for home in the event of severe weather.
Objective SCI.K.10.4: Use pictures to discuss severe weather.
Objective SCI.K.10.5: Describe and compare different kinds of severe weather.

GRADE 1

First-grade students continue to be eager learners who are curious about their world. This inquisitive nature leads them to ask a variety of questions that deepen understanding. Students are developing social skills that enable them to interact in inquiry-based and cooperative-learning opportunities. Students begin to take ownership of their learning experiences by making connections through meaningful investigations.

Students in Grade 1 learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students conduct experiments to discover the properties of light and sound waves. In Life Science, students determine similarities between parents and their offspring and how organisms adapt to their environment. In Earth and Space Science, students continue to explore Earth's systems through observations of seasonal patterns as well as patterns in the day and night sky. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three science domains and are denoted with an asterisk (*).

Grade 1 content standards provide students with opportunities for appropriate investigation and observation of the world around them. Through guided participation in specific engineering design projects, they find answers regarding how to use light or sound to communicate and how humans can imitate plant or animal parts for survival or protection.

Students will:

Waves and Their Applications in Technologies for Information Transfer

1. Conduct experiments to provide evidence that vibrations of matter can create sound (e.g., striking a tuning fork, plucking a guitar string) and sound can make matter vibrate (e.g., holding a piece of paper near a sound system speaker, touching your throat while speaking).

   Objective SCI.1.1.1: Define sound and vibration (e.g., use animated simulations).
   Objective SCI.1.1.2: Explore various objects that create sound and vibrations and share observations.

2. Construct explanations from observations that objects can be seen only when light is available to illuminate them (e.g., moon being illuminated by the sun, colors and patterns in a kaleidoscope being illuminated when held toward a light).

   Objective SCI.1.2.1: Define illuminate and kaleidoscope.
   Objective SCI.1.2.2: Demonstrate an understanding that light has a source and travels in a straight line until it strikes an object.
   Objective SCI.1.2.3: Demonstrate illumination with sunlight using an object (e.g., kaleidoscope).
   Objective SCI.1.2.4: Identify the cause and effect that light has on an object.

3. Investigate materials to determine which types allow light to pass through (e.g., transparent materials such as clear plastic wrap), allow only partial light to pass through (e.g., translucent materials such as wax paper), block light (e.g., opaque materials such as construction paper), or reflect light (e.g., shiny materials such as aluminum foil).

Objective SCI.1.3.1: Define transparent, translucent, opaque, and reflect.
Objective SCI.1.3.2: Compare how light travels through transparent and translucent materials (e.g., clear plastic wrap & wax paper).
Objective SCI.1.3.3: Compare how materials can either block or reflect light (e.g., construction paper & aluminum foil).

4. Design and construct a device that uses light or sound to send a communication signal over a distance (e.g., using a flashlight and a piece of cardboard to simulate a signal lamp for sending a coded message to a classmate, using a paper cup and string to simulate a telephone for talking to a classmate).*

Objective SCI.1.4.1: Define communication signal.
Objective SCI.1.4.2: Record observations using drawings and or writing to demonstrate knowledge that sound and light travel.
Objective SCI.1.4.3: Communicate over a distance using a lighting device (e.g., use a lighting device such as a flashlight, pointer, etc. to send signals).
Objective SCI.1.4.4: Communicate over a distance using a sound device. (e.g., drum patterns, cups with strings to create telephones).

From Molecules to Organisms: Structures and Processes

5. Design a solution to a human problem by using materials to imitate how plants and/or animals use their external parts to help them survive, grow, and meet their needs (e.g., outerwear imitating animal furs for insulation, gear mimicking tree bark or shells for protection).*

Objective SCI.1.5.1: Define mimicry.
Objective SCI.1.5.2: Design an animal that has special body parts that help the animal survive. (e.g., picture, project, or model)
Objective SCI.1.5.3: Design a structure to solve a human problem using items in nature (e.g., designing equipment to protect bicyclists by mimicking turtle shells, acorn shells, and animal scales).

6. Obtain information to provide evidence that parents and their offspring engage in patterns of behavior that help the offspring survive (e.g., crying of offspring indicating need for feeding, quacking or barking by parents indicating protection of young).

Objective SCI.1.6.1: Define offspring.
Objective SCI.1.6.2: Describe how parents use patterns of behavior to help their offspring survive (e.g., using media or texts).
Objective SCI.1.6.3: Illustrate examples of how parents meet the needs of their offspring.

Heredity: Inheritance and Variation of Traits

7. Make observations to identify the similarities and differences of offspring to their parents and to other members of the same species (e.g., flowers from the same kind of plant being the same shape, but differing in size; dog being same breed as parent, but differing in fur color or pattern).

Objective SCI.1.7.1: Define species and breed.
Objective SCI.1.7.2: Compare and contrast offspring to their parents and other members of the same species (e.g., picture cards).

Earth's Place in the Universe

8. Observe, describe, and predict patterns of the sun, moon, and stars as they appear in the sky (e.g., sun and moon appearing to rise in one part of the sky, move across the sky, and set; stars other than our sun being visible at night, but not during the day).

Objective SCI.1.8.1: **Model patterns of the earth, moon and sun (e.g., moon phases using cream filled cookies).**
Objective SCI.1.8.2: **Observe the movement of the sun to describe and predict patterns as it appears in the sky.**
Objective SCI.1.8.3: **Observe the movement of the moon to describe and predict patterns as it appears in the sky.**
Objective SCI.1.8.4: **Observe the movement of the stars to describe and predict patterns as they appear in the sky.**

9. Observe seasonal patterns of sunrise and sunset to describe the relationship between the number of hours of daylight and the time of year (e.g., more hours of daylight during summer as compared to winter).

Objective SCI.1.9.1: **Define sunrise and sunset.**
Objective SCI.1.9.2: **Describe the relationship between the amount of daylight and time of the year.**
Objective SCI.1.9.3: **Identify times of sunrise and sunset at different times of the year.**

GRADE 2

Second-grade students begin the school year with prior knowledge and skills that enable them to formulate answers to questions as they expand their comprehension of the world around them. Through continued exploration, they develop an understanding of the observable properties of materials and apply this understanding to the acquisition of new information and the construction of new models.

Students in Grade 2 learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students explore the physical properties and structure of matter. In Life Science, students explore plant needs and interactions within their habitats. In Earth and Space Science, students observe and identify Earth's events and physical features. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three scientific domains and are denoted with an asterisk (*).

Grade 2 content standards provide students with opportunities for appropriate exploration and observation of the world around them. Through guided participation in specific engineering design projects, they find answers regarding how properties of materials determine appropriate uses, how plants depend on animals for seed dispersal and pollination, and how to address changes caused by Earth events.

Students will:

Matter and Its Interactions

1. Conduct an investigation to describe and classify various substances according to physical properties (e.g., milk being a liquid, not clear in color, assuming shape of its container, mixing with water; mineral oil being a liquid, clear in color, taking shape of its container, floating in water; a brick being a solid, not clear in color, rough in texture, not taking the shape of its container, sinking in water).

   Objective SCI.2.1.1: Define physical properties, solids, liquids, and gases.
   Objective SCI.2.1.2: Classify various substances according to their physical properties.
   Objective SCI.2.1.3: Identify the properties of solids, liquids, and gases.

2. Collect and evaluate data to determine appropriate uses of materials based on their properties (e.g., strength, flexibility, hardness, texture, absorbency).*

   Objective SCI.2.2.1: Define strength, flexibility, hardness, texture, and absorbency.
   Objective SCI.2.2.2: Collect data about different kinds of materials by their observable properties.
   Objective SCI.2.2.3: Classify different kinds of materials by their observable properties.

3. Demonstrate and explain how structures made from small pieces (e.g., linking cubes, blocks, building bricks, creative construction toys) can be disassembled and then rearranged to make new and different structures.

   Objective SCI.2.3.1: Disassemble objects made from small pieces to make new structures.
   Objective SCI.2.3.2: Rearrange objects made from small pieces to make new structures.
   Objective SCI.2.3.3: Identify objects that can be disassembled and rearranged.

4. Provide evidence that some changes in matter caused by heating or cooling can be reversed (e.g., heating or freezing of water) and some changes are irreversible (e.g., baking a cake, boiling an egg).

Objective SCI.2.4.1: Define matter.
Objective SCI.2.4.2: Investigate reversible changes through heating and cooling (e.g., water and butter at different temperatures, melting ice or ice cream).
Objective SCI.2.4.3: Recognize changes in matter that are reversible and irreversible. (e.g., cooking an egg, boiling or freezing water).
Objective SCI.2.4.4: Identify physical and chemical changes.

Ecosystems: Interactions, Energy, and Dynamics

5. Plan and carry out an investigation, using one variable at a time (e.g., water, light, soil, air), to determine the growth needs of plants.

Objective SCI.2.5.1: Define variable.
Objective SCI.2.5.2: Recognize factors that contribute to plant growth.
Objective SCI.2.5.3: Identify causes and effects of plant growth.

6. Design and construct models to simulate how animals disperse seeds or pollinate plants (e.g., animals brushing fur against seed pods and seeds falling off in other areas, birds and bees extracting nectar from flowers and transferring pollen from one plant to another).*

Objective SCI.2.6.1: Define disperse and pollinate.
Objective SCI.2.6.2: Model ways animals disperse seeds and pollinate plants.

7. Obtain information from literature and other media to illustrate that there are many different kinds of living things and that they exist in different places on land and in water (e.g., woodland, tundra, desert, rainforest, ocean, river).

Objective SCI.2.7.1: Define woodland, tundra, desert, rainforest, ocean, and river.
Objective SCI.2.7.2: Describe different habitats in water.
Objective SCI.2.7.3: Describe different habitats on land.
Objective SCI.2.7.4: Match animals to various habitats.

Earth's Systems

8. Make observations from media to obtain information about Earth's events that happen over a short period of time (e.g., tornados, volcanic explosions, earthquakes) or over a time period longer than one can observe (e.g., erosion of rocks, melting of glaciers).

Objective SCI.2.8.1: Define tornados, volcanoes, earthquakes, erosion, rocks, and glaciers.
Objective SCI.2.8.2: Identify Earth events that happen over a long period of time.
Objective SCI.2.8.3: Identify Earth events that happen over a short period of time.
Objective SCI.2.8.4: Identify characteristics of Earth that have stayed the same over a long period of time.

9. Create models to identify physical features of Earth (e.g., mountains, valleys, plains, deserts, lakes, rivers, oceans).

Objective SCI.2.9.1: Define mountain, valleys, plains, deserts, lakes, rivers, and oceans.
Objective SCI.2.9.2: Identify patterns of physical features on Earth.

10. Collect and evaluate data to identify water found on Earth and determine whether it is a solid or a liquid (e.g., glaciers as solid forms of water; oceans, lakes, rivers, streams as liquid forms of water).

Objective SCI.2.10.1: Define water, oceans, lakes, rivers, glaciers, and streams.
Objective SCI.2.10.2: Identify where water is found on Earth as a solid.
Objective SCI.2.10.3: Identify where water is found on Earth as a liquid.

Earth and Human Activity

11. Examine and test solutions that address changes caused by Earth's events (e.g., dams for minimizing flooding, plants for controlling erosion).*

Objective SCI.2.11.1: Define erosion, mudslide, and flood.
Objective SCI.2.11.2: Correlate an event with the damage it causes.
Objective SCI.2.11.3: Describe events that change the earth's surface (e.g., wind, water, ice, gravity).

GRADES 3-5
Overview

In Grades 3-5, students are introduced to disciplinary core ideas and crosscutting concepts in the domains of Physical Science; Life Science; Earth and Space Science; and Engineering, Technology, and Applications of Science through content and participation in scientific and engineering practices. Direct experiences with physical models and materials remain important as students develop their ability to reason and communicate in multimodal scientific contexts. Students in Grades 3-5 ask increasingly sophisticated questions that stem from their observations, experiences, and prior learning. While students engage in the practices of science and engineering, they revise and extend their understanding of the role of science in the natural and technological environments in which they live. Physical evidence derived from numeric measurements and recorded data becomes an important part of students' emerging scientific explanations.

Learning environments in Grades 3-5 encourage a full range of inquiry, including opportunities to carry out scientific investigations and engineering design projects related to the disciplinary core ideas. Students engage in written and oral communication about the texts they read, the phenomena they observe, and the conclusions they draw from their scientific investigations and engineering projects. The role of mathematics becomes increasingly important as students produce and present numerical data in various forms such as tables and graphs. Being engaged in learning environments where content knowledge and scientific and engineering practices are intertwined, helps students develop more scientifically accurate and coherent conceptions of the laws and principles that govern the physical world.

Effective science instruction in Grades 3-5 provides students with opportunities for a variety of scientific activities and scientific thinking. Classroom experiences include investigations that range from those structured by the teacher to those that emerge from students' own questions. Students have opportunities to decide which data to gather, the variables that should be controlled, and which tools and instruments are needed to carry out investigations. Through participation in scientific and engineering practices, students develop their abilities to work in groups to design solutions to problems stemming from real-world scientific scenarios. Domain-specific core ideas, crosscutting concepts, and performance expectations within the content standards create a framework for instructional planning and student learning.

GRADE 3

Grade 3 students are increasingly aware of their environment and have already discovered many patterns and processes in nature. Their capacity to process information is growing, making them eager to participate in scientific and engineering practices. Writing and mathematics skills are used when students communicate scientific information during varied instructional activities.

Students in Grade 3 learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students investigate, measure, and predict the motion of an object and test the cause-and-effect relationship of electric and magnetic interactions. In Life Science, students use evidence to interpret fossil data and construct explanations of an organism's ability to survive in different habitats. Students examine organisms' life cycles and traits and the influence of environment on these traits. In Earth and Space Science, students develop representations to describe weather and climate. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three scientific domains and are denoted with an asterisk (*).

Grade 3 content standards provide students with opportunities for investigation, observation, and interpretation of a variety of scientific phenomena. Through participation in specific engineering design challenges, they find solutions regarding how to use magnets to solve a simple design problem, how to solve problems created by environmental changes, and how to reduce the impact of weather-related hazards.

Students will:

Motion and Stability: Forces and Interactions

1. Plan and carry out an experiment to determine the effects of balanced and unbalanced forces on the motion of an object using one variable at a time, including number, size, direction, speed, position, friction, or air resistance (e.g., balanced forces pushing from both sides on an object, such as a box, producing no motion; unbalanced force on one side of an object, such as a ball, producing motion), and communicate these findings graphically.

   Objective SCI.3.1.1: Define balanced forces, unbalanced forces, variable, friction, air resistance, speed, position, and motion.
   Objective SCI.3.1.2: Record and analyze data relating to force.
   Objective SCI.3.1.3: Demonstrate the cause and effect of balanced and unbalanced forces.
   Objective SCI.3.1.4: Demonstrate knowledge of different types of graphs relating to force and motion.
   Objective SCI.3.1.5: Describe and illustrate how different forces affect objects.

2. Investigate, measure, and communicate in a graphical format how an observed pattern of motion (e.g., a child swinging in a swing, a ball rolling back and forth in a bowl, two children teetering on a see-saw, a model vehicle rolling down a ramp of varying heights, a pendulum swinging) can be used to predict the future motion of an object.

   Objective SCI.3.2.1: Investigate methods of measuring various outcomes of motion.
   Objective SCI.3.2.2: Record measurements of motion to formulate a chart.
   Objective SCI.3.2.3: Predict patterns of motion resulting from various objects' positions.

3. Explore objects that can be manipulated in order to determine cause-and-effect relationships (e.g., distance between objects affecting strength of a force, orientation of magnets affecting direction of a magnetic force) of electric interactions between two objects not in contact with one another (e.g., force on hair from an electrically charged balloon, electrical forces between a charged rod and pieces of paper) or magnetic interactions between two objects not in contact with one another (e.g., force between two permanent magnets or between an electromagnet and steel paperclips, force exerted by one magnet versus the force exerted by two magnets).

Objective SCI.3.3.1: Define force, orientation, magnetic force, electrical force, and electromagnetic.
Objective SCI.3.3.2: Identify North and South Poles on a magnet.
Objective SCI.3.3.3: Observe a demonstration of magnetic forces.
Objective SCI.3.3.4: Discuss cause and effect relationships that occur in students' environment.
Objective SCI.3.3.5: Explore the cause and effect relationships between magnets.

4. Apply scientific ideas about magnets to solve a problem through an engineering design project (e.g., constructing a latch to keep a door shut, creating a device to keep two moving objects from touching each other such as a maglev system).*

Objective SCI.3.4.1: Define magnet.
Objective SCI.3.4.2: Implement the steps of the scientific process to solve a problem with magnets.
Objective SCI.3.4.3: Experiment with magnets to solve an everyday problem.
Objective SCI.3.4.4: Explore the properties of magnets.
Objective SCI.3.4.5: Research scientific inventions relating to magnets that have improved students' lives.
Objective SCI.3.4.6: Identify characteristics of magnets.

From Molecules to Organisms: Structures and Processes

5. Obtain and combine information to describe that organisms are classified as living things, rather than nonliving things, based on their ability to obtain and use resources, grow, reproduce, and maintain stable internal conditions while living in a constantly changing external environment.

Objective SCI.3.5.1: Define organism, resources, growth, reproduce, stable, internal, external, living, and nonliving.
Objective SCI.3.5.2: Identify conditions needed by living things for survival.
Objective SCI.3.5.3: Create a pictorial chart depicting living and nonliving materials.
Objective SCI.3.5.4: Identify patterns of living and nonliving things.

6. Create representations to explain the unique and diverse life cycles of organisms other than humans (e.g., flowering plants, frogs, butterflies), including commonalities such as birth, growth, reproduction, and death.

Objective SCI.3.6.1: Define life cycle, birth, growth, reproduction, death, unique, and diverse.
Objective SCI.3.6.2: Differentiate among stages of the life cycle of various organisms.
Objective SCI.3.6.3: Germinate a plant seed to observe and report on the growth cycle.

Heredity: Inheritance and Variation of Traits

7. Examine data to provide evidence that plants and animals, excluding humans, have traits inherited from parents and that variations of these traits exist in groups of similar organisms (e.g., flower colors in pea plants, fur color and pattern in animal offspring).

Objective SCI.3.7.1: **Define traits, inherit, and offspring.**
Objective SCI.3.7.2: **Identify types of evidence that demonstrates that plants and animals have inherited traits.**
Objective SCI.3.7.3: **Describe similarities among various plants and/or animals.**
Objective SCI.3.7.4: **Compare traits of various plants and/or animals (e.g., dogs, cats, fish, flowers, trees).**

8. Engage in argument from evidence to justify that traits can be influenced by the environment (e.g., stunted growth in normally tall plants due to insufficient water, change in an arctic fox's fur color due to light and/or temperature, stunted growth of a normally large animal due to malnourishment).

Objective SCI.3.8.1: **Experiment to observe the effects differences in sunlight and water have on plant growth.**
Objective SCI.3.8.2: **Recognize influential conditions on plant and/or animal traits.**
Objective SCI.3.8.3: **Predict traits based on various influences (e.g., sunlight, water, environment).**

Unity and Diversity

9. Analyze and interpret data from fossils (e.g., type, size, distribution) to provide evidence of organisms and the environments in which they lived long ago (e.g., marine fossils on dry land, tropical plant fossils in arctic areas, fossils of extinct organisms in any environment).

Objective SCI.3.9.1: **Define fossils, marine, tropical, arctic, and extinct.**
Objective SCI.3.9.2: **Research the data of scale, proportion, and quantity of fossil impressions.**
Objective SCI.3.9.3: **Use fossil characteristics to predict possible environment in which it may have lived.**
Objective SCI.3.9.4: **Simulate environments (e.g., marine, arctic, tropic) of different fossils.**
Objective SCI.3.9.5: **Create fossil impressions of various plants and animals.**

10. Investigate how variations in characteristics among individuals of the same species may provide advantages in surviving, finding mates, and reproducing (e.g., plants having larger thorns being less likely to be eaten by predators, animals having better camouflage coloration being more likely to survive and bear offspring).

Objective SCI.3.10.1: **Define predator, prey, and camouflage.**
Objective SCI.3.10.2: **Identify ways that plants and animals protect themselves in order to survive and reproduce**
Objective SCI.3.10.3: **Research survival techniques of an organism.**

11. Construct an argument from evidence to explain the likelihood of an organism's ability to survive when compared to the resources in a certain habitat (e.g., freshwater organisms survive well, less well, or not at all in saltwater; desert organisms survive well, less well, or not at all in woodlands).
    a. Construct explanations that forming groups helps some organisms survive.
    b. Create models that illustrate how organisms and their habitats make up a system in which the parts depend on each other.
    c. Categorize resources in various habitats as basic materials (e.g., sunlight, air, freshwater, soil), produced materials (e.g., food, fuel, shelter), or as nonmaterial (e.g., safety, instinct, nature-learned behaviors).

Objective SCI.3.11.1: Determine habitats based on geographic locations.
Objective SCI.3.11.2: Describe characteristics of plants and animals in their different environments.
Objective SCI.3.11.3: Create a model of an animal in its natural habitat (e.g., diorama).
Objective SCI.3.11.4: Create a chart to categorize basic needs to support a habitat.

12. Evaluate engineered solutions to a problem created by environmental changes and any resulting impacts on the types and density of plant and animal populations living in the environment (e.g., replanting of sea oats in coastal areas due to destruction by hurricanes, creating property development restrictions in vacation areas to reduce displacement and loss of native animal populations).*

Objective SCI.3.12.1: Define environmental change, engineered solution, and natural disaster.
Objective SCI.3.12.2: Describe effects of natural disasters (e.g., wildfires, hurricanes, tornados, floods, earthquakes, oil spills, and erosion) on the environment.
Objective SCI.3.12.3: Identify engineered solutions problems created by environmental changes.

Earth's Systems

13. Display data graphically and in tables to describe typical weather conditions expected during a particular season (e.g., average temperature, precipitation, wind direction).

Objective SCI.3.13.1: Define temperature, precipitation, and wind direction.
Objective SCI.3.13.2: Create a graph to show results of data collection.
Objective SCI.3.13.3: Collect temperatures, wind direction and/or precipitation for a given period of time.
Objective SCI.3.13.4: Compare weather patterns of different seasons.
Objective SCI.3.13.5: Analyze data of weather conditions from a particular season.

14. Collect information from a variety of sources to describe climates in different regions of the world.

Objective SCI.3.14.1: Use different resources (e.g., online media, newspapers) to identify weather and climates in various geographic locations.
Objective SCI.3.14.2: Identify diverse climate regions of the world.
Objective SCI.3.14.3: Identify sources of information on climates of the world.

Earth and Human Activity

15. Evaluate a design solution (e.g., flood barriers, wind resistant roofs, lightning rods) that reduces the impact of a weather-related hazard.*

Objective SCI.3.15.1: Define flood barrier, lightning rod, and hazard.
Objective SCI.3.15.2: Provide examples of different types of structures that reduce the effects of weather-related hazards.
Objective SCI.3.15.3: Identify weather related hazards.

GRADE 4

Grade 4 students' view of the natural world includes many scientifically accurate components. They recognize the role of evidence in scientific thinking and are beginning to include evidence in their scientific explanations. Fourth graders enjoy an active learning environment with opportunities to manipulate physical materials and construct models.

Fourth-grade students learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students construct explanations based on evidence connecting the speed of an object to the energy of that object, including the transference of energy in its various forms. They obtain information about sources, uses, and environmental effects of renewable and nonrenewable energy resources. Additionally, fourth-grade students analyze wave patterns with observable wavelengths and amplitudes. In Life Science, students compare the internal and external structures of plants and animals, obtain and communicate information about human body systems, and investigate ways animals process information. In Earth and Space Science, Grade 4 students examine evidence to construct explanations for both slow and rapid changes on Earth's land features, describe patterns of Earth's land and water based on maps, and carry out investigations relating to erosion. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three scientific domains and are denoted with an asterisk (*).

Grade 4 content standards provide students with opportunities for investigation, observation, and explanation of a variety of scientific phenomena. Through participation in specific engineering design projects, they find answers regarding which components of a device change energy from one form to another, how wave patterns can be used to transfer information, and how to limit the effects of harmful natural Earth processes on human life.

Students will:

Energy

1. Use evidence to explain the relationship of the speed of an object to the energy of that object.

   Objective SCI.4.1.1: Define speed and energy.
   Objective SCI.4.1.2: Demonstrate relationship between speed and energy of an object.

2. Plan and carry out investigations that explain transference of energy from place to place by sound, light, heat, and electric currents.
   a. Provide evidence that heat can be produced in many ways (e.g., rubbing hands together, burning leaves) and can move from one object to another by conduction.
   b. Demonstrate that different objects can absorb, reflect, and/or conduct energy.
   c. Demonstrate that electric circuits require a complete loop through which an electric current can pass.

   Objective SCI.4.2.1: Define transference of energy, conduction, electric currents, sound, heat, and light.
   Objective SCI.4.2.2: Identify ways heat can be produced.

3. Investigate to determine changes in energy resulting from increases or decreases in speed that occur when objects collide.

Objective SCI.4.3.1: Record and report results of experimentation when two objects collide.
Objective SCI.4.3.2: Demonstrate what happens when two objects collide.
Objective SCI.4.3.3: Predict what might happen when two objects collide.

4. Design, construct, and test a device that changes energy from one form to another (e.g., electric circuits converting electrical energy into motion, light, or sound energy; a passive solar heater converting light energy into heat energy).*

Objective SCI.4.4.1: Identify devices that change energy from one form to another.
Objective SCI.4.4.2: Identify different forms of energy.

5. Compile information to describe how the use of energy derived from natural renewable and nonrenewable resources affects the environment (e.g., constructing dams to harness energy from water, a renewable resource, while causing a loss of animal habitats; burning of fossil fuels, a nonrenewable resource, while causing an increase in air pollution; installing solar panels to harness energy from the sun, a renewable resource, while requiring specialized materials that necessitate mining).

Objective SCI.4.5.1: Define renewable resources and nonrenewable resources.
Objective SCI.4.5.2: Identify ways humans use renewable and nonrenewable resources to produce energy.
Objective SCI.4.5.3: Give examples of causes and effects that relate to renewable and nonrenewable resources.
Objective SCI.4.5.4: Identify renewable and nonrenewable resources.

Waves and Their Applications in Technologies for Information Transfer

6. Develop a model of waves to describe patterns in terms of amplitude and wavelength, and including that waves can cause objects to move.

Objective SCI.4.6.1: Define waves, amplitude, and wavelength.
Objective SCI.4.6.2: Identify characteristics of different types of waves
Objective SCI.4.6.3: Illustrate amplitude and wavelength on a diagram of a wave.

7. Develop and use models to show multiple solutions in which patterns are used to transfer information (e.g., using a grid of 1s and 0s representing black and white to send information about a picture, using drums to send coded information through sound waves, using Morse code to send a message).*

Objective SCI.4.7.1: Send messages using various methods and patterns.
Objective SCI.4.7.2: Identify various methods and patterns of sending information.

8. Construct a model to explain that an object can be seen when light reflected from its surface enters the eyes.

Objective SCI.4.8.1: Illustrate the presence and absence of light in regard to visible objects.
Objective SCI.4.8.2: Draw and label parts and function of the eye.
Objective SCI.4.8.3: Give examples of how light can be reflected or absorbed.

From Molecules to Organisms: Structures and Processes

9. Examine evidence to support an argument that the internal and external structures of plants (e.g., thorns, leaves, stems, roots, colored petals, xylem, phloem) and animals (e.g., heart, stomach, lung, brain, skin) function to support survival, growth, behavior, and reproduction.

Objective SCI.4.9.1: Identify the internal and external structures of plants.
Objective SCI.4.9.2: Identify the internal and external structures of animals.

10. Obtain and communicate information explaining that humans have systems that interact with one another for digestion, respiration, circulation, excretion, movement, control, coordination, and protection from disease.

Objective SCI.4.10.1: Define digestion, respiration, circulation, and excretion.
Objective SCI.4.10.2: Describe how two systems in the human body that work together.
Objective SCI.4.10.3: Illustrate different types of systems in the human body and their functions.

11. Investigate different ways animals receive information through the senses, process that information, and respond to it in different ways (e.g., skunks lifting tails and spraying an odor when threatened, dogs moving ears when reacting to sound, snakes coiling or striking when sensing vibrations).

Objective SCI.4.11.1: Identify ways animals receive information through their senses.
Objective SCI.4.11.2: Identify ways animals respond to sensory information.
Objective SCI.4.11.3: Compare and contrast how dogs and cats react to external stimuli.

Earth's Systems

12. Construct explanations by citing evidence found in patterns of rock formations and fossils in rock layers that Earth changes over time through both slow and rapid processes (e.g., rock layers containing shell fossils appearing above rock layers containing plant fossils and no shells indicating a change from land to water over time, 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).

Objective SCI.4.12.1: Diagram and label different rock layers in relationship to time.
Objective SCI.4.12.3: Describe the evidence needed to determine that a land mass was once covered by water.
Objective SCI.4.12.2: Identify types of evidence that shows that the earth has changed over time.
Objective SCI.4.12.4: Identify geographic locations on Earth that demonstrate how Earth has changed over time (e.g., glaciers, the Grand Canyon, volcanoes, oxbow lakes).

13. Plan and carry out investigations to examine properties of soils and soil types (e.g., color, texture, capacity to retain water, ability to support growth of plants).

Objective SCI.4.13.1: Experiment to determine which type of soil holds the most water.
Objective SCI.4.13.2: Compare various soil types.
Objective SCI.4.13.3: Identify the properties of soil.

14. Explore information to support the claim that landforms are the result of a combination of constructive forces, including crustal deformation, volcanic eruptions, and sediment deposition as well as a result of destructive forces, including erosion and weathering.

Objective SCI.4.14.1: Define land form, constructive forces, crustal deformations, volcanic eruption, sediment deposition, destructive forces, erosion, and weathering
Objective SCI.4.14.2: Compare the destruction of Pompeii and the construction of the Hawaiian Islands.
Objective SCI.4.14.3: Give examples of constructive and destructive forces.

15. Analyze and interpret data (e.g., angle of slope in downhill movement of water, volume of water flow, cycles of freezing and thawing of water, cycles of heating and cooling of water, speed of wind, relative rate of soil deposition, amount of vegetation) to determine effects of weathering and rate of erosion by water, ice, wind, and vegetation using one single form of weathering or erosion at a time.

Objective SCI.4.15.1: Define weathering, erosion, soil deposition, and water flow.
Objective SCI.4.15.2: Create a model to demonstrate the erosion of soil.
Objective SCI.4.15.3: Identify causes and effects of erosion.
Objective SCI.4.15.4: Describe causes and effects of weathering.
Objective SCI.4.15.5: Identify natural events that cause erosion.

16. Describe patterns of Earth's features on land and in the ocean using data from maps (e.g., topographic maps of Earth's land and ocean floor; maps of locations of mountains, continental boundaries, volcanoes, and earthquakes).

Objective SCI.4.16.1: Identify and label features found on a topographical map.
Objective SCI.4.16.2: Identify land and water components on various maps.
Objective SCI.4.16.3: Locate elements on maps that relate to Earth's features.

17. Formulate and evaluate solutions to limit the effects of natural Earth processes on humans (e.g., designing earthquake, tornado, or hurricane-resistant buildings; improving monitoring of volcanic activity).*

Objective SCI.4.17.1: Construct a model to withstand a simulated natural disaster.
Objective SCI.4.17.2: Describe causes and effects of catastrophic events and/or natural disasters on humans.
Objective SCI.4.17.3: Identify appropriate safety procedures for each type of natural disaster.
Objective SCI.4.17.4: Identify various types of natural disasters.

GRADE 5

Grade 5 students have developed many skills that enable them to conduct more refined measurements of data and communicate scientific information with greater detail through various forms of presentation. They are able to recognize the process needed for planning and carrying out investigations, relate numeric relationships to patterns discovered in data, and identify the role of design solutions to problems occurring in real life. Many fifth graders are emerging scientific thinkers. An encouraging and challenging learning environment can inspire fifth graders to develop a passion for science and engineering.

Fifth-grade students learn disciplinary core ideas from the three scientific domains of Physical, Life, and Earth and Space Sciences while demonstrating their learning in the context of the content standards for this grade level. In Physical Science, students classify matter based on its physical and chemical properties and carry out investigations to provide evidence of the principle of conservation of matter. In Life Science, they develop models to explain the flow of energy and matter in ecosystems, including classifying resources into living and nonliving and classifying organisms into producers, consumers, and decomposers. In Earth and Space Science, students use multiple ways to illustrate the distribution of water on Earth and the interaction of the atmosphere, biosphere, geosphere, and hydrosphere. Students obtain information about ways individuals and communities can protect Earth's resources and environment. Fifth graders find evidence of the gravitational force that pulls all objects downward, evaluate factors that cause some stars to shine more brightly than others, and construct explanations for the patterns of seasons, day and night, and the seasonal changes of stars visible in the sky. The disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain are integrated within the content standards of the three scientific domains and are denoted with an asterisk (*).

Grade 5 content standards provide students with opportunities for investigation, observation, and explanation of a variety of scientific phenomena. Through participation in specific engineering design projects, students find answers regarding which methods can be used to clean a polluted environment and how to modify the speed of a falling object due to gravity.

Students will:

Matter and Its Interactions

1. Plan and carry out investigations (e.g., adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, evaporating salt water) to provide evidence that matter is made of particles too small to be seen.

   Objective SCI.5.1.1: Define microscopic matter.
   Objective SCI.5.1.2: Compare and contrast objects (e.g., empty and filled balloon) to show evidence of matter.
   Objective SCI.5.1.3: Identify matter that exists but cannot be seen (e.g., germs, water molecules, gases).
   Objective SCI.5.1.4: Research media to identify various microscopic forms of matter.

2. Investigate matter to provide mathematical evidence, including graphs, to show that regardless of the type of reaction (e.g., new substance forming due to dissolving or mixing) or change

(e.g., phase change) that occurs when heating, cooling, or mixing substances, the total weight of the matter is conserved.

Objective SCI.5.2.1: Create a graph to show the changes in mass of two substances during a chemical reaction (e.g., baking soda, vinegar).
Objective SCI.5.2.2: Design an investigation to measure the effects of heating and cooling on a substance.
Objective SCI.5.2.3: Measure substances (e.g., sugar, water) before and after combining to show matter is conserved.
Objective SCI.5.2.4: Identify different reactions that can occur when heating, cooling, or mixing substances.

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

Objective SCI.5.3.1: Define conductivity, solubility, density, buoyancy, reflectivity, and thermal conductivity.
Objective SCI.5.3.2: Compare and contrast different materials based on their identified properties.
Objective SCI.5.3.3: Classify substances based on their identified physical properties.
Objective SCI.5.3.4: Identify properties of matter that can be used to identify materials.

4. Investigate whether the mixing of two or more substances results in new substances (e.g., mixing of baking soda and vinegar resulting in the formation of a new substance, gas; mixing of sand and water resulting in no new substance being formed).

Objective SCI.5.4.1: Define physical changes, chemical changes, chemical reaction, solution, and mixture
Objective SCI.5.4.2: Compare and contrast physical and chemical changes.
Objective SCI.5.4.3: Illustrate a chemical and a physical reaction.
Objective SCI.5.4.4: Identify examples of physical and chemical changes.

5. Construct explanations from observations to determine how the density of an object affects whether the object sinks or floats when placed in a liquid.

Objective SCI.5.5.1: Define mass, volume, density, and buoyancy.
Objective SCI.5.5.2: Measure the density of various objects.
Objective SCI.5.5.3: Explore different types of liquid (e.g., salt water, water, oil, shampoo) to determine densities.
Objective SCI.5.5.4: Experiment to determine what types of objects float and which sink when placed in water.

Motion and Stability: Forces and Interactions

6. Construct an explanation from evidence to illustrate that the gravitational force exerted by Earth on objects is directed downward towards the center of Earth.

Objective SCI.5.6.1: Define gravitational force.
Objective SCI.5.6.2: Summarize evidence to show gravitational forces on Earth.

Objective SCI.5.6.3: Experiment to gather evidence to support gravitational pull.
Objective SCI.5.6.4: Observe the force of gravity by dropping various objects.

7. Design and conduct a test to modify the speed of a falling object due to gravity (e.g., constructing a parachute to keep an attached object from breaking).*

Objective SCI.5.7.1: Define speed, friction, and air resistance.
Objective SCI.5.7.2: Create, test, and evaluate a prototype solving the problem of modifying the speed of a falling object due to gravity.
Objective SCI.5.7.3: Record the speed of an object dropped from different heights on a graph.
Objective SCI.5.7.4: Research to develop possible solutions and devise a plan to the problem of modifying the speed of a falling object due to gravity.
Objective SCI.5.7.5: Define a problem to be solved by modifying the speed of a falling object due to gravity.

Earth's Systems

8. Use a model to represent how any two systems, specifically the atmosphere, biosphere, geosphere, and/or hydrosphere, interact and support life (e.g., influence of the ocean on ecosystems, landform shape, and climate; influence of the atmosphere on landforms and ecosystems through weather and climate; influence of mountain ranges on winds and clouds in the atmosphere).

Objective SCI.5.8.1: Define atmosphere, biosphere, geosphere, and hydrosphere.
Objective SCI.5.8.2: Compare two systems to determine how they work together to support life.
Objective SCI.5.8.3: Describe how the atmosphere influences and supports life on Earth.
Objective SCI.5.8.4: Describe how the biosphere influences and supports life on Earth.
Objective SCI.5.8.5: Describe how the geosphere influences and supports life on Earth.
Objective SCI.5.8.6: Describe how the hydrosphere influences and supports life on Earth.
Objective SCI.5.8.7: Identify materials plants and animals obtain from air and water.

9. Identify the distribution of freshwater and salt water on Earth (e.g., oceans, lakes, rivers, glaciers, ground water, polar ice caps) and construct a graphical representation depicting the amounts and percentages found in different reservoirs.

Objective SCI.5.9.1: Define freshwater and salt water.
Objective SCI.5.9.2: Investigate to determine the percentage of fresh and salt water on Earth.
Objective SCI.5.9.3: Identify the location of sources of freshwater on Earth.
Objective SCI.5.9.4: Identify the location of sources of salt water on Earth.

Earth and Human Activity

10. Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment (e.g., terracing land to prevent soil erosion, utilizing no-till farming to improve soil fertility, regulating emissions from factories and automobiles to reduce air pollution, recycling to reduce overuse of landfill areas).

Objective SCI.5.10.1: Define natural resource, environment, terracing, and emissions.
Objective SCI.5.10.2: Identify ways individuals and communities can protect the environment and natural resources.

11. Design solutions, test, and revise a process for cleaning a polluted environment (e.g., simulating an oil spill in the ocean or a flood in a city and creating a solution for containment and/or cleanup).*

Objective SCI.5.11.1: Describe ways used to clean up environmental disasters.
Objective SCI.5.11.2: Identify different types of pollution in the environment.

Ecosystems: Interactions, Energy, and Dynamics

12. Defend the position that plants obtain materials needed for growth primarily from air and water.

Objective SCI.5.12.1: Define photosynthesis.
Objective SCI.5.12.2: Locate the source for elements that plants need to grow (e.g., carbon dioxide is found in the air, H_2O is found in water).
Objective SCI.5.13.3: Identify elements that plants need to grow.

13. Construct an illustration to explain how plants use light energy to convert carbon dioxide and water into a storable fuel, carbohydrates, and a waste product, oxygen, during the process of photosynthesis.

Objective SCI.5.13.1: Define carbohydrates, carbon dioxide, oxygen, and photosynthesis.
Objective SCI.5.13.2: Illustrate the process of photosynthesis. (e.g., through dramatization, use of manipulative objects).
Objective SCI.5.13.3: Identify steps of the photosynthetic process.

14. Construct and interpret models (e.g., diagrams, flow charts) to explain that energy in animals' food is used for body repair, growth, motion, and maintenance of body warmth and was once energy from the sun.

Objective SCI.5.14.1: Define nutrients and food chain.
Objective SCI.5.14.2: Create a visual representation that indicates food consumption tracing back to the sun (e.g., food chain).
Objective SCI.5.14.3: Identify ways an animal's body uses energy.

15. Create a model to illustrate the transfer of matter among producers; consumers, including scavengers and decomposers; and the environment.

Objective SCI.5.15.1: Define scavengers, decomposers, consumers, and producers.
Objective SCI.5.15.2: Construct a food pyramid.
Objective SCI.5.15.3: Categorize plants and animals into producers, consumers, scavengers or decomposers.

Earth's Place in the Universe

16. Defend the claim that one factor determining the apparent brightness of the sun compared to other stars is the relative distance from Earth.

    Objective SCI.5.16.1: Define star, sun, apparent magnitude and absolute magnitude.
    Objective SCI.5.16.2: Investigate to demonstrate the effect distance has on apparent brightness.
    Objective SCI.5.16.3: Research to compare distances between various stars and Earth.
    Objective SCI.5.16.4: Identify the sun as a component of our solar system.

17. Analyze data and represent with graphs 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 (e.g., shadows and the position and motion of Earth with respect to the sun, visibility of select stars only in particular months).

    Objective SCI.5.17.1: Define seasonal pattern and celestial pattern.
    Objective SCI.5.17.2: Use a star chart to demonstrate effects of celestial patterns based on Earth's revolution of the sun.
    Objective SCI.5.17.3: Experiment to demonstrate changes in shadows based on time of day and time of year.
    Objective SCI.5.17.4: Collect and graph shadow data.

GRADES 6-8
Overview

Students in Grades 6-8 develop independent, critical-thinking skills during a time when their bodies experience dramatic emotional changes and their minds shift from concrete to more conceptual thinking. Their curiosity, sense of purpose, and intellectual interests expand and mature. Middle school students are sensitive to peer perception and prefer interaction with peers during learning activities. Students possess multiple learning styles and a wide range of intellectual abilities. Teachers are challenged to incorporate effective instructional strategies using scientific, engineering, and technological practices that meet students' growing needs as individual learners while providing a safe, engaging learning environment.

Earth and Space Science, Life Science, and Physical Science content and skills are best taught through the integration of scientific and engineering practices, crosscutting concepts, and disciplinary core ideas. Students evaluate scientific evidence and engage in data-driven discussions about scientific concepts through peer review and independent verification. Precision and accuracy become more applicable to investigations as students use the International System of Units (SI) and dimensional analysis in their interpretation of empirical data. Students refine their understanding through comparisons, observations, and examinations of information gathered from experiences. By implementing a more rigorous, student-centered curriculum, science teachers enable students to become actively involved in their own learning.

Success in science creates independent, analytical, lifelong learners capable of meeting the needs and challenges of the 21st century. Students learn how scientific knowledge is acquired and how scientific explanations are developed. Through the engineering design process and the use of engineering, technology, and applications of science, students develop their abilities to work in cooperative groups to design solutions to problems encountered in the real world.

GRADE 6
Earth and Space Science

Grade 6 students are energetic and curious. They are maturing at a rapid rate and are in a transitional stage characterized by physical, social, and cognitive changes. The sixth-grade classroom environment addresses these changes by providing a balance between elementary and middle school practices. While these changes lead students toward emotional and academic independence, sixth graders continue to need guidance. They also need an environment that both supports and challenges them as they become more responsible learners.

Content standards challenge students to discover their world, their planet, and Earth's place in the universe. Students are provided opportunities to learn important scientific facts and to build conceptual understanding of scientific principles, laws, and theories. Students must understand and communicate scientific concepts in order to be scientifically literate. Inquiry-based instruction allows them to develop critical-thinking skills and problem-solving abilities needed in the field of science.

Grade 6 content focuses on the disciplinary core ideas in the Earth and Space Science domain. The first Earth and Space Science core idea, Earth's Place in the Universe, describes the universe as a whole and addresses its grand scale in both space and time. The second core idea, Earth's Systems, encompasses the processes that drive Earth's conditions and its continual change over time. The third core idea, Earth and Human Activity, addresses society's interactions with the planet. Integrated within the Earth and Space Science content standards are the disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain, which require students to employ tools and materials to solve problems and to use representations to convey various design solutions. ETS standards are denoted with an asterisk (*).

Students will:

Earth's Place in the Universe

1. Create and manipulate models (e.g., physical, graphical, conceptual) to explain the occurrences of day/night cycles, length of year, seasons, tides, eclipses, and lunar phases based on patterns of the observed motions of celestial bodies.

Objective SCI.6.1.1:	**Define celestial bodies, lunar phases, solar and lunar eclipses, and tides (neap and spring).**
Objective SCI.6.1.2:	**Design a model that depicts the phases of the moon in relation to the position of the sun and Earth during a lunar and solar eclipse.**
Objective SCI.6.1.3:	**Investigate the connection between the phases of the moon and the changes in the tides (neap and spring tide).**
Objective SCI.6.1.4:	**Examine how the position of the moon affects the alternating patterns of rising and falling ocean tides.**
Objective SCI.6.1.5:	**Illustrate the length of the year into four seasons.**
Objective SCI.6.1.6:	**Draw and label a diagram describing the occurrences of day and night cycles.**

2. Construct models and use simulations (e.g., diagrams of the relationship between Earth and man-made satellites, rocket launch, International Space Station, elliptical orbits, black holes, life cycles of stars, orbital periods of objects within the solar system, astronomical units and light years) to explain the role of gravity in affecting the motions of celestial bodies (e.g., planets, moons, comets, asteroids, meteors) within galaxies and the solar system.

Objective SCI.6.2.1: Define elliptical orbits, orbital, astronomical units, light year, asteroids, meteors, galaxy, solar system, black holes, satellite, and comets.
Objective SCI.6.2.2: Describe and illustrate the life cycle of a star.
Objective SCI.6.2.3: Explain the principles that keep a satellite in orbit.
Objective SCI.6.2.4: Predict what would happen to planets if there was no gravity.
Objective SCI.6.2.5: Describe life on the International Space Station.
Objective SCI.6.2.6: Compare and contrast man-made satellites and natural satellites.
Objective SCI.6.2.7: Simulate a meteor strike to observe the changes to Earth's surface.

3. Develop and use models to determine scale properties of objects in the solar system (e.g., scale model representing sizes and distances of the sun, Earth, moon system based on a one-meter diameter sun).

Objective SCI.6.3.1: Define scale model.
Objective SCI.6.3.2: Relate the distance of the celestial bodies in the solar system to local areas.
Objective SCI.6.3.3: Collect the data from a table or graph to determine the distance and size of the planets in our solar system.
Objective SCI.6.3.4: Label an illustration of the solar system.

Earth's Systems

4. Construct explanations from geologic evidence (e.g., change or extinction of particular living organisms; field evidence or representations, including models of geologic cross-sections; sedimentary layering) to identify patterns of Earth's major historical events (e.g., formation of mountain chains and ocean basins, significant volcanic eruptions, fossilization, folding, faulting, igneous intrusion, erosion).

Objective SCI.6.4.1: Define ocean basins, fossilization, folding, faulting, igneous intrusion, and erosion.
Objective SCI.6.4.2: Construct a geological timeline to deduce the relative age of rocks.
Objective SCI.6.4.3: Illustrate the geological layers of Earth including the age of fossils.
Objective SCI.6.4.4: Identify geologic evidence for changes in Earth's surface.

5. Use evidence to explain how different geologic processes shape Earth's history over widely varying scales of space and time (e.g., chemical and physical erosion; tectonic plate processes; volcanic eruptions; meteor impacts; regional geographical features, including Alabama fault lines, Rickwood Caverns, and Wetumpka Impact Crater).

Objective SCI.6.5.1: Define chemical erosion, physical erosion, tectonic plates, and fault lines.
Objective SCI.6.5.2: Simulate a meteor impact to observe changes in Earth's surface.

Objective SCI.6.5.3: Construct a model of a volcano to demonstrate constructive and destructive influences of Earth's surface.
Objective SCI.6.5.4: Use gathered evidence to support geological processes that have changed the surface of Earth.
Objective SCI.6.7.5: Identify processes that change Earth's surface.

6. Provide evidence from data of the distribution of fossils and rocks, continental shapes, and seafloor structures to explain past plate motions.

Objective SCI.6.6.1: Define sea-floor structures: continental shelf, trench, ridges, ocean basins, vents, continental drift, Pangea, and sea-floor spreading.
Objective SCI.6.6.2: Identify evidence from fossils, rock layers, climate, and land forms that support plate movement.
Objective SCI.6.6.3: Create a model to demonstrate how the continents fit together like a puzzle.
Objective SCI.6.6.4: Demonstrate how the continents fit together like a puzzle to support the theory of Pangea.

7. Use models to construct explanations of the various biogeochemical cycles of Earth (e.g., water, carbon, nitrogen) and the flow of energy that drives these processes.

Objective SCI.6.7.1: Define biogeochemical cycles, nitrogen cycle, and carbon cycle.
Objective SCI.6.7.2: Describe how various biogeochemical cycles are interrelated.
Objective SCI.6.7.3: Draw and label a diagram of the water cycle.
Objective SCI.6.7.4: Draw and label a diagram of the carbon cycle.
Objective SCI.6.7.5: Draw and label a diagram of the nitrogen cycle.

8. Plan and carry out investigations that demonstrate the chemical and physical processes that form rocks and cycle Earth's materials (e.g., processes of crystallization, heating and cooling, weathering, deformation, and sedimentation).

Objective SCI.6.8.1: Define crystallization, weathering, deformation, sedimentation, chemical weathering, physical weathering, constructive forces, destructive force, and igneous rock, sedimentary rock, and metamorphic rock.
Objective SCI.6.8.2: Demonstrate the causes and effects of chemical and physical weathering.
Objective SCI.6.8.3: Differentiate between igneous, sedimentary, and metamorphic rocks in relation to their formation within the Earth.
Objective SCI.6.8.4: Compare and contrast chemical and physical weathering.
Objective SCI.6.8.5: Create crystals to demonstrate how its process fits into the cycling of Earth's materials and flow of energy.
Objective SCI.6.8.6: Identify igneous, sedimentary, and metamorphic rocks.

9. Use models to explain how the flow of Earth's internal energy drives a cycling of matter between Earth's surface and deep interior causing plate movements (e.g., mid-ocean ridges, ocean trenches, volcanoes, earthquakes, mountains, rift valleys, volcanic islands).

Objective SCI.6.9.1: Define mid-ocean ridges, ocean trenches, rift valleys, volcanic hot spots, convection currents, convergent boundaries, divergent boundaries, and transform faults.

Objective SCI.6.9.2: Demonstrate convection currents within Earth.
Objective SCI.6.9.3: Compare and contrast causes and effects of earthquakes in relation to types of boundaries (e. g. convergent and divergent boundaries and transform faults).
Objective SCI.6.9.4: Draw diagrams of the different types of volcanoes.
Objective SCI.6.9.5: Demonstrate a volcanic eruption.
Objective SCI.6.9.6: Illustrate Earth's internal structures.

10. Use research-based evidence to propose a scientific explanation regarding how the distribution of Earth's resources such as minerals, fossil fuels, and groundwater are the result of ongoing geoscience processes (e.g., past volcanic and hydrothermal activity, burial of organic sediments, active weathering of rock).

Objective SCI.6.10.1: Define geoscience processes, minerals, fossil fuels, hydrothermal energy, and geothermal energy.
Objective SCI.6.10.2: Research examples of geothermal energy and hydrothermal activity.
Objective SCI.6.10.3: Identify causes and effects of geoscience processes that alter Earth's surface.
Objective SCI.6.10.4: Identify matter released by volcanoes.
Objective SCI.6.10.5: Identify types of fossil fuels and minerals.

11. Develop and use models of Earth's interior composition to illustrate the resulting magnetic field (e.g., magnetic poles) and to explain its measureable effects (e.g., protection from cosmic radiation).

Objective SCI.6.11.1: Define magnetic fields, magnetic poles, and cosmic radiation.
Objective SCI.6.11.2: Create a model of Earth's interior.
Objective SCI.6.11.3: Explain how magnetic fields protect Earth from cosmic radiation.
Objective SCI.6.11.4: Identify patterns of Earth's magnetic poles.
Objective SCI.6.11.5: Experiment with magnets to identify a magnetic field.

12. Integrate qualitative scientific and technical information (e.g., weather maps; diagrams; other visualizations, including radar and computer simulations) to support the claim that motions and complex interactions of air masses result in changes in weather conditions.
    a. Use various instruments (e.g., thermometers, barometers, anemometers, wet bulbs) to monitor local weather and examine weather patterns to predict various weather events, especially the impact of severe weather (e.g., fronts, hurricanes, tornados, blizzards, ice storms, droughts).

Objective SCI.6.12.1: Define radar, air masses, thermometers, barometers, anemometers, wet bulbs, quantitative, qualitative, convection currents, and fronts.
Objective SCI.6.12.2: Predict the climate of an area through weather patterns.
Objective SCI.6.12.3: Explain the effect air pressure has on weather conditions.
Objective SCI.6.12.4: Design and present a weather report.
Objective SCI.6.12.5: Create a weather diary.

Objective SCI.6.12.6: Differentiate between a hurricane, a typhoon, cyclone, and a tornado.
Objective SCI.6.12.7: Identify and use various instruments to measure weather.
Objective SCI.6.12.8: Identify types of winter storms.

13. Use models (e.g., diagrams, maps, globes, digital representations) to explain how the rotation of Earth and unequal heating of its surface create patterns of atmospheric and oceanic circulation that determine regional climates.
    a. Use experiments to investigate how energy from the sun is distributed between Earth's surface and its atmosphere by convection and radiation (e.g., warmer water in a pan rising as cooler water sinks, warming one's hands by a campfire).

Objective SCI.6.13.1: Define convection, Coriolis Effect and radiation.
Objective SCI.6.13.2: Demonstrate convection currents and radiation.
Objective SCI.6.13.3: Develop a diagram to show the uneven heating of Earth's surface.
Objective SCI.6.13.4: Correlate the effect of ocean currents on weather patterns.
Objective SCI.6.13.5: Identify examples of radiations and convection currents.

14. Analyze and interpret data (e.g., tables, graphs, maps of global and regional temperatures; atmospheric levels of gases such as carbon dioxide and methane; rates of human activities) to describe how various human activities (e.g., use of fossil fuels, creation of urban heat islands, agricultural practices) and natural processes (e.g., solar radiation, greenhouse effect, volcanic activity) may cause changes in local and global temperatures over time.

Objective SCI.6.14.1: Define greenhouse gases, greenhouse effect, urban heat islands, and solar radiation.
Objective SCI.6.14.2: Research a carbon footprint.
Objective SCI.6.14.3: Interpret a chart on elevation, average yearly temperature, and rainfall.
Objective SCI.6.14.4: Identify natural processes that impact weather patterns in a particular climate.
Objective SCI.6.14.5: Infer the effect of elevation on temperature using climate data.

Earth and Human Activity

15. Analyze evidence (e.g., databases on human populations, rates of consumption of food and other natural resources) to explain how changes in human population, per capita consumption of natural resources, and other human activities (e.g., land use, resource development, water and air pollution, urbanization) affect Earth's systems.

Objective SCI.6.15.1: Define urbanization and per capita consumption.
Objective SCI.6.15.2: Describe causes and effects of pollution on an organism.
Objective SCI.6.15.3: Research the impact of human activity on an ecosystem.
Objective SCI.6.15.4: Illustrate the impact on natural resources in the environment based on population growth.
Objective SCI.6.15.5: Identify renewable and nonrenewable natural resources.

16. Implement scientific principles to design processes for monitoring and minimizing human impact on the environment (e.g., water usage, including withdrawal of water from streams and aquifers or construction of dams and levees; land usage, including urban development, agriculture, or removal of wetlands; pollution of air, water, and land).*

Objective SCI.6.16.1: Define aquifers, aeration, and levees.
Objective SCI.6.16.2: Create a water filter.
Objective SCI.6.16.3: Investigate different methods of aeration and filtering to remove pollutants from water.
Objective SCI.6.16.4: Describe causes and effects of the human impact on the environment, (e.g. Horizon Oil Spill on the Gulf of Mexico).
Objective SCI.6.16.5: Identify ways humans impact the environment.
Objective SCI.6.16.6: Identify types of water filtration systems.

GRADE 7
Life Science

Seventh-grade students experience a wide range of physical and psychological changes during this stage of development where peer perception and social interactions play major roles in life and learning. As students mature and become more independent, their sense of curiosity and discovery must be fostered as they are encouraged to develop the self-discipline necessary for mastery of concepts at a higher level.

A variety of instructional strategies and techniques is essential for guiding students in Grade 7. Teachers must provide opportunities for students to communicate and interact with peers in a collaborative setting to develop explanations and design solutions to real-world problems using scientific concepts and processes. At this stage where learning progresses from concrete to abstract and from knowledge to applications in science, the method of cooperative learning provides an excellent strategy for instruction and a unique opportunity for teachers to capitalize on students' need for peer interaction.

Individual content standards are organized according to the disciplinary core ideas in the Life Science domain. The first Life Science core idea, From Molecules to Organisms: Structures and Processes, concentrates on the structure and function of cells and their connections to organs and organ systems. The second core idea, Ecosystems: Interactions, Energy, and Dynamics, investigates the interactions between living organisms and between biotic and abiotic factors. The third core idea, Heredity: Inheritance and Variation of Traits, centers on explaining genetic variations, describing the results of genetic mutations, and evaluating impacts of genetic technologies. The fourth core idea, Unity and Diversity, examines the patterns of change in populations of organisms over a long period of time and the relationship between natural selection and the reproduction and survival of a population. The Engineering, Technology, and Applications of Science (ETS) domain may be integrated within the Life Science content standards. The ETS domain requires students to use tools and materials to solve problems and to use representations to convey various design solutions.

Students will:

From Molecules to Organisms: Structures and Processes

1. Engage in argument from evidence to support claims of the cell theory.

   Objective SCI.7.1.1: Define cell theory.
   Objective SCI.7.1.2: Differentiate between living and nonliving materials.
   Objective SCI.7.1.3: Research evidence to support or refute the cell theory.
   Objective SCI.7.1.4: Explain the components of the cell theory.
   Objective SCI.7.1.5: Identify the components of the cell theory.

2. Gather and synthesize information to explain how prokaryotic and eukaryotic cells differ in structure and function, including the methods of asexual and sexual reproduction.

   Objective SCI.7.2.1: Define prokaryotic, eukaryotic, sexual reproduction and asexual reproduction.
   Objective SCI.7.2.2: Differentiate between prokaryotic and eukaryotic cells.
   Objective SCI.7.2.3: Compare and contrast sexual reproduction and asexual reproduction.

Objective SCI.7.2.4: Illustrate a prokaryotic and eukaryotic cell.
Objective SCI.7.2.5: Identify a prokaryotic and eukaryotic cell.

3. Construct an explanation of the function (e.g., mitochondria releasing energy during cellular respiration) of specific cell structures (i.e., nucleus, cell membrane, cell wall, ribosomes, mitochondria, chloroplasts, and vacuoles) for maintaining a stable environment.

Objective SCI.7.3.1:	**Define homeostasis, mitochondria, cellular respiration, nucleus, ribosomes, chloroplast, and vacuoles.**
Objective SCI.7.3.2:	**Create a model representing each organelle in a plant and animal cell.**
Objective SCI.7.3.3:	**Describe the role of each organelle in maintaining a stable environment.**
Objective SCI.7.3.4:	**Identify in sequence the levels of organization of an organism from cells through organ systems.**
Objective SCI.7.3.5:	**Identify the form and function of cell structures.**

4. Construct models and representations of organ systems (e.g., circulatory, digestive, respiratory, muscular, skeletal, nervous) to demonstrate how multiple interacting organs and systems work together to accomplish specific functions.

Objective SCI.7.4.1:	**Research how a failure of one system affects the whole organism.**
Objective SCI.7.4.2:	**Explain how each organ system interacts with other organ systems.**
Objective SCI.7.4.3:	**Draw and label the organs of each body system.**
Objective SCI.7.4.4:	**Identify the characteristics and function of each body system.**

Ecosystems: Interactions, Energy, and Dynamics

5. Examine the cycling of matter between abiotic and biotic parts of ecosystems to explain the flow of energy and the conservation of matter.
   a. Obtain, evaluate, and communicate information about how food is broken down through chemical reactions to create new molecules that support growth and/or release energy as it moves through an organism.
   b. Generate a scientific explanation based on evidence for the role of photosynthesis and cellular respiration in the cycling of matter and flow of energy into and out of organisms.

Objective SCI.7.5.1:	**Define photosynthesis, ecosystem, respiration, molecules, organism, abiotic, and biotic.**
Objective SCI.7.5.2:	**Explain the role of photosynthesis and respiration in the symbiotic relationship between plants and animals.**
Objective SCI.7.5.3:	**Summarize how energy transfer occurs during photosynthesis and cellular respiration.**
Objective SCI.7.5.4:	**Compare and contrast abiotic and biotic.**
Objective SCI.7.5.5:	**Identify the relationship between photosynthesis and respiration.**

6. Analyze and interpret data to provide evidence regarding how resource availability impacts individual organisms as well as populations of organisms within an ecosystem.

Objective SCI.7.6.1: Define ecosystem, population, and organism.
Objective SCI.7.6.2: Create a model of a food web.
Objective SCI.7.6.3: Describe types of interactions between organisms.
Objective SCI.7.6.4: Describe an ecosystem and its components.
Objective SCI.7.6.5: Identify evidence that shows the decline of a species.

7. Use empirical evidence from patterns and data to demonstrate how changes to physical or biological components of an ecosystem (e.g., deforestation, succession, drought, fire, disease, human activities, invasive species) can lead to shifts in populations.

Objective SCI.7.7.1: Define empirical, patterns, biological, deforestation, succession, drought, invasive populations, and ecosystem.
Objective SCI.7.7.2: Research causes and effects of deforestation.
Objective SCI.7.7.3: Identify causes and effects of fire on an ecosystem.
Objective SCI.7.7.4: Identify the impact of invasive species in Alabama.

8. Construct an explanation to predict patterns of interactions in different ecosystems in terms of the relationships between and among organisms (e.g., competition, predation, mutualism, commensalism, parasitism).

Objective SCI.7.8.1: Define ecosystem, competition, predation, mutualism, commensalism, and parasitism.
Objective SCI.7.8.2: Explain what happens when competition enters an ecosystem.
Objective SCI.7.8.3: Compare and contrast mutualism, commensalism, and parasitism.
Objective SCI.7.8.4: Identify relationships among organisms (e.g. competition, predation, mutualism, commensalism, and parasitism).

9. Engage in argument to defend the effectiveness of a design solution that maintains biodiversity and ecosystem services (e.g., using scientific, economic, and social considerations regarding purifying water, recycling nutrients, preventing soil erosion).

Objective SCI.7.9.1: Define biodiversity, ecosystem, purify, recycle, and erosion.
Objective SCI.7.9.2: Investigate various agricultural techniques that promote soil conservation (e.g. composting, replanting, alternating crops, and no-till farming).
Objective SCI.7.9.3: Research methods that prevent soil erosion.
Objective SCI.7.9.4: Identify ways agriculture impacts the local economy.

10. Use evidence and scientific reasoning to explain how characteristic animal behaviors (e.g., building nests to protect young from cold, herding to protect young from predators, attracting mates for breeding by producing special sounds and displaying colorful plumage, transferring pollen or seeds to create conditions for seed germination and growth) and specialized plant structures (e.g., flower brightness, nectar, and odor attracting birds that transfer pollen; hard outer shells on seeds providing protection prior to germination) affect the probability of successful reproduction of both animals and plants.

Objective SCI.7.10.1: Define predator, plumage, germination, specialized, probability, innate, and learned behaviors.

Objective SCI.7.10.2: Compare and contrast the male and female characteristics of animals (e.g., size, color, camouflage, nurturing, and food consumed).
Objective SCI.7.10.3: Describe how seeds are dispersed.
Objective SCI.7.10.4: Identify how plants reproduce.
Objective SCI.7.10.5: Identify how animals reproduce.

11. Analyze and interpret data to predict how environmental conditions (e.g., weather, availability of nutrients, location) and genetic factors (e.g., selective breeding of cattle or crops) influence the growth of organisms (e.g., drought decreasing plant growth, adequate supply of nutrients for maintaining normal plant growth, identical plant seeds growing at different rates in different weather conditions, fish growing larger in large ponds than in small ponds).

Objective SCI.7.11.1: Define genetic, selective breeding, drought, and adequate.
Objective SCI.7.11.2: Explain the effects of selective breeding on plants and animals.
Objective SCI.7.11.3: Interpret charts and graphs to predict environmental conditions in a certain location.
Objective SCI.7.11.4: Describe causes and effects of environmental conditions on plants and animals.
Objective SCI.7.11.5: Identify causes and effects of selective breeding on plants or animals.

Heredity: Inheritance and Variation of Traits

12. Construct and use models (e.g., monohybrid crosses using Punnett squares, diagrams, simulations) to explain that genetic variations between parent and offspring (e.g., different alleles, mutations) occur as a result of genetic differences in randomly inherited genes located on chromosomes and that additional variations may arise from alteration of genetic information.

Objective SCI.7.12.1: Define monohybrid, Punnett Square, mitosis, meiosis, simulation, genetic, variation, allele, mutation, chromosome, alteration, phenotype, genotype, homozygous, and heterozygous.
Objective SCI.7.12.2: Complete a Punnett square to predict the outcome of offspring.
Objective SCI.7.12.3: Explain how mutations cause variations in the development of an organism.
Objective SCI.7.12.4: Compare and contrast the process of mitosis and meiosis.
Objective SCI.7.12.5: Describe how randomly inherited genes are influenced by the process of meiosis.
Objective SCI.7.12.6: Identify common chromosomal abnormalities.

13. Construct an explanation from evidence to describe how genetic mutations result in harmful, beneficial, or neutral effects to the structure and function of an organism.

Objective SCI.7.13.1: Define traits, genetic, mutation, and beneficial.
Objective SCI.7.13.2: Illustrate a pedigree of a family tree.
Objective SCI.7.13.3: Identify genetic similarities and differences in offspring.

14. Gather and synthesize information regarding the impact of technologies (e.g., hand pollination, selective breeding, genetic engineering, genetic modification, gene therapy) on the inheritance and/or appearance of desired traits in organisms.

Objective SCI.7.14.1: Define pollination, selective breeding, genetic engineering, genetic modification, gene theory, inheritance, and traits.
Objective SCI.7.14.2: Describe the impact of technology on genetic engineering of various organisms.
Objective SCI.7.14.3: Identify technologies used to develop desired traits within an organism.

Unity and Diversity

15. Analyze and interpret data for patterns of change in anatomical structures of organisms using the fossil record and the chronological order of fossil appearance in rock layers.

Objective SCI.7.15.1: Define anatomical structure, fossil record, and chronological order.
Objective SCI.7.15.2: Illustrate anatomical changes in structures of an organism over time (e.g., cladogram).
Objective SCI.7.15.3: Identify, from fossil records, patterns of evidence that describe anatomical structure changes over time.

16. Construct an explanation based on evidence (e.g., cladogram, phylogenetic tree) for the anatomical similarities and differences among modern organisms and between modern and fossil organisms, including living fossils (e.g., alligator, horseshoe crab, nautilus, coelacanth).

Objective SCI.7.16.1: Define cladogram, phylogenetic tree, anatomical, nautilus, and coelacanth.
Objective SCI.7.16.2: Classify organisms using a phylogenetic tree.
Objective SCI.7.16.3: Compare fossils and modern organisms.
Objective SCI.7.16.4: Identify various types of fossils.

17. Obtain and evaluate pictorial data to compare patterns in the embryological development across multiple species to identify relationships not evident in the adult anatomy.

Objective SCI.7.17.1: Define pictorial data, embryology, and species.
Objective SCI.7.17.2: Compare and contrast the embryological development of various organisms.
Objective SCI.7.17.3: Illustrate the process of embryological development of a species.
Objective SCI.7.17.4: Identify each step in the process of metamorphosis.

18. Construct an explanation from evidence that natural selection acting over generations may lead to the predominance of certain traits that support successful survival and reproduction of a population and to the suppression of other traits.

Objective SCI.7.18.1: Define natural selection, predominance, traits, survival, and suppression.
Objective SCI.7.18.2: Create a historical timeline of changes in an organism.
Objective SCI.7.18.4: Predict changes in a species through natural selection.
Objective SCI.7.18.4: Identify species that have changed over time.

GRADE 8
Physical Science

Students in eighth grade exhibit a wide range of learning styles and intellectual abilities. This diversity in development requires the implementation of a science curriculum that engages students in scientific inquiry. The classroom environment must provide opportunities for students to identify problems, ask questions, make observations, design solutions, and explore important scientific concepts through investigations. As students' curiosity and creativity flourish, teachers must design activities that encourage students to construct explanations based upon their own experiences and to use their creative abilities to devise solutions to real-world problems. Students engage in higher-level, abstract-thinking processes as they make connections between and among disciplines and become well-grounded in experiences. Students work in a variety of groups that foster collaboration among peers.

Grade 8 content standards are based upon the disciplinary core ideas in the Physical Science domain. The first core idea, Matter and Its Interactions, concentrates on the composition and properties of matter. The second core idea, Motion and Stability: Forces and Interactions, focuses on examining forces and predicting and developing explanations for changes in motion. The third core idea, Energy, involves the conservation of energy, energy transformations, and applications of energy to everyday life. The final core idea, Waves and Their Applications in Technologies for Information Transfer, examines types and properties of waves and the use of waves in communication devices. Integrated into the Physical Science content standards are the disciplinary core ideas of the Engineering, Technology, and Applications of Science (ETS) domain, which require students to employ tools and materials to solve problems and to use representations to convey various design solutions. ETS standards are denoted with an asterisk (*).

Students will:

Matter and Its Interactions

1. Analyze patterns within the periodic table to construct models (e.g., molecular-level models, including drawings; computer representations) that illustrate the structure, composition, and characteristics of atoms and molecules.

   Objective SCI.8.1.1: Define atom, molecule, protons, neutrons, electrons, atomic mass, atomic number, and periodic table.
   Objective SCI.8.1.2: Construct a model of an atom.
   Objective SCI.8.1.3: Diagram the parts of an atom.
   Objective SCI.8.1.4: Describe the patterns of the periodic table.
   Objective SCI.8.1.5: Identify the components of the periodic table.
   Objective SCI.8.1.6: Identify the parts of an atom.

2. Plan and carry out investigations to generate evidence supporting the claim that one pure substance can be distinguished from another based on characteristic properties.

   Objective SCI.8.2.1: Define pure substance.
   Objective SCI.8.2.2: Compare and contrast various pure substances.
   Objective SCI.8.2.3: Identify the characteristics of a pure substances.

3. Construct explanations based on evidence from investigations to differentiate among compounds, mixtures, and solutions.
    a. Collect and analyze information to illustrate how synthetic materials (e.g., medicine, food additives, alternative fuels, plastics) are derived from natural resources and how they impact society.

Objective SCI.8.3.1: Define synthetic, compound, solution, derived, homogeneous mixture, heterogeneous, and natural resources.
Objective SCI.8.3.2 Research how natural resources are used to make synthetic materials.
Objective SCI.8.3.3: Describe how the production and use of synthetic materials impact the environment.
Objective SCI.8.3.4: Identify the characteristics of compounds.
Objective SCI.8.3.5: Identify the characteristics of solution.
Objective SCI.8.3.6: Identify the characteristics of mixtures.

4. Design and conduct an experiment to determine changes in particle motion, temperature, and state of a pure substance when thermal energy is added to or removed from a system.

Objective SCI.8.4.1: Define particle motion, pure substance, and thermal energy.
Objective SCI.8.4.2: Describe the particle motion of substances when heated.
Objective SCI.8.4.3: Draw a diagram showing the particle motion in a solids, liquids, and gases.
Objective SCI.8.4.4: Identify the differences in solids, liquids, and gases.

5. Observe and analyze characteristic properties of substances (e.g., odor, density, solubility, flammability, melting point, boiling point) before and after the substances combine to determine if a chemical reaction has occurred.

Objective SCI.8.5.1: Define reactant, product, substances, odor, density, solubility, flammability, melting point, and boiling point, chemical reaction, and physical change.
Objective SCI.8.5.2: Observe and record physical and chemical changes of a substance during a chemical reaction.
Objective SCI.8.5.3: Describe the properties of a substance.
Objective SCI.8.5.4: Identify the reactants and products of a chemical reaction.

6. Create a model, diagram, or digital simulation to describe conservation of mass in a chemical reaction and explain the resulting differences between products and reactants.

Objective SCI.8.6.1: Define reactant, product, chemical reaction, conservation, and digital simulation.
Objective SCI.8.6.2: Balance a chemical equation.
Objective SCI.8.6.3: Describe the conservation of mass.
Objective SCI.8.6.4: Identify types of chemical reactions.
Objective SCI.8.6.5: Identify the reactant in a chemical reaction.
Objective SCI.8.6.6: Identify the product in a chemical reaction.

7. Design, construct, and test a device (e.g., glow stick, hand warmer, hot or cold pack, thermal wrap) that either releases or absorbs thermal energy by chemical reactions (e.g., dissolving ammonium chloride or calcium chloride in water) and modify the device as needed based on criteria (e.g., amount/concentration, time, temperature).*

Objective SCI.8.7.1: Define thermal energy, concentration, endothermic, and exothermic reaction.
Objective SCI.8.7.2: Determine the change in temperature during a chemical reaction.
Objective SCI.8.7.3: Analyze data on the rate of a chemical reaction.
Objective SCI.8.7.4: Describe factors that affect the rate of reaction.
Objective SCI.8.7.5: Identify elements that affect a chemical reaction.

Motion and Stability: Forces and Interactions

8. Use Newton's first law to demonstrate and explain that an object is either at rest or moves at a constant velocity unless acted upon by an external force (e.g., model car on a table remaining motionless until pushed).

Objective SCI.8.8.1: Define inertia, constant velocity, and external force.
Objective SCI.8.8.2: Demonstrate Newton's first law of motion.
Objective SCI.8.8.3: Calculate the force of inertia.
Objective SCI.8.8.4: Explain effects of Newton's first law of motion on real-life experiences.
Objective SCI.8.8.5: Identify Newton's first law of motion.

9. Use Newton's second law to demonstrate and explain how changes in an object's motion depend on the sum of the external forces on the object and the mass of the object (e.g., billiard balls moving when hit with a cue stick).

Objective SCI.8.9.1: Define external forces and mass.
Objective SCI.8.9.2: Demonstrate Newton's second law of motion.
Objective SCI.8.9.3: Calculate the amount of force required to move various objects of different masses.
Objective SCI.8.9.4: Explain the effects of Newton's second law of motion on real-life experiences.
Objective SCI.8.9.5: Identify Newton's second law of motion.

10. Use Newton's third law to design a model to demonstrate and explain the resulting motion of two colliding objects (e.g., two cars bumping into each other, a hammer hitting a nail).*

Objective SCI.8.10.1: Define external forces, and mass.
Objective SCI.8.10.2: Demonstrate Newton's third law of motion.
Objective SCI.8.10.3: Explain the effects of Newton's third law of motion on real-life experiences.
Objective SCI.8.10.4: Identify Newton's third law of motion.

11. Plan and carry out investigations to evaluate how various factors (e.g., electric force produced between two charged objects at various positions; magnetic force produced by an electromagnet

with varying number of wire turns, varying number or size of dry cells, and varying size of iron core) affect the strength of electric and magnetic forces.

Objective SCI.8.11.1: Define electric force, charged objects, magnetic force, dry cell, wet cell, iron core, and electromagnet.
Objective SCI.8.11.2: Explain how an electromagnet works.
Objective SCI.8.11.3: Describe the strength of electromagnetic forces using various designs.
Objective SCI.8.11.4: Record and analyze data from experiments using electromagnets.
Objective SCI.8.11.5: Identify the characteristics of electric forces.
Objective SCI.8.11.6: Identify the characteristics of magnetic forces.

12. Construct an argument from evidence explaining that fields exist between objects exerting forces on each other (e.g., interactions of magnets, electrically charged strips of tape, electrically charged pith balls, gravitational pull of the moon creating tides) even when the objects are not in contact.

Objective SCI.8.12.1: Define pith ball, gravitational pull, tides, magnetic field, North Pole, South Pole, and force.
Objective SCI.8.12.2: Demonstrate the forces of a magnetic fields.
Objective SCI.8.12.3: Demonstrate the relationship between the mass of an object and its gravitational pull.
Objective SCI.8.12.4: Identify the north and south poles of a magnet.

Energy

13. Create and analyze graphical displays of data to illustrate the relationships of kinetic energy to the mass and speed of an object (e.g., riding a bicycle at different speeds, hitting a table tennis ball versus a golf ball, rolling similar toy cars with different masses down an incline).

Objective SCI.8.13.1: Define kinetic energy and mass.
Objective SCI.8.13.2: Illustrate the relationship of kinetic energy to the mass and speed of an object.
Objective SCI.8.13.3: Analyze a graph for the relationship between mass and speed of various object.
Objective SCI.8.13.4: Identify examples of kinetic energy.

14. Use models to construct an explanation of how a system of objects may contain varying types and amounts of potential energy (e.g., observing the movement of a roller coaster cart at various inclines, changing the tension in a rubber band, varying the number of batteries connected in a series, observing a balloon with static electrical charge being brought closer to a classmate's hair).

Objective SCI.8.14.1: Define potential energy.
Objective SCI.8.14.2: Calculate the amount of potential energy based on an object's position.
Objective SCI.8.14.3: Describe common uses for potential energy in the environment.
Objective SCI.8.14.4: Identify potential energy.

15. Analyze and interpret data from experiments to determine how various factors affect energy transfer as measured by temperature (e.g., comparing final water temperatures after different masses of ice melt in the same volume of water with the same initial temperature, observing the temperature change of samples of different materials with the same mass and the same material with different masses when adding a specific amount of energy).

Objective SCI.8.15.1: Define energy transfer, conductors, insulators, conduction, convection, and radiation.
Objective SCI.8.15.2: Determine the effects of changes in temperature on various materials with the same mass.
Objective SCI.8.15.3: Analyze and interpret data on heating various objects.
Objective SCI.8.15.4: Compare and contrast how conductors and insulators affect the transfer of energy.
Objective SCI.8.15.5: Identify examples of heat transfer.

16. Apply the law of conservation of energy to develop arguments supporting the claim that when the kinetic energy of an object changes, energy is transferred to or from the object (e.g., bowling ball hitting pins, brakes being applied to a car).

Objective SCI.8.16.1: Define kinetic energy, mass, and the law of conservation of energy.
Objective SCI.8.16.2: Demonstrate the transfer of kinetic energy.
Objective SCI.8.16.3: Predict patterns between mass and kinetic energy.
Objective SCI.8.16.4: Identify different forms of kinetic energy.

Waves and Their Applications in Technologies for Information Transfer

17. Create and manipulate a model of a simple wave to predict and describe the relationships between wave properties (e.g., frequency, amplitude, wavelength) and energy.
    a. Analyze and interpret data to illustrate an electromagnetic spectrum.

Objective SCI.8.17.1: Define frequency, amplitude, wavelength, longitudinal, transverse, electromagnetic wave, and electromagnetic spectrum.
Objective SCI.8.17.2: Measure the amplitude, wavelength, and frequency of a wave.
Objective SCI.8.17.3: Diagram the electromagnetic spectrum.
Objective SCI.8.17.4: Simulate a longitudinal and transverse wave.
Objective SCI.8.17.5: Draw and label the parts of a wave.
Objective SCI.8.17.6: Identify different types of waves.

18. Use models to demonstrate how light and sound waves differ in how they are absorbed, reflected, and transmitted through different types of media.

Objective SCI.8.18.1: Define absorbed, reflected, transmitted, amplitude, wavelength, frequency, media, sound waves, and electromagnetic waves.
Objective SCI.8.18.2: Compare and contrast properties of light waves and sound waves.
Objective SCI.8.18.3: Describe how sound waves are absorbed, reflected, and transmitted through different media.
Objective SCI.8.18.4: Describe how light waves are absorbed, reflected, and transmitted through different media.
Objective SCI.8.18.5: Identify light waves.
Objective SCI.8.18.6: Identify sound waves.

19. Integrate qualitative information to explain that common communication devices (e.g., cellular telephones, radios, remote controls, Wi-Fi components, global positioning systems [GPS], wireless technology components) use electromagnetic waves to encode and transmit information.

Objective SCI.8.19.1: Define encode, transmit, and electromagnetic waves.
Objective SCI.8.19.2: Explain how electromagnetic waves are used.
Objective SCI.8.19.3: Research the technology utilized in various communication devices.
Objective SCI.8.19.4: Illustrate how electromagnetic waves are transmitted.
Objective SCI.8.19.5: Identify communication devices.

GRADES 9-12
Overview

The high school science curriculum provides essential preparation for college and career readiness for all students in Grades 9-12. The courses are designed to enable students to attain scientific literacy of the disciplinary core ideas by engaging in science and engineering practices through increased rigor and sophistication to deepen their understanding of science content. By the end of high school, students should have an adequate scientific background to be active, informed citizens and to succeed in both the workplace and in postsecondary courses. Student expectations include the ability to formulate and pose scientific inquiries that establish what is known and what still needs to be understood, to conduct investigations based on well-developed hypotheses, to construct models to explain abstract concepts, to use appropriate tools to obtain numerical measurements that explain mathematical relationships, and to formulate their own explanations of scientific phenomena and be able to use these in problem solving. Finally, students should be able to obtain, assess, and communicate knowledge from scientific literature and construct and engage in evidence-based arguments.

The instructional environment of the science classroom should be student-centered, allowing individuals to participate in inquiry-based learning. All science courses in Grades 9-12 should include a laboratory-based component that encourages students to apply investigation and reasoning skills to develop explanations and propose solutions. Conceptual learning should be supported by computational and graphical representations, and students should be able to apply data analysis techniques, including calculating quantities involving significant figures, writing numbers in standard form and scientific notation, using the International System of Units (SI) as a form of measurement, and performing dimensional analysis. Teachers should incorporate literacy strategies (Appendix B) within the curriculum, including research using credible scientific sources and laboratory reports.

The 2015 *Alabama Course of Study: Science* contains the minimum required content for the Grades 9-12 courses of Physical Science, Biology, Chemistry, Physics, Human Anatomy and Physiology, Earth and Space Science, and Environmental Science. Content standards are integrated with scientific and engineering practices as well as crosscutting concepts that connect the knowledge discovered through observation of the natural world with concentrated themes that permeate throughout all science and engineering domains. This course of study specifies the required minimum subject content in a manner intended to balance a need for rigor in course offerings and consistency statewide with the need for flexibility in designing local course offerings. School systems are encouraged to expand the standards to address specific needs of the local student population and to utilize available resources while retaining the identified core as the foundation for all science courses. Current graduation requirements for students pursuing the Alabama High School Diploma, including the required science credits, are shown in Appendix B.

PHYSICAL SCIENCE

Physical Science is a conceptual, inquiry-based course that provides students with an investigation of the basic concepts of chemistry and physics. Students use evidence from their own investigations as well as the investigations of others to develop and refine knowledge of core ideas. Increased sophistication, both of their model-based explanations and the argumentation by which evidence and explanation are linked, is developed through language and mathematical skills appropriate to the individual student's cognitive ability level. The standards provide a depth of conceptual understanding that will adequately prepare them for college, career, and citizenship with an appropriate level of scientific literacy. Resources specific to the local area as well as external resources, including evidence-based literature found within scientific journals, should be used to extend and increase the complexity of the core ideas.

Content standards are organized according to the disciplinary core ideas for the Physical Science domain. The core idea, Matter and Its Interactions, deals with the substances and processes that encompass our universe on both microscopic and macroscopic levels. The second core idea, Motion and Stability: Forces and Interactions, includes the components of forces and motion, types of interactions, and stability/instability in physical systems. The third core idea, Energy, involves the conservation of energy, energy transformations, and applications of energy to everyday life. The fourth core idea, Waves and Their Applications in Technologies for Information Transfer, examines wave properties, electromagnetic radiation, and information technologies and instrumentation. Integrated within the disciplinary core ideas of Physical Science are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

Matter and Its Interactions

1. Use the periodic table as a model to predict the relative properties and trends (e.g., reactivity of metals; types of bonds formed, including ionic, covalent, and polar covalent; numbers of bonds formed; reactions with oxygen) of main group elements based on the patterns of valence electrons in atoms.

- ♦ **Objective PS.1.1: Define properties, trends, reactivity, ionic bond, covalent bond, polar covalent bond, main group elements, and valence electrons.**
- **Objective PS.1.2: Predict bond types.**
- **Objective PS.1.3: Calculate valence electrons using group numbers.**
- **Objective PS.1.4: Analyze patterns using the periodic table to construct models.**
- ♦ **Objective PS.1.5: Illustrate composition of atoms using the periodic table.**
- **Objective PS.1.6: Recognize composition and characteristics of atoms and molecules using the periodic table.**
- ♦ **Objective PS.1.7: Identify main group elements.**

2. Plan and carry out investigations (e.g., squeezing a balloon, placing a balloon on ice) to identify the relationships that exist among the pressure, volume, density, and temperature of a confined gas.

- **Objective PS.2.1: Define: pressure, volume, density, and confined gas.**
- **Objective PS.2.2: Conduct planned investigation that demonstrates relationships between pressure, volume, density, and temperature of a confined gas.**
- **Objective PS.2.3: Predict relationship that exists between pressure, volume, density, and temperature of a confined gas.**
- **Objective PS.2.4: Recognize the relationship that exists among pressure, volume, density, and temperature of a confined gas.**

3. Analyze and interpret data from a simple chemical reaction or combustion reaction involving main group elements.

- **Objective PS.3.1: Define chemical reaction, combustion reaction, and main group elements.**
- **Objective PS.3.2: Observe and analyze characteristic properties of substances before and after the substances combine to determine if a chemical reaction has occurred.**
- **Objective PS.3.3: Compare and contrast a simple chemical reaction and a combustion reaction.**
- **Objective PS.3.4: Observe and record data from simple chemical reactions and combustion reactions.**

4. Analyze and interpret data using acid-base indicators (e.g., color-changing markers, pH paper) to distinguish between acids and bases, including comparisons between strong and weak acids and bases.

- **Objective PS.4.1: Define: acids, bases, pH, acid-base indicators, weak acid, weak base, strong acid, and strong base.**
- **Objective PS.4.2: Match acids and bases, including strong and weak acids and bases, to their location on the pH scale.**
- **Objective PS.4.3: Recognize examples of acids and bases.**

5. Use mathematical representations to support and verify the claim that atoms, and therefore mass, are conserved during a simple chemical reaction.

- **Objective PS.5.1: Define molar mass, law of conservation of mass, chemical reaction, reactants, and products.**
- **Objective PS.5.2: Calculate molar mass of reactants and products given a balanced equation.**
- **Objective PS.5.3: Calculate molar mass through step-by-step procedure.**
- **Objective PS.5.4: Model conservation of mass in a chemical reaction.**
- **Objective PS.5.5: Explain the differences between products and reactants.**
- **Objective PS.5.6: Recognize an equation to calculate molar mass.**

6. Develop models to illustrate the concept of half-life for radioactive decay.
   a. Research and communicate information about types of naturally occurring radiation and their properties.
   b. Develop arguments for and against nuclear power generation compared to other types of power generation.

- **Objective PS.6.1: Define half-life, radioactive decay, radiation, nuclear power generation, and power generation.**
- **Objective PS.6.2: Compare and contrast nuclear and non-nuclear power generation.**
- **Objective PS.6.3: Identify types of non-nuclear generation.**
- **Objective PS.6.4: Identify types of nuclear power generation.**

Objective PS.6.5: Recognize examples of naturally occurring radiation.

Motion and Stability: Forces and Interactions

7. Analyze and interpret data for one- and two-dimensional motion applying basic concepts of distance, displacement, speed, velocity, and acceleration (e.g., velocity versus time graphs, displacement versus time graphs, acceleration versus time graphs).

- **Objective PS.7.1: Define one-dimensional motion, two-dimensional motion, distance, displacement, speed, velocity, and acceleration.**

Objective PS.7.2: Calculate displacement, velocity, and acceleration when given formulas and step-by-step procedure.

Objective PS.7.3: Analyze two-dimensional motion graphs.

Objective PS.7.4: Analyze one-dimensional motion graphs.

- **Objective PS.7.5: Recognize constant velocity vs. acceleration in an example.**
- **Objective PS.7.6: Recognize distance, displacement, speed, velocity and acceleration when given examples.**

8. Apply Newton's laws to predict the motion of a system by constructing force diagrams that identify the external forces acting on the system, including friction (e.g., a book on a table, an object being pushed across a floor, an accelerating car).

- **Objective PS.8.1: Define Newton's first law, Newton's second law, Newton's third law, system, force diagram, external forces, law of conservation, mechanical energy, and elastic collision.**

Objective PS.8.2: Demonstrate Newton's third law.

Objective PS.8.3: Demonstrate Newton's second law.

Objective PS.8.4: Demonstrate Newton's first law.

- **Objective PS.8.5: Explain Newton's third law.**
- **Objective PS.8.6: Explain Newton's second law.**
- **Objective PS.8.7: Explain Newton's first law.**

9. Use mathematical equations (e.g., $(m_1v_1 + m_2v_2)_{\text{before}} = (m_1v_1 + m_2v_2)_{\text{after}}$) and diagrams to explain that the total momentum of a system of objects is conserved when there is no net external force on the system.
   a. Use the laws of conservation of mechanical energy and momentum to predict the result of one-dimensional elastic collisions.

- **Objective PS.9.1: Define conservation of momentum, momentum, system, external force, law of conservation of mechanical energy, and elastic collision.**
- **Objective PS.9.2: Recognize conservation of momentum when given mathematical equations.**
- **Objective PS.9.3: Identify how conservation of momentum occurs when given diagrams.**

10. Construct simple series and parallel circuits containing resistors and batteries and apply Ohm's law to solve typical problems demonstrating the effect of changing values of resistors and voltages.

- **Objective PS.10.1: Define series circuit, parallel circuit, resistors, Ohm's law, and voltage.**
- **Objective PS.10.2: Recognize variable in typical problem and place them correctly when given Ohm's law.**
- **Objective PS.10.3: Diagram simple and parallel circuits.**
- **Objective PS.10.4: Interpret an electrical diagram.**

Energy

11. Design and conduct investigations to verify the law of conservation of energy, including transformations of potential energy, kinetic energy, thermal energy, and the effect of any work performed on or by the system.

- **Objective PS.11.1: Define law of conservation of energy, potential energy, kinetic energy, thermal energy, work, and system.**
- **Objective PS.11.2: Create a graphical display demonstrating changes in kinetic energy, mass, and speed in a system.**
- **Objective PS.11.3: Illustrate the relationships of kinetic energy to the mass and speed of an object.**
- **Objective PS.11.4: Describe kinetic energy.**

12. Design, build, and test the ability of a device (e.g., Rube Goldberg devices, wind turbines, solar cells, solar ovens) to convert one form of energy into another form of energy.*

- **Objective PS.12.1: Define law of conservation of energy.**
- **Objective PS.12.2: Construct a device to convert one form of energy into another form of energy, given a procedure.**
- **Objective PS.12.3: Recognize energy conversions in a system.**

Waves and Their Applications in Technologies for Information Transfer

13. Use mathematical representations to demonstrate the relationships among wavelength, frequency, and speed of waves (e.g., the relation $v = \lambda f$) traveling in various media (e.g., electromagnetic radiation traveling in a vacuum and glass, sound waves traveling through air and water, seismic waves traveling through Earth).

- **Objective PS.13.1: Define wavelength, frequency, speed, media, and**

electromagnetic radiation.

Objective PS.13.2: **Solve problems involving velocity, wavelength, and frequency, when given formulas.**

Objective PS.13.3: **Demonstrate how light and sound waves differ when absorbed, reflected, and transmitted through different types of media using model.**

Objective PS.13.4: **Model a simple wave to predict and describe the relationships between waves and wave properties.**

♦ **Objective PS.13.5:** **Recognize formula relating to wavelength, frequency, and speed.**

14. Propose and defend a hypothesis based on information gathered from published materials (e.g., trade books, magazines, Internet resources, videos) for and against various claims for the safety of electromagnetic radiation.

♦ **Objective PS.14.1:** **Define hypothesis and electromagnetic radiation.**
♦ **Objective PS.14.2:** **Match published material to a given hypothesis.**
♦ **Objective PS.14.3:** **Recognize a hypothesis.**

15. Obtain and communicate information from published materials to explain how transmitting and receiving devices (e.g., cellular telephones, medical-imaging technology, solar cells, wireless Internet, scanners, **So**und **N**avigation **a**nd **R**anging [SONAR]) use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

♦ **Objective PS.15.1:** **Define wave behavior and wave interactions.**

Objective PS.15.2: **Predict the relationships between waves and wave properties using a model of simple waves.**

Objective PS.15.3: **Describe common communication devices that use electromagnetic waves to encode and transmit information.**

♦ **Objective PS.15.4:** **Describe the relationships between waves and wave properties using a model of simple waves.**

BIOLOGY

Biology is a required, inquiry-based course focused on providing all high school students with foundational life science content about the patterns, processes, and interactions among living organisms. The emphasis is on increased sophistication and rigor of a limited number of core ideas rather than on memorizing a breadth of factual content. Students use prior and new knowledge to build conceptual understandings based on evidence from their own and others' investigations. They use their own learning and experiences to support claims and engage in argument from evidence. The standards provide a depth of conceptual understanding to adequately prepare them for college, career, and citizenship with an appropriate level of scientific literacy. Resources specific to the local area as well as external resources, including evidenced-based literature found within scientific journals, should be used to extend and increase the complexity of the core ideas.

Content standards within this course are organized according to the disciplinary core ideas for the Life Science domain. The first core idea, From Molecules to Organisms: Structures and Processes, concentrates on the structure of cells and how their functions are necessary for supporting life, growth, behavior, and reproduction. The second core idea, Ecosystems: Interactions, Energy, and Dynamics, investigates the positive and negative interactions between living organisms and other biotic and abiotic factors. The third core idea, Heredity: Inheritance and Variation of Traits, centers on the formation of proteins that affect the trait expression, also known as the central dogma of molecular biology; the passing of distinguishing genetic information throughout generations; and how environmental factors and genetic errors can cause gene mutations. The fourth core idea, Unity and Diversity, examines the variation of traits within a population over a long period of time that results in diversity among organisms. Integrated within the disciplinary core ideas of Biology are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

From Molecules to Organisms: Structures and Processes

1. Use models to compare and contrast how the structural characteristics of carbohydrates, nucleic acids, proteins, and lipids define their function in organisms.

- ♦ **Objective B.1.1:** **Define carbohydrates, nucleic acids, lipids, proteins, and macromolecules.**
- **Objective B.1.2:** **Create a model to compare the structural characteristics of the macromolecules.**
- ♦ **Objective B.1.3:** **Identify structures and functions of macromolecules found in living things.**
- ♦ **Objective B.1.4:** **Identify patterns in macromolecules.**

2. Obtain, evaluate, and communicate information to describe the function and diversity of organelles and structures in various types of cells (e.g., muscle cells having a large amount of mitochondria, plasmids in bacteria, chloroplasts in plant cells).

- **Objective B.2.1: Define organelles, mitochondria, plasmids, chloroplast, cell wall, plasma membrane, centrioles, Smooth and Rough ER, eukaryotic cells and prokaryotic cells.**
- **Objective B.2.2: Create a model of a plant and animal cell.**
- **Objective B.2.3: Explain relationships of organelles and their structure in various types of cells using a chart or diagram.**
- **Objective B.2.4: Compare and contrast functions and structures of the organelles in plant and animal cells.**
- **Objective B.2.5: Draw and label plant and animal cell.**

3. Formulate an evidence-based explanation regarding how the composition of deoxyribonucleic acid (DNA) determines the structural organization of proteins.
   a. Obtain and evaluate experiments of major scientists and communicate their contributions to the development of the structure of DNA and to the development of the central dogma of molecular biology.
   b. Obtain, evaluate, and communicate information that explains how advancements in genetic technology (e.g., Human Genome Project, **Enc**yclopedia **o**f **D**NA **E**lements [ENCODE] project, 1000 Genomes Project) have contributed to the understanding as to how a genetic change at the DNA level may affect proteins and, in turn, influence the appearance of traits.
   c. Obtain information to identify errors that occur during DNA replication (e.g., deletion, insertion, translocation, substitution, inversion, frame-shift, point mutations).

- **Objective B.3.1: Define deoxyribonucleic acids, ribonucleic acids, DNA replication, deletion, insertion, translocation, point shift and frame shift mutation.**
- **Objective B.3.2: Analyze the errors and patterns that occur during DNA replication.**
- **Objective B.3.3: Construct a model of DNA.**
- **Objective B.3.4: Identify the complementary nitrogen base pairs.**
- **Objective B.3.5: Explain the relationship between DNA, genes, and chromosomes.**
- **Objective B.3.6: Describe the roles of DNA and RNA in protein synthesis.**
- **Objective B.3.7: Compare and contrast RNA and DNA.**

4. Develop and use models to explain the role of the cell cycle during growth and maintenance in multicellular organisms (e.g., normal growth and/or uncontrolled growth resulting in tumors).

- **Objective B.4.1: Define mitosis, interface, meiosis, and mutations.**
- **Objective B.4.2: Analyze uncontrolled growth of cells resulting in tumors/cancers.**
- **Objective B.4.3: Construct models of mitosis and meiosis.**
- **Objective B.4.4: Explain the steps in mitosis and meiosis.**
- **Objective B.4.5: Diagram the cell cycle.**

5. Plan and carry out investigations to explain feedback mechanisms (e.g., sweating and shivering) and cellular processes (e.g., active and passive transport) that maintain homeostasis.
    a. Plan and carry out investigations to explain how the unique properties of water (e.g., polarity, cohesion, adhesion) are vital to maintaining homeostasis in organisms.

- **Objective B.5.1: Define active transport, passive transport, osmosis, diffusion, homeostasis, exocytosis, endocytosis, hypotonic, hypertonic, and isotonic solutions.**
- **Objective B.5.2: Conduct an experiment to show a cell's reaction in hypotonic, hypertonic, and isotonic solutions.**
- **Objective B.5.3: Illustrate an activity to demonstrate homeostasis**.
- **Objective B.5.4: Compare and contrast active transport and passive ransport.**
- **Objective B.5.5: Identify examples of active transport and passive transport.**

6. Analyze and interpret data from investigations to explain the role of products and reactants of photosynthesis and cellular respiration in the cycling of matter and the flow of energy.
    a. Plan and carry out investigations to explain the interactions among pigments, absorption of light, and reflection of light.

- **Objective B.6.1: Define photosynthesis, cellular respiration, reactants, products, pigments, and chlorophyll.**
- **Objective B.6.2: Explain how pigments, light reflection, and light absorption effect photosynthesis in plants.**
- **Objective B.6.3: Interpret information from the photosynthesis formula.**
- **Objective B.6.4: Write the formulas for photosynthesis and cellular respiration.**
- **Objective B.6.5: Identify reactants and products of photosynthesis and cellular respiration.**

Ecosystems: Interactions, Energy, and Dynamics

7. Develop and use models to illustrate examples of ecological hierarchy levels, including biosphere, biome, ecosystem, community, population, and organism.

- **Objective B.7.1: Define biosphere, biomes, ecosystem, community, population, and organisms.**
- **Objective B.7.2: Defend the effectiveness of a design solution that maintains biodiversity.**
- **Objective B.7.3: Construct models that represent ecosystems and biomes.**
- **Objective B.7.4: Identify examples of abiotic and biotic factors.**

8. Develop and use models to describe the cycling of matter (e.g., carbon, nitrogen, water) and flow of energy (e.g., food chains, food webs, biomass pyramids, ten percent law) between abiotic and biotic factors in ecosystems.

- **Objective B.8.1: Define food chain, food web, biomass, trophic pyramids, abiotic and biotic. factors Symbiotic relationships, mutualism, predation, competition, commensalism, and parasitism.**
- **Objective B.8.2: Develop a food chain and a food web.**
- **Objective B.8.3: Illustrate how the ten percent law applies to the food chain.**

- **Objective B.8.4: Illustrate how matter and energy flows through the carbon, nitrogen, and water cycle.**
- **Objective B.8.5: Illustrate the cycling of matter between abiotic and biotic parts of the ecosystem.**
- **Objective B.8.6: Explain the flow of energy and the conservation of matter in an ecosystem.**
- **Objective B.8.7: Label a food chain and a food web.**

9. Use mathematical comparisons and visual representations to support or refute explanations of factors that affect population growth (e.g., exponential, linear, logistic).

- **Objective B.9.1: Define population growth, exponential growth, death rate, growth rate, and birth rate.**
- **Objective B.9.2: Determine possible causes of birth and death rates in an ecosystem.**
- **Objective B.9.3: Demonstrate how changes to physical and biological components of an ecosystem can lead to shifts in populations.**
- **Objective B.9.4: Model exponential and linear growth in an ecosystem.**
- **Objective B.9.5: Chart a population's growth, birth, and death rates.**

10. Construct an explanation and design a real-world solution to address changing conditions and ecological succession caused by density-dependent and/or density-independent factors.*

- **Objective B.10.1: Define ecological succession, primary and secondary succession, density dependent and density independent factors.**
- **Objective B.10.2: Model an ecosystem that shows primary and secondary succession.**
- **Objective B.10.3: Interpret data to provide evidence regarding how resources availability impacts individual organisms as well as populations of organisms in an ecosystem.**
- **Objective B.10.4: Determine if a change to an ecosystem is caused by a density-dependent or a density-independent factor.**

Heredity: Inheritance and Variation of Traits

11. Analyze and interpret data collected from probability calculations to explain the variation of expressed traits within a population.
    a. Use mathematics and computation to predict phenotypic and genotypic ratios and percentages by constructing Punnett squares, including using both homozygous and heterozygous allele pairs.
    b. Develop and use models to demonstrate codominance, incomplete dominance, and Mendel's laws of segregation and independent assortment.
    c. Analyze and interpret data (e.g., pedigree charts, family and population studies) regarding Mendelian and complex genetic disorders (e.g., sickle-cell anemia, cystic fibrosis, type 2 diabetes) to determine patterns of genetic inheritance and disease risks from both genetic and environmental factors.

- **Objective B.11.1: Define probability, monohybrid crossing, phenotype, genotype, Punnett Square, homozygous, heterozygous, allele, codominance, incomplete dominance, Law of Segregation, independent assortment, and genetic disorders.**

Objective B.11.2: **Predict genetic disorders by using pedigrees and studying family history.**
Objective B.11.3: **Calculate genotypic and phenotypic percentages and ratios using a Punnett Square.**
Objective B.11.4: **Evaluate the causes of different genetic disorders.**
♦ **Objective B.11.5:** **Illustrate Mendel's law of segregation and independent assortment.**
♦ **Objective B.11.6:** **Interpret inheritance patterns shown in charts and graphs.**

12. Develop and use a model to analyze the structure of chromosomes and how new genetic combinations occur through the process of meiosis.
    a. Analyze data to draw conclusions about genetic disorders caused by errors in meiosis (e.g., Down syndrome, Turner syndrome).

♦ **Objective B.12.1:** **Define chromosomes, DNA, genetic recombination, sexual reproduction, haploid and diploid, and meiosis.**
Objective B.12.2: **Research genetic disorders caused by errors in meiosis.**
Objective B.12.3: **Model chromosome movement during meiosis.**
♦ **Objective B.12.4:** **Discuss information on genetic disorders.**
♦ **Objective B.12.5:** **Illustrate the steps in meiosis.**

Unity and Diversity

13. Obtain, evaluate, and communicate information to explain how organisms are classified by physical characteristics, organized into levels of taxonomy, and identified by binomial nomenclature (e.g., taxonomic classification, dichotomous keys).
    a. Engage in argument to justify the grouping of viruses in a category separate from living things.

♦ **Objective B.13.1:** **Define taxonomy, levels of taxonomy (kingdom/species), binomial nomenclature, and classification.**
Objective B.13.2: **Identify organisms using a dichotomous key.**
Objective B.13.3: **Analyze a dichotomous key.**
Objective B.13.4: **Identify organisms using binomial nomenclature.**
♦ **Objective B.13.5:** **Compare and contrast viruses to living organisms.**
♦ **Objective B.13.6:** **Sequence taxa from most inclusive to least inclusive.**

14. Analyze and interpret data to evaluate adaptations resulting from natural and artificial selection that may cause changes in populations over time (e.g., antibiotic-resistant bacteria, beak types, peppered moths, pest-resistant crops).

♦ **Objective B.14.1:** **Define natural selection, artificial selection, adaptations, and evolution.**
Objective B.14.2: **Describe adaptations of organisms formed through the process of evolution.**
Objective B.14.3: **Hypothesize population outcomes from natural and artificial selections.**
♦ **Objective B.14.4:** **Identify dominant characteristics of a population.**

15. Engage in argument from evidence (e.g., mathematical models such as distribution graphs) to explain how the diversity of organisms is affected by overpopulation of species, variation due to genetic mutations, and competition for limited resources.

- **Objective B.15.1: Define Diversity, genetic mutations, and limited resources.**
- **Objective B.15.2: Interpret data to predict how environmental conditions and genetic factors influence the growth of organisms.**
- **Objective B.15.3: Differentiate between genetic mutations and competitions for limited resources, resulting in population trends.**
- **Objective B.15.4: Identify trends in populations from different biomes.**

16. Analyze scientific evidence (e.g., DNA, fossil records, cladograms, biogeography) to support hypotheses of common ancestry and biological evolution.

- **Objective B.16.1: Define scientific evidence, cladogram, biological evolution, phylogeny, and fan diagram.**
- **Objective B.16.2: Analyze cladograms.**
- **Objective B.16.3: Categorize scientific evidence supporting hypothesis of common ancestry.**
- **Objective B.16.4: Research scientific evidence on biological evolution of species.**
- **Objective B.16.5: Describe the anatomical similarities and differences between modern organisms and fossil organisms.**

CHEMISTRY

Chemistry is an elective course that provides students with an investigation of empirical concepts central to biology, earth science, environmental science, and physiology. Chemistry encompasses both qualitative and quantitative ideas derived using the scientific process. By its very nature, the study of chemistry encourages an inquiry-based approach to understanding the substances and processes that explain our world as well as ourselves. Using the practices of science, core ideas are explored in greater detail and refined with increased sophistication and rigor based upon knowledge acquired in earlier grades. Students use the academic language of science in context to communicate claims, evidence, and reasoning for chemical phenomena. The course provides high school students with more in-depth investigations on the properties and interactions of matter. Students acquire prerequisite skills for postsecondary studies and careers in science, technology, engineering, and mathematics (STEM) fields. Additional external resources, including evidence-based research found in scientific journals, should be utilized to provide students with a broad scientific experience that will adequately prepare them for college, career, and citizenship.

Content standards within this course are organized according to three of the core ideas for Physical Science. The first core idea, Matter and Its Interactions, deals with the substances and processes that encompass our universe on both microscopic and macroscopic levels. The second core idea, Motion and Stability: Forces and Interactions, concentrates on forces and motion, types of interactions, and stability and instability in chemical systems. The third core idea, Energy, involves the conservation of energy, energy transformations, and applications of energy to everyday life. Integrated within the disciplinary core ideas of Chemistry are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

Matter and Its Interactions

1. Obtain and communicate information from historical experiments (e.g., work by Mendeleev and Moseley, Rutherford's gold foil experiment, Thomson's cathode ray experiment, Millikan's oil drop experiment, Bohr's interpretation of bright line spectra) to determine the structure and function of an atom and to analyze the patterns represented in the periodic table.

   Objective C.1.1: **Construct models that illustrate the structure, function, composition, and characteristics of atoms and molecules.**
   Objective C.1.2: **Interpret information that can be determined from mass number and atomic number.**
   Objective C.1.3: **Analyze patterns within the periodic table.**
   Objective C.1.4: **Identify atomic number and atomic mass using a periodic table.**

2. Develop and use models of atomic nuclei to explain why the abundance-weighted average of isotopes of an element yields the published atomic mass.

   Objective C.2.1: **Define isotope, abundance-weighted average, atomic mass, proton, neutron, and electron.**
   Objective C.2.2: **Compare number of neutrons in isotopes of same elements.**

Objective C.2.3: Recognize all elements have isotopes.
Objective C.2.4: Calculate averages.

3. Use the periodic table as a systematic representation to predict properties of elements based on their valence electron arrangement.
   a. Analyze data such as physical properties to explain periodic trends of the elements, including metal/nonmetal/metalloid behavior, electrical/heat conductivity, electronegativity and electron affinity, ionization energy, and atomic-covalent/ionic radii, and how they relate to position in the periodic table.
   b. Develop and use models (e.g., Lewis dot, 3-D ball-and-stick, space-filling, valence-shell electron-pair repulsion [VSEPR]) to predict the type of bonding and shape of simple compounds.
   c. Use the periodic table as a model to derive formulas and names of ionic and covalent compounds.

Objective C.3.1: Define valence electrons, physical properties, metal, nonmetal, metalloid, conductivity, electronegativity, election affinity, ionization energy, ionic compounds, and covalent compounds.
Objective C.3.2: Predict ionic charges using the periodic table.
Objective C.3.3: Calculate number of atoms in a formula.
Objective C.3.4: Calculate valence electrons using group number.
Objective C.3.5: Locate groups and periods on the periodic table.
Objective C.3.6: Locate metals, non-metals, and metalloids on the periodic table.
Objective C.3.7: Recognize prefixes for binary molecular compounds.
Objective C.3.8: Identify group number from periodic table.

4. Plan and conduct an investigation to classify properties of matter as intensive (e.g., density, viscosity, specific heat, melting point, boiling point) or extensive (e.g., mass, volume, heat) and demonstrate how intensive properties can be used to identify a compound.

Objective C.4.1: Define intensive properties and extensive properties.
Objective C.4.2: Analyze substances to determine if a chemical reaction has occurred.
Objective C.4.3: Differentiate between intensive and extensive properties.
Objective C.4.4: Describe properties of matter.

5. Plan and conduct investigations to demonstrate different types of simple chemical reactions based on valence electron arrangements of the reactants and determine the quantity of products and reactants.
   a. Use mathematics and computational thinking to represent the ratio of reactants and products in terms of masses, molecules, and moles.
   b. Use mathematics and computational thinking to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.

Objective C.5.1: Define valence electrons, reactants, products, molecules, moles, and Avogadro's number, chemical equations, compounds, and mixtures.
Objective C.5.2: Calculate problems utilizing Avogadro's number and molar mass
Objective C.5.3: Calculate molar mass.
Objective C.5.4: Balance chemical equations.
Objective C.5.5: Differentiate between coefficients and subscripts.

Objective C.5.6: **Calculate problems utilizing significant figures, ratios, scientific notation properly using rules.**
Objective C.5.7: **Recognize the five types of chemical reactions.**
Objective C.5.8: **Identify products and reactants.**
Objective C.5.9: **Differentiate among compounds, mixtures, and solutions.**

6. Use mathematics and computational thinking to express the concentrations of solutions quantitatively using molarity.
    a. Develop and use models to explain how solutes are dissolved in solvents.
    b. Analyze and interpret data to explain effects of temperature on the solubility of solid, liquid, and gaseous solutes in a solvent and the effects of pressure on the solubility of gaseous solutes.
    c. Design and conduct experiments to test the conductivity of common ionic and covalent substances in a solution.
    d. Use the concept of pH as a model to predict the relative properties of strong, weak, concentrated, and dilute acids and bases (e.g., Arrhenius and Brønsted-Lowry acids and bases).

Objective C.6.1: **Define concentration, molarity, solutes, solvents, solubility, ionic and covalent, pH, acids, bases, concentrated, and diluted.**
Objective C.6.2: **Restate the factors affecting solubility.**
Objective C.6.3: **Describe the behavior of atoms in each of the 3 states of matter.**
Objective C.6.4: **Match acids and bases, including strong and weak acids and bases, to their location on the pH scale.**
Objective C.6.5: **Recognize examples of acids and bases.**

7. Plan and carry out investigations to explain the behavior of ideal gases in terms of pressure, volume, temperature, and number of particles.
    a. Use mathematics to describe the relationships among pressure, temperature, and volume of an enclosed gas when only the amount of gas is constant.
    b. Use mathematical and computational thinking based on the ideal gas law to determine molar quantities.

Objective C.7.1: **Define ideal gas law.**
Objective C.7.2: **Predict the relationship that exists among pressure, volume, density, and temperature of a confined gas in specific conditions.**
Objective C.7.3: **Recognize the relationship that exists among pressure, volume, density, and temperature of a confined gas.**
Objective C.7.4: **Explain the ideal gas law in terms of pressure, temperature, and volume.**

8. Refine the design of a given chemical system to illustrate how LeChâtelier's principle affects a dynamic chemical equilibrium when subjected to an outside stress (e.g., heating and cooling a saturated sugar-water solution).*

Objective C.8.1: **Define molarity, stoichiometry, concentration, catalysts, endothermic, and exothermic.**
Objective C.8.2: **Recognize outside stresses that effect chemical reactions.**
Objective C.8.3: **Describe dynamic chemical equilibrium.**
Objective C.8.4: **Balance chemical equations.**

Motion and Stability: Forces and Interactions

9. Analyze and interpret data (e.g., melting point, boiling point, solubility, phase-change diagrams) to compare the strength of intermolecular forces and how these forces affect physical properties and changes.

Objective C.9.1:	**Define intermolecular forces, physical properties, physical changes and phase changes.**
Objective C.9.2:	**Interpret a phase change diagram.**
Objective C.9.3:	**Discuss the impact of intermolecular forces on physical properties and physical changes.**
Objective C.9.4:	**Explain causes of physical changes.**
Objective C.9.5:	**Distinguish between physical properties and physical changes.**

Energy

10. Plan and conduct experiments that demonstrate how changes in a system (e.g., phase changes, pressure of a gas) validate the kinetic molecular theory.
    a. Develop a model to explain the relationship between the average kinetic energy of the particles in a substance and the temperature of the substance (e.g., no kinetic energy equaling absolute zero [0K or -273.15^{o}C]).

Objective C.10.1:	**Define kinetic energy, absolute zero, and kinetic molecular theory.**
Objective C.10.2:	**Describe the movement of particles in a substance at absolute zero.**
Objective C.10.3:	**Discuss intermolecular forces impact on kinetic energy of particles in substance.**
Objective C.10.4:	**Describe states of matter.**

11. Construct an explanation that describes how the release or absorption of energy from a system depends upon changes in the components of the system.
    a. Develop a model to illustrate how the changes in total bond energy determine whether a chemical reaction is endothermic or exothermic.
    b. Plan and conduct an investigation that demonstrates the transfer of thermal energy in a closed system (e.g., using heat capacities of two components of differing temperatures).

Objective C.11.1:	**Define bond energy, closed system, endothermic, exothermic, heat capacity, and thermal energy.**
Objective C.11.2:	**Describe the transfer of thermal energy in a closed system.**
Objective C.11.3:	**Compare heat capacity of two components.**
Objective C.11.4:	**Recognize what changes in bond energy in a system cause endothermic and exothermic reactions.**

PHYSICS

Physics is an elective course focused on providing high school students with foundational content regarding properties of physical matter, physical quantities, and their interactions. The course provides the required science background preparation for students who plan to pursue postsecondary studies and careers in science, technology, engineering, and mathematics (STEM) fields. Using the practices of science, core ideas are explored and developed in more detail and refined with increased sophistication and rigor based upon knowledge acquired in earlier grades. Students learn through investigation and analysis of data and from their own experiments and those that cannot be undertaken in a science classroom. The academic language of physics is used in context to communicate claims, evidence, and reasoning for phenomena and to engage in argument from evidence to justify and defend claims. Students take part in active learning involving authentic investigations and engineering design processes. The Physics course provides a rich learning context for acquiring knowledge of the practices, core ideas, and crosscutting concepts that lead to the development of critical-thinking, problem-solving, and information-literacy skills. Additional external resources, including evidence-based literature found within scientific journals, research, and other sources, should be utilized to provide students with science experiences that will adequately prepare them for college, career, and citizenship.

Content standards within this course are organized according to three of the core ideas for Physical Science. The first core idea, Motion and Stability: Forces and Interactions, concentrates on forces and motion, types of interactions, and stability and instability in physical systems. The second core idea, Energy, investigates conservation of energy, energy transformations, and applications of energy to everyday life. The final core idea, Waves and Their Applications in Technologies for Information Transfer, examines wave properties, electromagnetic radiation, and information technologies and instrumentation. The Engineering, Technology, and Applications of Science (ETS) core ideas may be integrated into the Physics content. The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

Motion and Stability: Forces and Interactions

1. Investigate and analyze, based on evidence obtained through observation or experimental design, the motion of an object using both graphical and mathematical models (e.g., creating or interpreting graphs of position, velocity, and acceleration versus time graphs for one- and two-dimensional motion; solving problems using kinematic equations for the case of constant acceleration) that may include descriptors such as position, distance traveled, displacement, speed, velocity, and acceleration.

2. Identify external forces in a system and apply Newton's laws graphically by using models such as free-body diagrams to explain how the motion of an object is affected, ranging from simple to complex, and including circular motion.
    a. Use mathematical computations to derive simple equations of motion for various systems using Newton's second law.
    b. Use mathematical computations to explain the nature of forces (e.g., tension, friction, normal) related to Newton's second and third laws.

3. Evaluate qualitatively and quantitatively the relationship between the force acting on an object, the time of interaction, and the change in momentum using the impulse-momentum theorem.

4. Identify and analyze forces responsible for changes in rotational motion and develop an understanding of the effect of rotational inertia on the motion of a rotating object (e.g., merry-go-round, spinning toy, spinning figure skater, stellar collapse [supernova], rapidly spinning pulsar).

Energy

5. Construct models that illustrate how energy is related to work performed on or by an object and explain how different forms of energy are transformed from one form to another (e.g., distinguishing between kinetic, potential, and other forms of energy such as thermal and sound; applying both the work-energy theorem and the law of conservation of energy to systems such as roller coasters, falling objects, and spring-mass systems; discussing the effect of frictional forces on energy conservation and how it affects the motion of an object).

6. Investigate collisions, both elastic and inelastic, to evaluate the effects on momentum and energy conservation.

7. Plan and carry out investigations to provide evidence that the first and second laws of thermodynamics relate work and heat transfers to the change in internal energy of a system with limits on the ability to do useful work (e.g., heat engine transforming heat at high temperature into mechanical energy and low-temperature waste heat, refrigerator absorbing heat from the cold reservoir and giving off heat to the hot reservoir with work being done).
    a. Develop models to illustrate methods of heat transfer by conduction (e.g., an ice cube in water), convection (e.g., currents that transfer heat from the interior up to the surface), and radiation (e.g., an object in sunlight).
    b. Engage in argument from evidence regarding how the second law of thermodynamics applies to the entropy of open and closed systems.

Waves and Their Applications in Technologies for Information Transfer

8. Investigate the nature of wave behavior to illustrate the concept of the superposition principle responsible for wave patterns, constructive and destructive interference, and standing waves (e.g., organ pipes, tuned exhaust systems).
    a. Predict and explore how wave behavior is applied to scientific phenomena such as the Doppler effect and **So**und **N**avigation **a**nd **R**anging (SONAR).

9. Obtain and evaluate information regarding technical devices to describe wave propagation of electromagnetic radiation and compare it to sound propagation. (e.g., wireless telephones, magnetic resonance imaging [MRI], microwave systems, **Ra**dio **D**etection **a**nd **R**anging [RADAR], SONAR, ultrasound).

10. Plan and carry out investigations that evaluate the mathematical explanations of light as related to optical systems (e.g., reflection, refraction, diffraction, intensity, polarization, Snell's law, the inverse square law).

11. Develop and use models to illustrate electric and magnetic fields, including how each is created (e.g., charging by either conduction or induction and polarizing; sketching field lines for situations such as point charges, a charged straight wire, or a current carrying wires such as solenoids; calculating the forces due to Coulomb's laws), and predict the motion of charged particles in each field and the energy required to move a charge between two points in each field.

12. Use the principles of Ohm's and Kirchhoff's laws to design, construct, and analyze combination circuits using typical components (e.g., resistors, capacitors, diodes, sources of power).

HUMAN ANATOMY AND PHYSIOLOGY

The Human Anatomy and Physiology course is designed to address the structure and function of human body systems from the cellular level to the organism level in an approach that complements the natural curiosity of high school students. The course addresses the interactions within and between systems that maintain homeostasis in an organism. It is designed for students who have an interest in learning how the human body works and for those interested in health-related science, technology, engineering, and mathematics (STEM) careers. As students engage in the study of human body systems, they are encouraged to apply the knowledge and processes of science to personally relevant issues, including how personal choices, environmental factors, and genetic factors affect the human body.

The Human Anatomy and Physiology standards provide a depth of conceptual understanding to adequately prepare students for college, career, and citizenship with an appropriate level of scientific literacy. This course encourages critical thinking, the integration of technology, and the application of knowledge and skills to solve problems. An important component of this course is a safe laboratory setting where students participate in active learning to illustrate scientific concepts that incorporate activities such as histological studies, dissections, urinalysis and blood-testing simulations, and computer-based electrocardiography. Students are expected to use clear and accurate academic language, keep detailed records, make oral and written presentations, and defend claims based on evidence from their own and others' scientific investigations.

Content standards within this course are organized according to one of the core ideas of Life Science, From Molecules to Organisms: Structures and Processes. This core idea is explored more extensively within the specific context of the anatomy and physiology of human body systems. Content standards focus on the growth and development of human body systems as well as on the structure and function of these systems from the cellular level to the organism level. Integrated within the discipline of Human Anatomy and Physiology are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

From Molecules to Organisms: Structures and Processes

1. Develop and use models and appropriate terminology to identify regions, directions, planes, and cavities in the human body to locate organs and systems.

- ♦ **Objective HAP.1.1: Define cells, tissues, organs, and organ systems.**
  Objective HAP.1.2: Model organ systems to determine how multiple interacting organs and systems work together to accomplish specific functions.
- ♦ **Objective HAP.1.3: Illustrate main organs within the regions, planes, and cavities of the human body.**
  Objective HAP.1.4: Illustrate that cells differentiate in patterns and perform specific functions.
- ♦ **Objective HAP.1.5: Recognize main organs and their association with the body systems.**

2. Analyze characteristics of tissue types (e.g., epithelial tissue) and construct an explanation of how the chemical and structural organizations of the cells that form these tissues are specialized to conduct the function of that tissue (e.g., lining, protecting).

- ♦ **Objective HAP.2.1: Define epithelial tissue, connective tissue, muscular tissue, and nervous tissue.**
- **Objective HAP.2.2: Correlate tissue locations with their structures and functions.**
- ♦ **Objective HAP.2.3: Differentiate between tissue types.**
- ♦ **Objective HAP.2.4: Locate different tissue types within the body.**

3. Obtain and communicate information to explain the integumentary system's structure and function, including layers and accessories of skin and types of membranes.
   a. Analyze the effects of pathological conditions (e.g., burns, skin cancer, bacterial and viral infections, chemical dermatitis) to determine the body's attempt to maintain homeostasis.

- ♦ **Objective HAP.3.1: Define integumentary system, membrane, and pathological conditions.**
- **Objective HAP.3.2: Illustrate the integumentary system.**
- **Objective HAP.3.3: Explain pathological effects on integumentary system.**
- ♦ **Objective HAP.3.4: Identify structures and functions of the three levels of the epidermis.**

4. Use models to identify the structure and function of the skeletal system (e.g., classification of bones by shape, classification of joints and the appendicular and axial skeletons).
   a. Obtain and communicate information to demonstrate understanding of the growth and development of the skeletal system (e.g., bone growth and remodeling).
   b. Obtain and communicate information to demonstrate understanding of the pathology of the skeletal system (e.g., types of bone fractures and their treatment, osteoporosis, rickets, other bone diseases).

- ♦ **Objective HAP.4.1: Define bones, joints, appendicular, fractures, osteoporosis, and skeletal system.**
- **Objective HAP.4.2: Predict growth patterns of male and female Homo sapiens.**
- ♦ **Objective HAP.4.3: Discuss hindrances of bone growth.**
- ♦ **Objective HAP.4.4: Examine reasons for abnormal bone growth.**
- ♦ **Objective HAP.4.5: Construct and label a skeletal system.**

5. Develop and use models to illustrate the anatomy of the muscular system, including muscle locations and groups, actions, origins and insertions.
   a. Plan and conduct investigations to explain the physiology of the muscular system (e.g., muscle contraction/relaxation, muscle fatigue, muscle tone), including pathological conditions (e.g., muscular dystrophy).

- ♦ **Objective HAP.5.1: Define contractions, relaxations, muscular dystrophy, muscle fatigue, and muscle tone.**
- **Objective HAP.5.2: Describe the components of the muscular system.**
- ♦ **Objective HAP.5.3: Illustrate structure of the muscular system.**
- ♦ **Objective HAP.5.4: Identify muscular pathological conditions.**
- ♦ **Objective HAP.5.5: Demonstrate muscle contraction and relaxation.**

6. Obtain, evaluate, and communicate information regarding how the central nervous system and peripheral nervous system interrelate, including how these systems affect all other body systems to maintain homeostasis.
    a. Use scientific evidence to evaluate the effects of pathology on the nervous system (e.g., Parkinson's disease, Alzheimer's disease, cerebral palsy, head trauma) and argue possible prevention and treatment options.
    b. Design a medication to treat a disorder associated with neurotransmission, including mode of entry into the body, form of medication, and desired effects.*

- ♦ **Objective HAP.6.1: Define central nervous system, peripheral nervous system, pathology, and neurotransmission.**
- **Objective HAP.6.2: Research treatments associated with the pathology of the nervous system.**
- **Objective HAP.6.3: Describe the effects of different pathogens on the nervous system.**
- ♦ **Objective HAP.6.4: Describe each system and how they interact in the body as a whole.**

7. Use models to determine the relationship between the structures in and functions of the cardiovascular system (e.g., components of blood, blood circulation through the heart and systems of the body, ABO blood groups, anatomy of the heart, types of blood vessels).
    a. Engage in argument from evidence regarding possible prevention and treatment options related to the pathology of the cardiovascular system (e.g., myocardial infarction, mitral valve prolapse, varicose veins, arteriosclerosis, anemia, high blood pressure).
    b. Design and carry out an experiment to test various conditions that affect the heart (e.g., heart rate, blood pressure, electrocardiogram [ECG] output).

- ♦ **Objective HAP.7.1: Define cardiovascular system, myocardial infarction, mitral valve prolapse, varicose veins, arteriosclerosis, anemia, and high blood pressure.**
- **Objective HAP.7.2: Research prevention and treatment options relating to the cardiovascular system.**
- ♦ **Objective HAP.7.3: Describe various conditions that affect the heart.**
- ♦ **Objective HAP.7.4: Illustrate structure and function of the cardiovascular system.**
- ♦ **Objective HAP.7.5: Illustrate the anatomy of the heart.**
- ♦ **Objective HAP.7.6: Identify the ABO blood groups.**

8. Communicate scientific information to explain the relationship between the structures and functions, both mechanical (e.g., chewing, churning in stomach) and chemical (e.g., enzymes, hydrochloric acid [HCl] in stomach), of the digestive system, including the accessory organs (e.g., salivary glands, pancreas).
    a. Obtain and communicate information to demonstrate an understanding of the disorders of the digestive system (e.g., ulcers, Crohn's disease, diverticulitis).

- ♦ **Objective HAP. 8.1: Define mechanical digestion, chemical digestion, salivary glands, and pancreas.**
- **Objective HAP.8.2: Research causes and effects of digestive disorders.**
- ♦ **Objective HAP.8.3: Compare and contrast the relationship between mechanical and chemical functions of the digestive system.**
- ♦ **Objective HAP.8.4: Identify the components of the digestive system.**

9. Develop and use a model to explain how the organs of the respiratory system function.
    a. Engage in argument from evidence describing how environmental (e.g., cigarette smoke, polluted air) and genetic factors may affect the respiratory system, possibly leading to pathological conditions (e.g., cystic fibrosis).

- ♦ **Objective HAP.9.1: Define organs, respiratory system, pathological, pollution, and cystic fibrosis.**
- **Objective HAP.9.2: Research evidence to support environmental effects on the respiratory system.**
- ♦ **Objective HAP.9.3: Describe structures and functions of the respiratory system.**
- ♦ **Objective HAP.9.4: Identify the components of the respiratory system.**

10. Obtain, evaluate, and communicate information to differentiate between the male and female reproductive systems, including pathological conditions that affect each.
    a. Use models to demonstrate what occurs in fetal development at each stage of pregnancy.

- ♦ **Objective HAP.10.1: Define reproduction, fetus, embryo, egg, sperm, ovaries, and uterus.**
- ♦ **Objective HAP.10.2: Evaluate various pathological conditions that effect the male and female reproductive system.**
- ♦ **Objective HAP.10.3: Compare and contrast the male and female reproduction system.**
- ♦ **Objective HAP.10.4: Illustrate fetal development at each stage of pregnancy.**

11. Use models to differentiate the structures of the urinary system and to describe their functions.
    a. Analyze and interpret data related to the urinary system to show the relationship between homeostatic imbalances and disease (e.g., kidney stones, effects of pH imbalances).

- ♦ **Objective HAP.11.1: Define homeostatic imbalances, urinary tract, urinary system, kidney, kidney stone, and pH.**
- **Objective HAP.11.2: Describe how homeostatic imbalances and diseases affect the urinary systems.**
- **Objective HAP.11.3: Illustrate the structure of the urinary system.**
- **Objective HAP.11.4: Summarize the organs and their functions in the urinary system.**
- ♦ **Objective HAP.11.5: Trace water flow of the urinary system in males and females.**

12. Obtain and communicate information to explain the lymphatic organs and their structure and function.
    a. Develop and use a model to explain the body's lines of defense and immunity.
    b. Obtain and communicate information to demonstrate an understanding of the disorders of the immune system (e.g., acquired immunodeficiency syndrome [AIDS], severe combined immunodeficiency [SCID]).

- ♦ **Objective HAP.12.1: Define lymphatic organs, immunity, and immune system.**
- **Objective HAP.12.2: Correlate immune system disorders and their effect on the body.**
- ♦ **Objective HAP.12.3: Research immune system disorders.**
- **Objective HAP.12.4: Model the body's defense systems and immunity.**
- ♦ **Objective HAP.12.5: Define and describe the lymphatic organs structures and functions of the lymphatic organs.**

13. Obtain, evaluate, and communicate information to support the claim that the endocrine glands secrete hormones that help the body maintain homeostasis through feedback loops.
    a. Analyze the effects of pathological conditions (e.g., pituitary dwarfism, Addison's disease, diabetes mellitus) caused by imbalance of the hormones of the endocrine glands.

- **Objective HAP.13.1: Define endocrine system, feedback loops, hormones, homeostatic, endocrine glands, dwarfism, and diabetes.**
- **Objective HAP.13.2: Analyze hormonal imbalances resulting in pathological conditions.**
- **Objective HAP.13.3: Describe the pathological consequences of hormonal imbalances on the body.**
- **Objective HAP.13.4: Describe the secretion of hormones in the endocrine glands.**
- **Objective HAP.13.5: Describe hormonal imbalances.**
- **Objective HAP.13.6: Illustrate functions and structures of the endocrine system.**

EARTH AND SPACE SCIENCE

The Earth and Space Science course is highly recommended for all high school students. Content focuses on a comprehensive application of all disciplines of science and is based upon the biologically active nature of our ever-changing planet and the integration of systems that constantly evolve. In an effort to encourage students to pursue careers in the fields of science, technology, engineering, and mathematics (STEM), this course incorporates the scientific and engineering practices that reflect the scientific processes used by scientists. The scientific and engineering practices are implemented through a student-centered, laboratory-intensive, collaborative classroom environment.

The Earth and Space Science standards provide a depth of conceptual understanding to adequately prepare students for college, career, and citizenship with an appropriate level of scientific literacy. Resources specific to the local area as well as external resources, including evidence-based literature found within scientific journals, should be used to extend and increase the complexity of the core ideas.

The foundation of the course is taken from two disciplinary core ideas in the Earth and Space Science domain. The first core idea, Earth's Place in the Universe, addresses the concepts of the universe and its stars, Earth and the solar system, and the history of planet Earth. The second core idea, Earth's Systems, examines Earth's materials and systems, plate tectonics and large-scale system interactions, the roles of water in Earth's surface processes, weather and climate, and biogeology. Integrated within the disciplinary core ideas of Earth and Space Science are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

Earth's Place in the Universe

1. Develop and use models to illustrate the lifespan of the sun, including energy released during nuclear fusion that eventually reaches Earth through radiation.

- ♦ **Objective ESS.1.1: Define energy, nuclear fusion, and radiation.**
  Objective ESS.1.2: Compare small scale nuclear fusion to that of the sun.
  Objective ESS.1.3: Describe nuclear fusion-including the release of photons.
- ♦ **Objective ESS.1.4: Relate a star's mass to its length of life.**

2. Engage in argument from evidence to compare various theories for the formation and changing nature of the universe and our solar system (e.g., Big Bang Theory, Hubble's law, steady state theory, light spectra, motion of distant galaxies, composition of matter in the universe).

  Objective ESS.2.1: Use models to determine scale properties of objects in the solar system.
  Objective ESS.2.2: Compare and contrast theories of changing nature and formation of universe and solar system.
- ♦ **Objective ESS.2.3: Paraphrase theories that describe the formation and the changing nature of the solar system.**
- ♦ **Objective ESS.2.4: Paraphrase theories that describe the formation and the changing nature of the universe.**

3. Evaluate and communicate scientific information (e.g., Hertzsprung-Russell diagram) in reference to the life cycle of stars using data of both atomic emission and absorption spectra of stars to make inferences about the presence of certain elements.

- **Objective ESS.3.1: Define atomic emission and absorption spectra.**
- **Objective ESS.3.2: Identify relationship between presence of elements in an absorption spectra to the age of a star.**
- **Objective ESS.3.3: Relate information from an absorption spectra to presence of certain elements.**
- **Objective ESS.3.4: Match data from atomic emission and absorption spectra.**
- **Objective ESS.3.5: Describe the life cycle of a star.**

4. Apply mathematics and computational thinking in reference to Kepler's laws, Newton's laws of motion, and Newton's gravitational laws to predict the orbital motion of natural and man-made objects in the solar system.

- **Objective ESS.4.1: Define Kepler's laws, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion, Newton's law of universal gravitation, and orbital motion.**
- **Objective ESS.4.2: Describe orbital motion of natural and man-made objects in a solar system.**
- **Objective ESS.4.3: Match Kepler's laws, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion, and Newton's law of universal gravitation to each of their corresponding mathematical equations.**
- **Objective ESS.4.4: Paraphrase Kepler's laws, Newton's first law of motion, Newton's second law of motion, Newton's third law of motion, and Newton's law of universal gravitation.**

5. Use mathematics to explain the relationship of the seasons to the tilt of Earth's axis (e.g., zenith angle, solar angle, surface area) and its revolution about the sun, addressing intensity and distribution of sunlight on Earth's surface.

- **Objective ESS.5.1: Define revolution and intensity.**
- **Objective ESS.5.2: Construct a model showing how seasons change based on the tilt of Earth's axis and its revolution about the sun.**
- **Objective ESS.5.3: Summarize the relationship of Earth's axis and the distribution of the sun's light and its intensity to the seasons.**
- **Objective ESS.5.4: Describe factors affecting the intensity of the sun's light striking Earth.**
- **Objective ESS.5.5: Describe factors affecting distribution of sun's light on Earth.**

6. Obtain and evaluate information about Copernicus, Galileo, Kepler, Newton, and Einstein to communicate how their findings challenged conventional thinking and allowed for academic advancements and space exploration.

- **Objective ESS.6.1: Describe the importance of collaboration in scientific investigations.**
- **Objective ESS.6.2: Relate and link each scientists' work to the others in chronological order.**
- **Objective ESS.6.3: Identify conventional thinking for the era of each scientist.**

Earth's Systems

7. Analyze and interpret evidence regarding the theory of plate tectonics, including geologic activity along plate boundaries and magnetic patterns in undersea rocks, to explain the ages and movements of continental and oceanic crusts.

- ♦ **Objective ESS.7.1: Define plate tectonics, geologic activity, magnetic patterns, continental crusts, and oceanic crusts.**
- **Objective ESS.7.2: Model Earth's interior composition to illustrate the resulting magnetic field and to explain its measurable effects.**
- **Objective ESS.7.3: Explain how the flow of Earth's internal energy drives a continuous movement of matter between Earth's surface and deep interior causing plate movements.**
- **Objective ESS.7.4: Explain how geologic processes shape Earth's history over widely varying scales of space and time.**
- ♦ **Objective ESS.7.5: Describe distribution of fossils and rocks, continental shapes, and sea-floor structures to explain past plate motions.**

8. Develop a time scale model of Earth's biological and geological history to establish relative and absolute age of major events in Earth's history (e.g., radiometric dating, models of geologic cross sections, sedimentary layering, fossilization, early life forms, folding, faulting, igneous intrusions).

- ♦ **Objective ESS.8.1: Define biological history and geological history.**
- **Objective ESS.8.2: Construct explanations from geologic evidence to identify patterns of Earth's major historical events.**
- ♦ **Objective ESS.8.3: Illustrate the chemical and physical processes that form rocks and cycle Earth's materials.**

9. Obtain, evaluate, and communicate information to explain how constructive and destructive processes (e.g., weathering, erosion, volcanism, orogeny, plate tectonics, tectonic uplift) shape Earth's land features (e.g., mountains, valleys, plateaus) and sea features (e.g., trenches, ridges, seamounts).

- ♦ **Objective ESS.9.1: Define constructive processes and destructive processes.**
- **Objective ESS.9.2: Explain how the flow of Earth's internal energy drives a continuous movement of matter between Earth's surface and deep interior causing plants movements using models.**
- ♦ **Objective ESS.9.3: Differentiate between constructive and destructive processes and how they shape Earth's features.**
- ♦ **Objective ESS.9.4: Classify Earth's land features vs. Earth's sea features.**

10. Construct an explanation from evidence for the processes that generate the transformation of rocks in Earth's crust, including chemical composition of minerals and characteristics of sedimentary, igneous, and metamorphic rocks.

- ♦ **Objective ESS.10.1: Define chemical composition, sedimentary rocks, igneous rocks, and metamorphic rocks.**

Objective ESS.10.2: Demonstrate the chemical and physical processes that form rocks and cycle Earth's materials.

- **Objective ESS.10.3: Describe processes that generate transformation of rocks in Earth's crust.**
- **Objective ESS.10.4: Examine characteristics of three types of rocks.**

11. Obtain and communicate information about significant geologic characteristics (e.g., types of rocks and geologic ages, earthquake zones, sinkholes, caves, abundant fossil fauna, mineral and energy resources) that impact life in Alabama and the southeastern United States.

- **Objective ESS.11.1: Define geologic characteristics.**

Objective ESS.11.2: Examine geologic events in Alabama and the southeastern United States that describe how Earth's internal energy drives a continuous movement of matter.

- **Objective ESS.11.3: Explain how specific geologic processes in Alabama and the southeastern United States shape its history.**
- **Objective ESS.11.4: Identify patterns of Earth's major historical events.**

12. Develop a model of Earth's layers using available evidence to explain the role of thermal convection in the movement of Earth's materials (e.g., seismic waves, movement of tectonic plates).

- **Objective ESS.12.1: Define thermal convection.**

Objective ESS.12.2: Describe how Earth's internal energy drives a continuous movement of matter.

- **Objective ESS.12.3: Explain how different geologic processes shape Earth's history over time.**

13. Analyze and interpret data of interactions between the hydrologic and rock cycles to explain the mechanical impacts (e.g., stream transportation and deposition, erosion, frost-wedging) and chemical impacts (e.g., oxidation, hydrolysis, carbonation) of Earth materials by water's properties.

- **Objective ESS.13.1: Define hydrologic cycles, rock cycles, and mechanical impacts.**

Objective ESS.13.2: Distinguish between mechanical impacts and chemical impacts of water on Earth.

- **Objective ESS.13.3: Illustrate the rock cycle.**
- **Objective ESS.13.4: Illustrate the hydrologic cycle.**
- **Objective ESS.13.5: Describe the properties of water.**

14. Construct explanations from evidence to describe how changes in the flow of energy through Earth's systems (e.g., volcanic eruptions, solar output, ocean circulation, surface temperatures, precipitation patterns, glacial ice volumes, sea levels, Coriolis effect) impact the climate.

- **Objective ESS.14.1: Define atmosphere, biosphere, geosphere, and hydrosphere.**
- **Objective ESS.14.2: Describe human activities and natural processes that may cause changes in local and global temperatures over time by analyzing and interpreting data.**

Objective ESS.14.3: Describe the interaction among the atmosphere, biosphere, geosphere, and hydrosphere, and how they support life.

15. Obtain, evaluate, and communicate information to verify that weather (e.g., temperature, relative humidity, air pressure, dew point, adiabatic cooling, condensation, precipitation, winds, ocean currents, barometric pressure, wind velocity) is influenced by energy transfer within and among the atmosphere, lithosphere, biosphere, and hydrosphere.
    a. Analyze patterns in weather data to predict various systems, including fronts and severe storms.
    b. Use maps and other visualizations to analyze large data sets that illustrate the frequency, magnitude, and resulting damage from severe weather events in order to predict the likelihood and severity of future events.

- **Objective ESS.15.1: Define atmosphere, lithosphere, biosphere, hydrosphere, system, and magnitude.**
  Objective ESS.15.2: Integrate quantitative scientific and technical information to support the claim that motions and complex interactions of air masses result in changes in weather conditions.
- **Objective ESS.15.3: Predict weather based on weather maps.**
- **Objective ESS.15.4: Match weather map symbols with weather occurrences.**

ENVIRONMENTAL SCIENCE

Environmental Science is a course that introduces students to a broad view of the biosphere and the physical parameters that affect it. The course incorporates the scientific and engineering practices reflecting the scientific processes used in science, technology, engineering, and mathematics (STEM) fields. The scientific and engineering practices are implemented through a student-centered and collaborative classroom environment that is laboratory-intensive and includes field investigations and case studies.

Core ideas are explored and developed in more detail and refined with increased sophistication and rigor based upon knowledge gained in earlier grades. Students learn by constructing explanations from evidence acquired through analysis and interpretation of data from laboratory investigations, field investigations, and case studies. Students integrate and evaluate multiple sources of authentic information to address issues or suggest possible solutions to problems in the environment based on current findings. The academic language of the core idea is used in context to communicate claims, evidence, and reasoning for phenomena and to engage in argument from evidence to justify and defend claims. Students are encouraged to use creativity in designing engineering solutions to solve various problems affecting Earth and its environment.

The Environmental Science content standards provide a depth of conceptual understanding to adequately prepare students for college, career, and citizenship with an appropriate level of scientific literacy. The foundation of the course is based upon Earth and Human Activity, one of the disciplinary core ideas in the Earth and Space Science domain. This core idea involves areas of study that include natural resources, natural hazards, human impacts on Earth systems, and global climate change. Integrated within the disciplinary core ideas of Environmental Science are the Engineering, Technology, and Applications of Science (ETS) core ideas, which are denoted with an asterisk (*). The ETS core ideas require students to use tools and materials to solve simple problems and to use representations to convey design solutions to a problem and determine which is most appropriate.

Students will:

Earth and Human Activity

1. Investigate and analyze the use of nonrenewable energy sources (e.g., fossil fuels, nuclear, natural gas) and renewable energy sources (e.g., solar, wind, hydroelectric, geothermal) and propose solutions for their impact on the environment.

   - **Objective ES.1.1: Define nonrenewable energy, renewable energy, fossil fuel, hydroelectric energy, and geothermal energy.**
   - **Objective ES.1.2: Research solutions to minimize the impact of non-renewable energy sources has on the environment.**
   - **Objective ES.1.3: Compare and contrast renewable and nonrenewable energy sources.**
   - **Objective ES.1.4: Identify nonrenewable and renewable energy resources.**

2. Use models to illustrate and communicate the role of photosynthesis and cellular respiration as carbon cycles through the biosphere, atmosphere, hydrosphere, and geosphere.

   - **Objective ES.2.1: Define photosynthesis, cellular respiration, carbon dioxide,**

biosphere, atmosphere, hydrosphere, geosphere, and cellular respiration.

Objective ES.2.2: Demonstrate the role photosynthesis and cellular respiration play in the biosphere, atmosphere, hydrosphere, and geosphere.

♦ **Objective ES.2.3: Illustrate how carbon cycles through the atmosphere, biosphere, hydrosphere, and geosphere.**

3. Use mathematics and graphic models to compare factors affecting biodiversity and populations in ecosystems.

♦ **Objective ES.3.1: Define biodiversity, ecosystem, and population.**

Objective ES.3.2: Predict future population changes in an ecosystem based on a specific factor.

♦ **Objective ES.3.3: Analyze ecosystem changes affected by a specific factor.**

Objective ES.3.4: Determine factors affecting biodiversity in ecosystems.

♦ **Objective ES.3.5: Identify factors affecting biodiversity in populations.**

4. Engage in argument from evidence to evaluate how biological or physical changes within ecosystems (e.g., ecological succession, seasonal flooding, volcanic eruptions) affect the number and types of organisms, and that changing conditions may result in a new or altered ecosystem.

♦ **Objective ES.4.1: Define ecological succession, physical changes, and biological.**

♦ **Objective ES.4.2: Chart patterns of change in the ecosystem which effect populations.**

♦ **Objective ES.4.3: Determine how biological or physical changes in an ecosystem can cause a change in population rate.**

♦ **Objective ES.4.5: Identify biological and physical changes that occur in ecosystems.**

5. Engage in argument from evidence to compare how individual versus group behavior (e.g., flocking; cooperative behaviors such as hunting, migrating, and swarming) may affect a species' chance to survive and reproduce over time.

♦ **Objective ES.5.1: Define flocking, migrating, swarming, survival, and reproduce.**

♦ **Objective ES.5.2: Explain the success rate between individual behavior versus group behavior when hunting.**

♦ **Objective ES.5.3: Collect data on success rates relating to grouped animal behavior.**

6. Obtain, evaluate, and communicate information to describe how human activity may affect biodiversity and genetic variation of organisms, including threatened and endangered species.

♦ **Objective ES.6.1: Define biodiversity, genetic variations, threatened species, and endangered species.**

♦ **Objective ES.6.2: Differentiate between threatened and endangered species.**

Objective ES.6.3: Categorize types of human activity affecting the biodiversity and genetic variations of organisms and species as either sustainable or non-sustainable.

Objective ES.6.4: List different types of human activities which affect biodiversity and genetic variation of organisms.

7. Analyze and interpret data to investigate how a single change on Earth's surface may cause changes to other Earth systems (e.g., loss of ground vegetation causing an increase in water runoff and soil erosion).

- **Objective ES.7.1: Define vegetation, runoff, and soil erosion.**
- **Objective ES.7.2: Gather data describing how single changes on Earth's surface create feedbacks that cause changes to other Earth systems.**
- **Objective ES.7.3: Identify changes to Earth's surface that cause a change to other Earth's systems.**

8. Engage in an evidence-based argument to explain how over time Earth's systems affect the biosphere and the biosphere affects Earth's systems (e.g., microbial life increasing the formation of soil; corals creating reefs that alter patterns of erosion and deposition along coastlines).

- **Objective ES.8.1: Define biosphere, microbial, corals, coral reefs, erosion, and deposition.**
- **Objective ES.8.2: Identify ways the biosphere affects Earth's systems.**
- **Objective ES.8.3: Identify ways Earth's systems affect the biosphere.**
- **Objective ES.8.4: Identify examples of Earth's systems.**

9. Develop and use models to trace the flow of water, nitrogen, and phosphorus through the hydrosphere, atmosphere, geosphere, and biosphere.

- **Objective ES.9.1: Define coastal, marine, freshwater, recreation, biosphere, hydrosphere, atmosphere, geosphere, nitrogen, and phosphorous.**
- **Objective ES.9.2: Illustrate the water and nitrogen cycles.**
- **Objective ES.9.3: Trace the flow of water through the atmosphere.**

10. Design solutions for protection of natural water resources (e.g., bioassessment, methods of water treatment and conservation) considering properties, uses, and pollutants (e.g., eutrophication, industrial effluents, agricultural runoffs, point and nonpoint pollution resources).*

- **Objective ES.10.1: Define pollutants, run off, point pollution, non- point pollutions, and conservation.**
- **Objective ES.10.2: Create solutions to protect natural water resources.**
- **Objective ES.10.3: Determine pollutants found in natural water resources.**
- **Objective ES.10.4: Discuss water conservation solutions.**
- **Objective ES.10.5: Identify point and non-point pollution resources.**
- **Objective ES.10.6: Identify environmental protection laws.**

11. Engage in argument from evidence to defend how coastal, marine, and freshwater sources (e.g., estuaries, marshes, tidal pools, wetlands, beaches, inlets, rivers, lakes, oceans, coral reefs) support biodiversity, economic stability, and human recreation.

- **Objective ES.11.1: Define coastal, marine, freshwater, recreation, and biodiversity.**
- **Objective ES.11.2: Create a diorama of a freshwater ecosystem and a marine ecosystem.**
- **Objective ES.11.3: Compare and contrast marine and freshwater ecosystems.**
- **Objective ES.11.4: Identify coastal, marine, and freshwater resources.**

12. Analyze and interpret data and climate models to predict how global or regional climate change can affect Earth's systems (e.g., precipitation and temperature and their associated impacts on sea level, glacial ice volumes, and atmosphere and ocean composition).

- **Objective ES. 12.1: Define climate, precipitation, temperature, glaciers, and atmosphere.**
- **Objective ES.12.2: Predict future temperature trends in certain regions based on climate data.**
- **Objective ES.12.3: Predict how climate change affect Earth's systems regionally and globally.**
- **Objective ES.12.4: Collect data on regional temperatures.**

13. Obtain, evaluate, and communicate information based on evidence to explain how key natural resources (e.g., water sources, fertile soils, concentrations of minerals and fossil fuels), natural hazards, and climate changes influence human activity (e.g., mass migrations).

- **Objective ES.13.1: Define natural resources, natural hazard, and climate change.**
- **Objective ES.13.2: Determine the difference between natural resources and natural hazards.**

14. Analyze cost-benefit ratios of competing solutions for developing, conserving, managing, recycling, and reusing energy and mineral resources to minimize impacts in natural systems (e.g., determining best practices for agricultural soil use, mining for coal, and exploring for petroleum and natural gas sources).*

- **Objective ES.14.1: Define cost benefit, conserving/conservation, and recycling.**
- **Objective ES.14.2: Research and communicate cost effective methods for sustainability of waste management.**
- **Objective ES.14.3: Identify the benefits of recycling plastic bottles and aluminum cans.**

15. Construct an explanation based on evidence to determine the relationships among management of natural resources, human sustainability, and biodiversity (e.g., resources, waste management, per capita consumption, agricultural efficiency, urban planning).

- **Objective ES.15.1: Define waste management, natural resources, sustainability, per capita consumption, and biodiversity.**
- **Objective ES.15.2: Identify ways urban planning affects natural resources.**
- **Objective ES.15.3: Create a model of a landfill.**
- **Objective ES.15.4: Identify ways humans manage natural resources.**

16. Obtain and evaluate information from published results of scientific computational models to illustrate the relationships among Earth's systems and how these relationships may be impacted by human activity (e.g., effects of an increase in atmospheric carbon dioxide on photosynthetic biomass, effect of ocean acidification on marine populations).

- **Objective ES.16.1: Define carbon dioxide, photosynthetic, biomass, and ocean acidification.**
- **Objective ES.16.2: Compare and contrast methods used to restore a damaged environment.**
- **Objective ES.16.3: Explain ways a manmade disaster can affect the environment.**
- **Objective ES.16.4: Identify man-made disasters.**

17. Obtain, evaluate, and communicate geological and biological information to determine the types of organisms that live in major biomes.
    a. Analyze and interpret data collected through geographic research and field investigations (e.g., relief, topographic, and physiographic maps; rivers; forest types; watersheds) to describe the biodiversity by region for the state of Alabama (e.g., terrestrial, freshwater, marine, endangered, invasive).

- **Objective ES.17.1: Define geological, biological, topography, topographic map, terrestrial, biomes, geographic research, physiographic maps, and invasive.**
- **Objective ES.17.2: Identify different types of data that can be collected and analyzed to describe biodiversity in Alabama.**
- **Objective ES.17.3: Identify geological and biological information that can be used to determine effects on organisms that live in a biome.**

Objective ES.17.4: Participate in a field investigation to observe organisms within a specific region of Alabama.

GLOSSARY OF SCIENCE TERMS

Air mass. Body of air covering a relatively wide area, exhibiting approximately uniform properties through any horizontal section

Allele. Any of several forms of a gene, usually arising through mutation, that are responsible for hereditary variation.

Amplitude. The maximum extent of a vibration or oscillation, measure from the position of equilibrium

Anatomical structures. Relating to a particular complex part of a living thing.

Anemometer. Any instrument used to measure the speed of wind.

Aquifers. Any geological formation containing or conducting ground water, especially one that supplies the water for wells, springs, etc.

Asexual reproduction. Type of reproduction involving a single parent that results in offspring genetically identical to the parent.

Astronomical unit. A unit of length, equal to the mean distance of the earth from the sun; approximately 93 million miles (150 million km). Abbreviation: AU

Boyle's Law. Describes the inverse relationship between the pressure and volume of a fixed amount of gas at a constant temperature.

Chemical composition. Refers to the arrangement, type, and ratio of atoms in molecules of chemical substances.

Chloroplast. A structure within the cells of plants and other organisms that is the site of photosynthesis.

Chromosomes. The microscopic threadlike part of the cell that carries hereditary information in the form of genes.

Chronological. Any method used to order time and to place events in the sequence in which they occurred.

Cladogram. A branching diagram depicting patterns of shared characteristics among species.

Global climate change. Changes in average weather that occurs in an area over a period of years or decades.

Closed system. A physical system that does not allow certain types of transfers (such as transfer of mass) in or out of the system.

Coastal. The area where land meets the sea or ocean, or a line that forms the boundary between the land and the ocean or a lake.

Codominance. Situation in which the phenotypes produced by both alleles are completely expressed.

Coefficient. A number in a chemical equation that indicates the relative number of units of a reactant or product involved in the reaction.

Coelacanth. Large, bony, marine fish with a three-lobed tail fin and pectoral fins thought to be related to the ancestors of land vertebrates.

Combustion reaction. A chemical reaction between substances, usually including oxygen and usually accompanied by the generation of heat and light in the form of flame.

Commensalism. A relationship between individuals of two species in which one species obtains food or other benefits from the other without either harming or benefiting the latter.

Competition. A relationship in which multiple organisms seek the same limited resource.

Compound. Any substance formed by the chemical combination of two or more elements in definite proportions.

Concentration. A measured amount of solute dissolved in a definite amount of solvent.

Conduction. The transfer of heat energy from particle to particle within a substance or between substances through contact of atoms.

Conductivity. The property of transmitting heat, electricity or sound.

Conductor. A material with the ability to conduct heat or electricity.

Conservation of mass. Matter can neither be created nor destroyed in a chemical reaction.

Conservation of Momentum. The general law of physics according to which the quantity called momentum that characterizes motion never changes in an isolated collection of objects; that is, the total momentum of a system remains constant.

Constant velocity. Velocity that does not change over a period of time.

Constructive forces. Processes that help build up the Earth, either by depositing soil or silt in a river, or by volcanoes and lava flows that generates new land.

Continental crust. The layer of igneous, sedimentary, and metamorphic rocks that forms the continents and the areas of shallow seabed close to their shores, known as continental shelves.

Continental drift. The large-scale horizontal movements of continents relative to one another and to the ocean basins during one or more episodes of geologic time.

Convection. The transfer of heat by the physical motion of masses of fluid (liquids and gases) by changes in density of the fluid.

Convection currents. A current in a fluid that results from convection by which heat is transferred by movement of a heated fluid such as air or water.

Convergent boundary. An actively deforming region where two (or more) tectonic plates or fragments of the lithosphere move toward one another and collide.

Correlations. A mutual relationship or connection between two or more things.

Cosmic Radiation. Radiation coming from outside the solar system.

Covalent Compound. Formed when two or more nonmetal atoms bond by sharing valence electrons.

Crystallization. A chemical solid–liquid separation technique, in which mass transfer of a solute from the liquid solution to a pure solid crystalline phase occurs.

Deforestation. The clearing of trees, transforming a forest into cleared land.

Deformation. The action or process of changing in shape or distorting, especially through the application of pressure.

Density. The intensive physical property of a substance described by its mass per unit volume and often expressed as g/cm^3.

Desert. A region that has little or no vegetation, long periods without rain, and extreme temperatures, usually found in warm climates.

Destructive forces. Processes that break down the Earth, either through the violent actions of volcanoes and earthquakes or by the steady flow of a river.

Dichotomous Key. A tool that allows the user to determine the identity of items in the natural world, such as trees, wildflowers, mammals, reptiles, rocks, and fish.

Diffusion. Process by which particles tend to move from an area where they are more concentrated to an area where they are less concentrated.

Dilution. Process of making a solution less concentrated by adding solvent.

Dispersion. In Ecology, the action or process of distributing things or people over a wide area; in Chemistry, a system of dispersed particles suspended in a solid, liquid, or gas; in Optics, the separation of white or compound light into its respective colors.

Displacement. The moving of something from its place or position.

Distance. An amount of space between two things or people.

Divergent boundary. A linear feature that exists between two tectonic plates that are moving away from each other.

Drought. A prolonged period of abnormally low rainfall; a shortage of water resulting from low rainfall.

Dynamic Chemical Equilibrium. A state of balance between continuing processes.

Ecology. The branch of science that deals with the distribution and abundance of organisms, the interactions among them, and the interactions between organisms and their abiotic environments.

Ecological Succession. Process by which one community or organisms slowly replaces another in an area.

Ecosystem. A biological community of interacting organisms and their physical environment.

Elastic Collisions. An encounter between two bodies in which the total kinetic energy of the two bodies after the encounter is equal to their total kinetic energy before the encounter.

Electron Affinity. The amount of energy needed to remove an electron from a negatively charged ion.

Electric force. An attractive or repulsive force between two charged objects.

Electromagnet. A device consisting of a core of magnetic material surrounded by a coil through which an electric current is passed to magnetize the core.

Electromagnetic spectrum. The entire distribution of electromagnetic radiation according to frequency or wavelength.

Electromagnetic radiation. The flow of energy at the universal speed of light through free space or through a material medium in the form of the electric and magnetic fields that make up electromagnetic waves such as radio waves, visible light, and gamma rays.

Electromagnetic wave. A wave of energy with a frequency within the electromagnetic spectrum, generated by the periodic fluctuation of an electromagnetic field resulting from the acceleration or oscillation of an electric charge.

Electronegative. Electrically negative; (of an element) tending to acquire electrons and form negative ions in chemical reactions.

Electrons. A stable subatomic particle with a charge of negative electricity, found in all atoms and acting as the primary carrier of electricity in solids.

Elements. Each of more than one hundred substances that cannot be chemically interconverted or broken down into simpler substances and are primary constituents of matter.

Elliptical orbits. A small body in space orbits a large one (like a planet around the sun) along an elliptical path, with the large body being located at one of the ellipse foci.

Embryology. The branch of biology and medicine concerned with the study of embryos and their development.

Empirical formula. Formula for the smallest possible ratio of the elements in a compound.

Endothermic. A reaction or process accompanied by or requiring the absorption of heat.

Energy. The property of matter and radiation that is manifest as a capacity to perform work (such as causing motion or the interaction of molecules); power derived from the utilization of physical or chemical resources, especially to provide light and heat or to work machines.

Energy transfer. The conveyance of energy from one item to another; the transfer occurs among different scales and motions; a major premise of the interaction between energy-producing and energy-utilizing metabolic pathways in living cells.

Erosion. The action of exogenic processes (such as water flow or wind) which remove soil and rock from one location on the Earth's crust, then transport it to another location where it is deposited.

Eukaryotic. Any organism whose cells contain a nucleus and other organelles enclosed within membranes.

Exothermic. A reaction or process accompanied by the release of heat.

External Forces. Pressures that arise from outside a system.

Fault lines. A line on a rock surface or the ground that traces a geological fault.

Faulting. (Of a rock formation) be broken by a fault or faults.

Filtration. The mechanical or physical operation which is used for the separation of solids from fluids (liquids or gases) by interposing a medium through which only the fluid can pass.

Folding. The result of compression that causes the formation of the geological structures known as anticlines.

Force. A quality that tends to produce movement or acceleration of a body in the direction of its application; a push or pull.

Force diagram. A tool which is used to find all of the forces acting on an object and to calculate the net (total) force acting on the object.

Fossil fuels. A nonrenewable energy source formed from the remains of organisms that lived long ago; examples include oil, coal, and natural gas.

Fossil record. The total number of fossils that have been discovered and the information derived from them

Frame shift mutation. A genetic mutation caused by a deletion or insertion in a DNA sequence that shifts the way the sequence is read.

Gene therapy. The transplantation of normal genes into cells in place of missing or defective ones in order to correct genetic disorders.

Genetic modification. Any alteration of genetic material, as in agriculture, to make them capable of producing new substances or performing new functions.

Genetic variations. Variations of genomes between members of a species, or between groups of species thriving in different parts of the world as a result of genetic mutation.

Geologic activity. Geological processes that occur to reshape the land.

Geologic timeline. A system of chronological measurement that relates stratigraphy to time, and is used to describe the timing and relationships between events that have occurred throughout Earth's history.

Geologic cross section. A vertical cross section of the earth showing rock units, folds and faults.

Geoscience processes. Processes that change Earth's surface at time and spatial scales that can be large, such as plate movement or as small as landslides or microscopic geochemical reactions.

Greenhouse effect. A warming of Earth's surface and troposphere (the lowest layer of the atmosphere) caused by the presence of water vapor, carbon dioxide, methane, and certain other gases in the air.

Half-life. In radioactivity, the interval of time required for one-half of the atomic nuclei of a radioactive sample to decay (change spontaneously into other nuclear species by emitting particles and energy), or, equivalently, the time interval required for the number of disintegrations per second of a radioactive material to decrease by one-half.

Heat capacity. The ratio of heat absorbed by a material to the temperature change.

Heredity. The sum of all biological processes by which particular characteristics are transmitted from parents to their offspring.

Heterogeneous mixture. A type of mixture in which the components are unevenly mixed and not combined.

Heterozygote. An organism which has two different alleles of a given gene or genes.

Homozygote. An organism having identical pairs of genes for any given pair of hereditary characteristics.

Ionic Bond. The electrostatic bond between two ions formed through the transfer of one or more electrons.

Ionic Compound. A chemical compound of cations and anions which are held together by ionic bonds in a lattice structure.

Isotonic solution. When the concentration of two solutions is the same.

Isotopes. Atoms of the same element with different numbers of neutrons in the nucleus, and thus different atomic masses.

Kepler's Three Laws of Planetary Motion. Any one of the three laws governing planetary motion, each planet revolves in an ellipse, with the sun at one focus (low of ellipses); the line connecting a planet to sun sweeps out equal areas in equal periods of time (law of equal areas); or the ratios of the squares of the period of any two planets is equal to the ratio of the cubes of their average distances from the sun (harmonic law).

Kinetic energy. The energy an object or particle has because it is moving.

Kinetic Molecular Theory. A theory of the thermodynamic behavior of matter, especially the relationships among pressure, volume, and temperature in gases, based on the dependence of temperature on the kinetic energy of the rapidly moving particles of a substance.

Law of Conservation of Energy. States that energy cannot be created or destroyed, it can only change form or be transferred.

Law of Conservation of Mechanical Energy. States that the total mechanical energy in a system (i.e., the sum of the potential plus kinetic energies) remains constant as long as the only forces acting are conservative forces.

Law of Segregation. The principle, originated by Gregor Mendel, stating that during the production of gametes the two copies of each hereditary factor segregate so that offspring acquire one factor from each parent.

Le Chatelier's Principle. A principal stating that if a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change.

Levees. An embankment designed to prevent the flooding of a river.

Light Intensity. Luminous intensity measured in candelas.

Light year. The distance traversed by light in one mean solar year, about 5.88 trillion miles; used as a unit in measuring stellar distances.

Liquids. Matter that has a definite volume, but not a definite shape.

Lithosphere. The outermost layer of Earth's surface, which is rocky and solid; includes the crust and the rigid part of the upper mantle.

Longitudinal wave. A wave that oscillates back and forth parallel to the direction it is traveling.

Lymph System. Network of tissues and organs that help rid the body of toxins, waste and other unwanted materials; transports lymph, a fluid containing infection-fighting white blood cells throughout the body.

Macromolecules. A very large molecule, such as a protein, nucleic acid, carbohydrate or lipid.

Magnetic Field. A region of magnetic force around a magnet.

Magnetic force. The attractive or repulsive force that acts between magnetic materials.

Magnetic Poles. One of the two ends of a magnet where the magnetism seems to be concentrated.

Magnitude. Strength or intensity of a property or event, such as the brightness of a star or plant, or the strength of an earthquake.

Main Group Elements. Any of the chemical elements belonging to the S (groups 1-2) and P (groups 13-18) blocks.

Mass. The amount of matter in an object.

Mechanical Energy. The sum of kinetic energy and potential energy in objects.

Culture Medium. Substance, either solid or liquid, used for the cultivation, isolation, identification, or storage of microorganisms.

Meiosis. A type of cell division that produces sex cells (eggs or sperm), which have only half the chromosomes of the parent cell.

Metals. Elements, usually solid, with a shiny surface; metals conduct electricity and thermal energy well; examples include gold, iron, lead, copper, and silver.

Metalloid. A nonmetal that in combination with a metal forms an alloy.

Metamorphic Rock. In geology, denoting rock that has undergone transformation by heat, pressure, or other natural agencies, e.g., in the folding of strata or the nearby intrusion of igneous rocks.

Mid-ocean Ridge. Undersea mountain range that forms where two parts of Earth's crust are pushing apart.

Minerals. Element or compound, formed by nature but not formed by living things, that has a specific crystal structure and physical and chemical properties.

Mitochondrion. Structures in the cell that transform the energy in food into a form cells can use to carry out their activities.

Mitosis. A type of cell division that results in two daughter cells each having the same number and kind of chromosomes as the parent nucleus.

Mixture. A combination of two or more substances that have not combined chemically and that can be separated by physical means.

Molar Mass. The weight of one mole in any chemical substance.

Molarity. (Also known as molar concentration.) The number of moles of solute dissolved in one liter of solution.

Mole (mol). The SI unit of amount of substance, equal to 6.02×10^{23} units, where the unit may be any specified entity; it is the chemist's "counting" aid.

Molecules. The smallest particle of a substance that still has the properties of that substance.

Momentum. The quantity of motion of a moving body, measured as the product of the mass and velocity.

Monohybrid. A hybrid that is heterozygous with respect to a specific gene.

Mutation. Change in the genetic material of a cell.

Mutualism. Symbiotic relationship in which both species benefit from the relationship.

Natural Hazards. A naturally occurring event that might have a negative effect on people or the environment.

Natural Selection. Process by organisms that are most suited to their environment survive and reproduce most successfully; also called survival of the fittest.

Nautilus. A cephalopod mollusk with a light external spiral shell and numerous short tentacles around the mouth.

Net Force. Sum of the individual forces acting on that object.

Neurotransmission. The process by which signaling molecules called neurotransmitters are released by a neuron and bind to and activate the receptors of another neuron.

Neutron. In an atom, particle with a neutral charge; located in the nucleus.

Newton's First Law of Motion. States that an object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force.

Newton's Law of Universal Gravitation. States that any two bodies in the universe attract each other with a force that is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

Newton's Second Law of Motion. States that the acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force, in the same direction as the net force, and inversely proportional to the mass of the object.

Newton's Third Law of Motion. States that for every action, there is an equal and opposite reaction.

Nitrogen Cycle. In the environment, the movement of nitrogen between the living and non-living parts of an ecosystem.

Nonmetal. A chemical element that mostly lacks metallic properties such as conductivity, malleability, and ductility. They are generally gases or soft, brittle solids.

Non-renewable Resources. A natural resource that is being used up faster than it can be replaced by natural processes; most fossil fuels, such as oil, coal, and natural gas are considered nonrenewable resources in that their use is not sustainable because their formation takes billions of years.

Nuclear Fusion. A nuclear reaction in which nuclei combine to form more massive nuclei with the release of a large amount of energy. During this process, matter is not conserved because some of the matter of the fusing nuclei is converted to photons.

Nucleus. In biology, in cells, the structure that contains the cell's genetic material in the form of DNA; In chemistry, the positively charged center of an atom, made up of protons and neutrons.

Oceanic crust. The outermost layer of Earth's lithosphere that is found under the ocean.

Ohm's Law. An equation that describes the relationship among current, voltage, and resistance in an electric circuit: $I = V/R$.

Opaque. Not allowing light to pass through.

Orbital Motion. Motion of an object in an orbit around a fixed point.

Organism. A living thing; anything that can carry out life's processes independently.

Osmosis. The diffusion of fluids through membranes or porous partitions.

Pangea. The hypothetical landmass that existed when all continents were joined, from about 300 to 200 million years ago.

Parallel Circuits. A circuit in which each load forms a separate circuit with the energy source; if one load stops working, the other loads keep working.

Parasitism. Symbiotic relationship in which one organism lives on or inside another organism and harms it.

Particle. One of the extremely small constituents of matter, as an atom or nucleus.

Passive Transport. The cellular process of moving molecules and other substances across membranes without need of energy input.

Pedigree. An ancestral line; line of descent; lineage; ancestry.

Periodic Table of Elements. A chart where all elements are organized into periods and groups according to their properties.

pH Scale. Scale ranging from 0-14, used to describe how acidic (<7) or basic (>7) a substance is.

Phase changes. A change from one state (solid or liquid or gas) to another without a change in chemical composition.

Phenotype. The physical appearance of an organism.

Photosynthesis. The chemical process by which plants use light energy to make sugar from water and carbon dioxide.

Phylogenetic Tree. The diagram or chart showing the development or evolution of a particular group of organisms.

Phylogeny. The development or evolution of a particular group of organisms.

Physical Change. Occurs when one or more physical properties of a substance are changed; many physical changes can be undone by physical means.

Physical Property. Any property of matter that does not change its chemical composition, such as density, boiling point, mass, and temperature.

Physical weathering. Breaking down of rock into bits and pieces by exposure to temperature changes and the physical action of moving ice and water, growing roots, and human activities such as construction and farming.

Physiographic map. A map that defines Earth's landforms as a bird's eye view through pictures.

Pictorial Data. Data represented through pictures.

Pith Ball. Lightweight, nonconductive substance usually made of plastic, but once made of spongy material in plant called pith, that is suspended by a thread and used to test the presence of a charge on an object.

Plains. An area of land not significantly higher than adjacent areas and with relatively minor differences in elevation, commonly less than 500 feet (150 meters), within the area.

Plane. Being level or straight or regular and without variation as e.g. in shape or texture.

Plate Tectonics. Theory that describes and explains the way that continents separated into today's land masses from one large ancestral land mass (Pangaea); also, the study of lithospheric plates, their movements, and Earth features they affect.

Plumage. The light horny waterproof structure forming the external covering of birds.

Point Mutation. A mutation that changes one nucleotide in a gene or DNA sequence by substitution, deletion, or addition.

Polar Covalent Bonds. From uneven sharing of electrons resulting in regions of partial positive and partial negative charge.

Pollination. The transfer of pollen from the male part of the plant (stamen) to the female part of the plant (pistil).

Potential energy. Stored energy an object has because of its position or shape.

Power generation. The process of generating electric power from other sources of primary energy.

Precipitation. (Weather) water that falling from clouds in any form, such as snow, ice, raindrops, or drizzle; (Chemistry) the process of separating a solid substance from a liquid.

Predation. Process by which one organism hunts and kills another organism for food.

Predator. Organism that hunts and kills another organism for food.

Pressure. Amount of force exerted on a given area.

Probability. A measure of how often a particular event will happen if something is done repeatedly.

Product. A substance that is formed as a result of a chemical reaction.

Prokaryote. Organisms with cells that do not have a nucleus or membrane-bound organelles.

Property. Characteristic of a material that helps to identify or classify matter.

Proton. Positively charged particle located in the nucleus of an atom.

Punnett Square. In genetics, table used to predict what traits offspring will have, based on what traits the parents have.

Purify. Remove impurities from, increase the concentration of, and separate through the process of distillation.

Radar (Radio Detection and Ranging). Measuring instrument; use of reflected radio waves to determine the distance of an object and the direction it is moving.

Radiation. Electromagnetic waves that directly transport energy in all directions through space.

Rock cycle. Process by which rocks, over geologic ages, can be changed into different kinds of rock.

Scientific Notation. A way of writing extremely large or extremely small numbers; uses a number between 1-10 multiplied by a power of 10, such as 2.3×10^{4} or 3.9×10^{-3}.

Sediment. Small pieces of material that have broken off of rocks and have been deposited by water, wind, or ice.

Significant Figures. All the nonzero digits of a number and the zeros that are included between them or that are final zeros and signify accuracy.

Simulation. The representation of physical systems and phenomena by computers, models, and other equipment.

Solids. Matter that has a definite shape and volume, such as a rock.

Solubility. The quantity of a particular substance that can dissolve in a particular solvent to form a saturated solution at a particular temperature.

Solute. The dissolved matter in a solution.

Solution. Mixture in which the molecules of one substance, known as the solute, are dissolved in another substance, known as the solvent; the solute is present in a smaller quantity than the solvent.

Solvents. A liquid substance capable of dissolving other substances.

Sound. Energy that travels through matter as mechanical waves, and can be heard by the ear.

Species. Group of similar organisms that can interbreed and produce fertile offspring.

Speed. Distance traveled by an object in a given amount of time.

Stoichiometry. The study of relationships (mass-mole-volume) among substances involved in chemical reaction.

Strong Acid. An acid that is completely ionized when dissolved in water.

Strong Base. A base which completely dissociates in water into the cation and OH (hydroxide ion).

Suppression. (Botany) the absence of parts normally or usually present due to the action of frost, disease, or insects; (Radio electronics) the elimination of a component of a varying emissions, as the elimination of a frequency or group of frequencies from a signal.

Synthesize. To combine and form a complex whole.

Synthetic. A compound made artificially by chemical reactions.

Tectonic plate. Sub-layers of the earth's crust that move, float, and sometimes, fracture and whose interaction causes continental drift, earthquakes, volcanoes, mountains, and oceanic trenches.

Terrestrial. Pertaining to or consisting of land, distinguished from water.

Thermal Convection. Atmospheric currents, predominantly vertical, arising from the release of gravitational visibility, commonly produced by solar heating of the ground; the cause of convective (cumulus) clouds.

Topographic Map. Map that shows the shape and elevation of the land surface using contour lines, and shows other land features using symbols and colors.

Trench. A deep furrow, ditch or cut (oceanography) a long, steep-sided, narrow depression in the ocean floor.

Two Dimensional Motion. Where an object undergoes motion along the x and y axis at the same time.

Unbalanced Forces. Occur when the net force on an object does not equal zero; results in the object changing its motion.

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