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 twenty-first 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 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.

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.

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.

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.

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.

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.

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).*

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 at rest until pushed).

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).

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).*

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.

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.

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).

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).

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).

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).

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.

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

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.

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.

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.

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

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.

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

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.

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).

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).

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.

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.

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.

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.*

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).

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.

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, **S**ound **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.