SOUTH CAROLINA
SCIENCE ACADEMIC STANDARDS

South Carolina Department of Education
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Contents

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State Science Panel
The members of the State Science Panel reviewed and recommended revisions to the 2000 standards document, *South Carolina Science Curriculum Standards.* The panel's report and a listing of the State Panel members are online at http://www.myscschools.com/offices/cso/science/StandardsRevision2004.cfm.

South Carolina Education Oversight Committee
Dr. Jo Anne Anderson, executive director of the South Carolina Education Oversight Committee (EOC), and Dr. Paul Horne, the EOC's director of curriculum and program overview, facilitated the work of three science review teams, which included national experts, parents, and business leaders. The EOC report on the review of the 2000 standards is published online at http://www.myscschools.com/offices/cso/science/StandardsRevision2004.cfm.

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State Department of Education
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The following SDE staff members assisted in the design and development of this document:

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Introduction

Science is a method of learning about the physical universe by applying the principles of the scientific inquiry, which includes making empirical observations, proposing hypotheses to explain those observations, and testing those hypotheses in valid and reliable ways. Science is also, therefore, the organized body of knowledge that results from scientific inquiry. This document, *South Carolina Science Academic Standards*, contains the academic standards in science for the state's students in kindergarten through grade twelve.

Beginning in 2004, the term for the state-approved expectations for student learning and academic performance in South Carolina was changed from *curriculum standards* to *academic standards.* In accordance with the South Carolina Education Accountability Act of 1998 (S.C. Code Ann. § 59-18-110), State Board of Education Regulation 43-234 explains the purpose of academic standards thusly:

> Each school district board of trustees will ensure quality schooling by providing a rigorous, relevant curriculum for all students.
>
> Each school district must use the academic achievement standards adopted by the State Board of Education to push schools and students toward high performance by aligning the state assessments to those standards and linking policies and criteria for performance standards, accreditation, reporting, school rewards, and targeted assistance.

The *South Carolina Science Academic Standards* is not a curriculum. The academic standards in this document are not sequenced for instruction, do not prescribe classroom activities or materials, and do not dictate instructional strategies, approaches, and practices. A science curriculum support document, issued by the SDE, will assist the districts in constructing their own standards-based science curriculum, allowing them to add or expand topics they feel are important and to organize the content to fit their students' needs and materials. The support document will include suggested materials and resources for use in the classroom.

Development and Review of the South Carolina Science Standards

The State Department of Education (SDE), in partnership with Mid-Continent Research for Education and Learning, developed the academic standards and indicators for science utilizing a number of resources. Central among these resources were the *South Carolina Science Curriculum Standards*, published by the SDE in 2000, and the 2004 recommendations of the State Science Panel and the Education Oversight Committee (EOC) panel on science.

The *National Science Education Standards*, produced by the National Research Council and published in 1996 by the National Academy Press in Washington, DC (available at http://www.nap.edu/readingroom/books/nses/html/) was the foundation of the 2000 South Carolina science standards and continues as the primary basis for the 2005 standards and the supporting indicators. The following national documents were utilized in addition:

> *Atlas of Science Literacy*, produced by Project 2061 and the National Science Teachers Association (Washington, DC: American Association for the Advancement of Science, 2001).

Benchmarks for Science Literacy, produced by Project 2061 and the American Association for the Advancement of Science (New York: Oxford University Press, 1993).

Content Knowledge: A Compendium of Standards and Benchmarks for K–12 Education, by John S. Kendall and Robert J. Marzano. 3rd ed. (Aurora, CO : Mid-Continent Regional Educational Laboratory, 2000).

NSTA Pathways to the Science Standards, edited by Lawrence F. Lowery. Elementary School Edition (Arlington VA: National Science Teachers Association, 1998).

NSTA Pathways to the Science Standards: Guidelines for Moving the Vision into Practice, edited by Steven J. Rakow. Middle School Edition (Arlington, VA: National Science Teachers Association, 1998).

NSTA Pathways to the Science Standards, edited by Julliana Texley and Ann Wild. High School Edition (Arlington, VA: National Science Teachers Association, 1998).

Science Assessment and Exercise Specifications for the National Assessment of Educational Progress, developed by the Council of Chief State School Officers, NAEP Science Consensus Project (Washington, DC: National Assessment Governing Board, U.S. Department of Education, n.d.).

Science Framework for the 1996 and 2000 National Assessment of Educational Progress, developed by the Council of Chief State School Officers with the National Center for Improving Science Education and the American Institutes for Research; edited by Mark D. Musick (Washington, DC: National Assessment Governing Board, U.S. Department of Education, 1999). Available online at http://www.nagb.org/pubs/96-2000science/toc.html.

Operating procedures for the review of all newly revised South Carolina academic standards were agreed upon by the SDE and the EOC during the summer of 2003. Those procedures (accessible online at http://www.myscschools.com/offices/cso/) were used in the field review of the first draft of the revised South Carolina science standards, conducted from April through June 2005. Feedback from that review was incorporated into the final draft, which was presented to the State Board of Education in fall 2005.

Changes in the South Carolina Science Standards Document

The structure and organization of the South Carolina science standards document have been changed in several ways:

- An overview describing specific subject matter and themes is now provided on a cover page for each grade and each high school core area.

- The number of standards—which ranges from five to seven for each grade or high school core area—has been significantly reduced.

- Academic standards are specified for nine grade levels (kindergarten through grade eight) and five high school core areas: physical science, biology, chemistry, physics, and earth science.

- The standards for kindergarten through the eighth grade are no longer organized by content area—life science, earth science, or physical science. However, the specific area from which each of the content standards is drawn is specified in parenthesis immediately following the statement of the standard.

- The statements of the academic standards themselves are newly constructed.

  Each standard is now stated as one full sentence that begins with the clause "The student will demonstrate an understanding of . . ." and goes on to specify the particular topics to be addressed by that standard. The verb phrase "to demonstrate an understanding of" is used with its general, everyday meaning and does not describe a cognitive category from the taxonomy.

  Following each of the academic standard statements are indicators, which are intended to help meet teachers' needs for specificity. These indicators are statements of the specific cognitive processes (expressed in the main verbs) and the content knowledge and skills that students must demonstrate in order to meet the grade-level or high school core area standard.

  The main verbs in the indicators are taxonomic—that is, they identify specific aspects of the cognitive process as described in the revised Bloom's taxonomy, which is included in this standards document in appendix B. Use of this new taxonomy will allow teachers to identify the kind of content (knowledge) addressed in the indicators (as factual, conceptual, procedural, or metacognitive) and will help teachers to align their lessons with both the content and the cognitive process identified in the indicators.

  Many of the indicators in science address conceptual knowledge and fall under the second category of cognitive processing, *understanding*, which fosters transfer and meaningful learning rather than rote learning and memorization. These revised science standards also contain some indicators that require students to *analyze* or *evaluate* data and/or the results of investigations so that they must use understanding as they demonstrate even more cognitively complex learning.

  The term *including* appears frequently in parenthetical statements in the science indicators to introduce a list of specifics that are intended to clarify and focus the teaching and learning of the particular concept. That is, within these parenthetical *including* statements are specified the components of the indicator that are critical for the specific grade level or core area with regard both to the state assessments and to the management of time in the classroom. Teachers must focus their instruction on the entire indicator, but they also need to include in the instruction the components specified in the parenthetical *including* statements.

- In addition to the content standards, each grade and high school core area has a separate *scientific inquiry* standard, with indicators that are now differentiated across grade levels and core areas. The skills, processes, and tools specified in the scientific inquiry indicators are also embedded in the content standards and indicators wherever appropriate.

  Unlike the content standards, however, scientific inquiry is a process standard with indicators that specify the tools and equipment, safety procedures, and investigative skills and approaches that students must master in conjunction with the topics identified in the content standards for the particular grade level or high school core area. Magnifiers, thermometers,

graduated cylinders, and spring scales are examples of tools that students must learn to use accurately, safely, and appropriately. Teachers should note that only those tools that have *not* been introduced in earlier grades are listed in the scientific inquiry indicators at the higher levels.

Scientific inquiry requires an understanding of scientific methodology. As the authors of *National Science Education Standards* put it, "Full inquiry involves asking a simple question, completing an investigation, answering the question, and presenting the results to others." Though the specific parts of this process may be explicitly mentioned in only a few standards and indicators in the scientific inquiry sections of the South Carolina science standards, they are primary concerns in state assessments in science and, therefore, in classroom instruction.

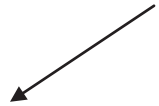
Statewide Assessments

The science standards for grades three through eight will be used as the basis for the questions on the Palmetto Achievement Challenge Tests (PACT) in science. The science standards for the high school core areas of physical science and biology will be used as the basis for items on the state-required end-of-course examination for Biology 1 and Applied Biology 2 and the end-of-course examination for Physical Science.

The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and in most cases will measure the specific cognitive process stated in the main verb in the indicator. However, some indicators may be assessed through items that address other appropriate cognitive processes within the same category as the main verb in the indicator or may address processes in categories of lower cognitive complexity. For example, the assessment of an indicator that requires students to classify minerals—which would fall in the second cognitive category, *understand*—might also ask the student to demonstrate other related cognitive processes such as comparing minerals or giving examples of particular minerals. Or a PACT item might require students to recall specific minerals, which falls into the first cognitive category, *remember*. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

The skills of scientific inquiry, including an understanding of the use of particular tools, will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed cumulatively. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators from all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

Format of Standards for All Grade Levels and the High School Core Areas



This is the introductory page for the third-grade science standards. The text of each of the introductory pages gives an overview of the subject matter and themes for the particular grade level or high school core area.

Grade 3

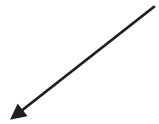
Overview

Science in grade three focuses on students' conducting investigations in which they collect and analyze data and communicate their findings. Learning to observe and analyze through hands-on experiments, students gain new insights into how scientists understand our world. Third-grade students explore the life, earth, and physical sciences within the framework of the following topics: "Habitats and Adaptations" (physical and behavioral adaptations); "Earth's Materials and Changes" (rocks, soil, water, fossils); "Heat and Changes in Matter" (sources of heat, solids, liquids, gases); and "Motion and Sound" (position, effects of force, vibrations, and pitch).

The science standards for grade three provide for a rich variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they examine new concepts and expand their understanding.

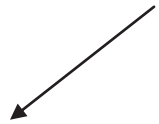
The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.



This is academic standard 3-5, the fifth standard for grade 3. The term in parentheses indicates the area in which the particular standard is centered. The fifth standard for grade 3 is a *physical science* standard.

Standard 3-5: ---------- (Physical Science)



The indicators illustrated, 3-5.1 and 3-5.2, are the first two indicators of the fifth standard for grade 3.

Indicators

3-5.1 ----------

3-5.2 ----------

GRADE-LEVEL STANDARDS

Kindergarten

Overview

The focus of science in kindergarten is to provide students with hands-on experiences that will utilize their natural curiosity at the beginning of their development of scientific knowledge. Kindergarten students need to expand their observation skills as they learn about the life, earth, and physical sciences. These students will explore the sciences within the framework of the following topics: "Characteristics of Organisms" (basic needs of organisms and life cycles); "My Body" (body structures and functions); "Seasonal Changes" (weather from day to day and season to season); and "Exploring Matter" (observable properties).

The standards for kindergarten describe only a core of knowledge that must be brought to life and enhanced through a wide variety of learning experiences, materials, and instructional strategies that accommodate the broad range of individual differences. These standards support active engagement in learning. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, the scientific inquiry indicators will be assessed *cumulatively*. Students must therefore demonstrate the skills and the knowledge of the use of the tools and equipment designated for kindergarten in preparation for grade one. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

KINDERGARTEN

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Kindergarten students must therefore demonstrate an understanding of the specific content of these indicators. A table of the K–12 of scientific inquiry standards and indicators is provided in appendix A.

Standard K-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

K-1.1 Identify observed objects or events by using the senses.
K-1.2 Use tools (including magnifiers and eyedroppers) safely, accurately, and appropriately when gathering specific data.
K-1.3 Predict and explain information or events based on observation or previous experience.
K-1.4 Compare objects by using nonstandard units of measurement.
K-1.5 Use appropriate safety procedures when conducting investigations.

KINDERGARTEN

Characteristics of Organisms

Standard K-2: The student will demonstrate an understanding of the characteristics of organisms. (Life Science)

Indicators

K-2.1 Recognize what organisms need to stay alive (including air, water, food, and shelter).
K-2.2 Identify examples of organisms and nonliving things.
K-2.3 Match parents with their offspring to show that plants and animals closely resemble their parents.
K-2.4 Compare individual examples of a particular type of plant or animal to determine that there are differences among individuals.
K-2.5 Recognize that all organisms go through stages of growth and change called life cycles.

KINDERGARTEN

My Body

Standard K-3: The student will demonstrate an understanding of the distinct structures of human body and the different functions they serve. (Life Science)

Indicators

K-3.1 Identify the distinct structures in the human body that are for walking, holding, touching, seeing, smelling, hearing, talking, and tasting.

K-3.2 Identify the functions of the sensory organs (including the eyes, nose, ears, tongue, and skin).

KINDERGARTEN

Seasonal Changes

Standard K-4: The student will demonstrate an understanding of seasonal weather changes. (Earth Science)

Indicators

K-4.1 Identify weather changes that occur from day to day.
K-4.2 Compare the weather patterns that occur from season to season.
K-4.3 Summarize ways that the seasons affect plants and animals.

KINDERGARTEN

Exploring Matter

Standard K-5: The student will demonstrate the understanding that objects can be described by their observable properties. (Physical Science)

Indicators

K-5.1 Classify objects by observable properties (including size, color, shape, magnetic attraction, heaviness, texture, and the ability to float in water).

K-5.2 Compare the properties of different types of materials (including wood, plastic, metal, cloth, and paper) from which objects are made.

Grade 1

Overview

The goal of science in grade one is to provide the opportunity for students to develop the skills of wondering, questioning, investigating, and communicating as the means of making sense of the world. Students will use scientific tools to gather data and carry out investigations and will continue to develop their observation skills as they learn about the life, earth, and physical sciences. First-grade students will explore the sciences within the framework of the following topics: "Plants" (basic needs, structures and life cycles); "Sun and Moon" (features and changes in appearance); "Earth Materials" (composition and properties); and "Exploring Motion" (push or pull and movement).

The grade-one science standards provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students will actively engage in their learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—from all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

GRADE 1

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 1-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

1-1.1 Compare, classify, and sequence objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate.
1-1.2 Use tools (including rulers) safely, accurately, and appropriately when gathering specific data.
1-1.3 Carry out simple scientific investigations when given clear directions.
1-1.4 Use appropriate safety procedures when conducting investigations.

GRADE 1

Plants

Standard 1-2: The student will demonstrate an understanding of the special characteristics and needs of plants that allow them to survive in their own distinct environments. (Life Science)

Indicators

1-2.1 Recall the basic needs of plants (including air, water, nutrients, space, and light) for energy and growth.

1-2.2 Illustrate the major structures of plants (including stems, roots, leaves, flowers, fruits, and seeds).

1-2.3 Classify plants according to their characteristics (including what specific type of environment they live in, whether they have edible parts, and what particular kinds of physical traits they have).

1-2.4 Summarize the life cycle of plants (including germination, growth, and the production of flowers and seeds).

1-2.5 Explain how distinct environments throughout the world support the life of different types of plants.

1-2.6 Identify characteristics of plants (including types of stems, roots, leaves, flowers, and seeds) that help them survive in their own distinct environments.

GRADE 1

Sun and Moon

Standard 1-3: The student will demonstrate an understanding of the features of the sky and the patterns of the Sun and the Moon. (Earth Science)

Indicators

1-3.1 Compare the features of the day and night sky.
1-3.2 Recall that the Sun is a source of heat and light for Earth.
1-3.3 Recognize that the Sun and the Moon appear to rise and set.
1-3.4 Illustrate changes in the Moon's appearance (including patterns over time).

GRADE 1

Earth Materials

Standard 1-4: The student will demonstrate an understanding of the properties of Earth materials. (Earth Science)

Indicators

1-4.1 Recognize the composition of Earth (including rocks, sand, soil, and water).
1-4.2 Classify rocks and sand by their physical appearance .
1-4.3 Compare soil samples by sorting them according to properties (including color, texture, and the capacity to nourish growing plants).
1-4.4 Recognize the observable properties of water (including the fact that it takes the shape of its container, flows downhill, and feels wet).
1-4.5 Illustrate the locations of water on Earth by using drawings, maps, or models.
1-4.6 Exemplify Earth materials that are used for building structures or for growing plants.

GRADE 1

Exploring Motion

Standard 1-5: The student will demonstrate an understanding of the positions and motions of objects. (Physical Science)

Indicators

1-5.1 Identify the location of an object relative to another object.
1-5.2 Explain the importance of pushing and pulling to the motion of an object.
1-5.3 Illustrate the fact that sound is produced by vibrating objects.
1-5.4 Illustrate ways in which objects can move in terms of direction and speed (including straight forward, back and forth, fast or slow, zigzag, and circular).

Grade 2

Overview

The science standards for grade two focus on instilling in students the understanding that everyone has the ability to participate in science and to explore scientific ideas. Students begin to build on the concept that in science it is helpful to collaborate with others, to work as a team and to share thoughts, ideas, and discoveries. Second graders explore the life, earth, and physical sciences within the framework of the following topics: "Animals" (basic needs, environments, and life cycles); "Weather" (weather terminology and weather conditions); "Properties and Changes in Matter" (solids and liquids); and "Magnetism" (attracting and repelling).

The science standards for grade two provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students actively engage in learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, the scientific inquiry indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

GRADE 2

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 2-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

2-1.1 Carry out simple scientific investigations to answer questions about familiar objects and events.

2-1.2 Use tools (including thermometers, rain gauges, balances, and measuring cups) safely, accurately, and appropriately when gathering specific data in US customary (English) and metric units of measurement.

2-1.3 Represent and communicate simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language.

2-1.4 Infer explanations regarding scientific observations and experiences.

2-1.5 Use appropriate safety procedures when conducting investigations.

GRADE 2

Animals

Standard 2-2: The student will demonstrate an understanding of the needs and characteristics of animals as they interact in their own distinct environments. (Life Science)

Indicators

2-2.1 Recall the basic needs of animals (including air, water, food, and shelter) for energy, growth, and protection.

2-2.2 Classify animals (including mammals, birds, amphibians, reptiles, fish, and insects) according to their physical characteristics.

2-2.3 Explain how distinct environments throughout the world support the life of different types of animals.

2-2.4 Summarize the interdependence between animals and plants as sources of food and shelter.

2-2.5 Illustrate the various life cycles of animals (including birth and the stages of development).

GRADE 2

Weather

Standard 2-3: The student will demonstrate an understanding of daily and seasonal weather conditions. (Earth Science)

Indicators

2-3.1 Explain the effects of moving air as it interacts with objects.
2-3.2 Recall weather terminology (including temperature, wind direction, wind speed, and precipitation as rain, snow, sleet, and hail).
2-3.3 Illustrate the weather conditions of different seasons.
2-3.4 Carry out procedures to measure and record daily weather conditions (including temperature, precipitation amounts, wind speed as measured on the Beaufort scale, and wind direction as measured with a windsock or wind vane).
2-3.5 Use pictorial weather symbols to record observable sky conditions.
2-3.6 Identify safety precautions that one should take during severe weather conditions.

GRADE 2

Properties and Changes in Matter

Standard 2-4: The student will demonstrate an understanding of the properties of matter and the changes that matter undergoes. (Physical Science)

Indicators

2-4.1 Recall the properties of solids and liquids.
2-4.2 Exemplify matter that changes from a solid to a liquid and from a liquid to a solid.
2-4.3 Explain how matter can be changed in ways such as heating or cooling, cutting or tearing, bending or stretching.
2-4.4 Recognize that different materials can be mixed together and then separated again.

GRADE 2

Magnetism

Standard 2-5: The student will demonstrate an understanding of force and motion by applying the properties of magnetism. (Physical Science)

Indicators

2-5.1 Use magnets to make an object move without being touched.
2-5.2 Explain how the poles of magnets affect each other (that is, they attract and repel one another).
2-5.3 Compare the effect of magnets on various materials.
2-5.4 Identify everyday uses of magnets.

Grade 3

Overview

Science in grade three focuses on students' conducting investigations in which they collect and analyze data and communicate their findings. Learning to observe and analyze through hands-on experiments, students gain new insights into how scientists understand our world. Third-grade students explore the life, earth, and physical sciences within the framework of the following topics: "Habitats and Adaptations" (physical and behavioral adaptations); "Earth's Materials and Changes" (rocks, soil, water, fossils); "Heat and Changes in Matter" (sources of heat, solids, liquids, gases); and "Motion and Sound" (position, effects of force, vibrations, and pitch).

The science standards for grade three provide for a rich variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they examine new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively.* Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 3

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 3-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

3-1.1 Classify objects by two of their properties (attributes).
3-1.2 Classify objects or events in sequential order.
3-1.3 Generate questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation.
3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.
3-1.5 Use tools (including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes) safely, accurately, and appropriately when gathering specific data.
3-1.6 Infer meaning from data communicated in graphs, tables, and diagrams.
3-1.7 Explain why similar investigations might produce different results.
3-1.8 Use appropriate safety procedures when conducting investigations.

GRADE 3

Habitats and Adaptations

Standard 3-2: The student will demonstrate an understanding of the structures, characteristics, and adaptations of organisms that allow them to function and survive within their habitats. (Life Science)

Indicators

3-2.1 Illustrate the life cycles of seed plants and various animals and summarize how they grow and are adapted to conditions within their habitats.

3-2.2 Explain how physical and behavioral adaptations allow organisms to survive (including hibernation, defense, locomotion, movement, food obtainment, and camouflage for animals and seed dispersal, color, and response to light for plants).

3-2.3 Recall the characteristics of an organism's habitat that allow the organism to survive there.

3-2.4 Explain how changes in the habitats of plants and animals affect their survival.

3-2.5 Summarize the organization of simple food chains (including the roles of producers, consumers, and decomposers).

GRADE 3

Earth's Materials and Changes

Standard 3-3: The student will demonstrate an understanding of Earth's composition and the changes that occur to the features of Earth's surface. (Earth Science)

Indicators

3-3.1 Classify rocks (including sedimentary, igneous, and metamorphic) and soils (including humus, clay, sand, and silt) on the basis of their properties.

3-3.2 Identify common minerals on the basis of their properties by using a minerals identification key.

3-3.3 Recognize types of fossils (including molds, casts, and preserved parts of plants and animals).

3-3.4 Infer ideas about Earth's early environments from fossils of plants and animals that lived long ago.

3-3.5 Illustrate Earth's saltwater and freshwater features (including oceans, seas, rivers, lakes, ponds, streams, and glaciers).

3-3.6 Illustrate Earth's land features (including volcanoes, mountains, valleys, canyons, caverns, and islands) by using models, pictures, diagrams, and maps.

3-3.7 Exemplify Earth materials that are used as fuel, as a resource for building materials, and as a medium for growing plants.

3-3.8 Illustrate changes in Earth's surface that are due to slow processes (including weathering, erosion, and deposition) and changes that are due to rapid processes (including landslides, volcanic eruptions, floods, and earthquakes).

GRADE 3

Heat and Changes in Matter

Standard 3-4: The student will demonstrate an understanding of the changes in matter that are caused by heat.

Indicators

3-4.1 Classify different forms of matter (including solids, liquids, and gases) according to their observable and measurable properties.

3-4.2 Explain how water and other substances change from one state to another (including melting, freezing, condensing, boiling, and evaporating).

3-4.3 Explain how heat moves easily from one object to another through direct contact in some materials (called conductors) and not so easily through other materials (called insulators).

3-4.4 Identify sources of heat and exemplify ways that heat can be produced (including rubbing, burning, and using electricity).

GRADE 3

Motion and Sound

Standard 3-5: The student will demonstrate an understanding of how motion and sound are affected by a push or pull on an object and the vibration of an object. (Physical Science)

Indicators

3-5.1 Identify the position of an object relative to a reference point by using position terms such as “above,” “below,” “inside of,” “underneath,” or “on top of” and a distance scale or measurement.
3-5.2 Compare the motion of common objects in terms of speed and direction.
3-5.3 Explain how the motion of an object is affected by the strength of a push or pull and the mass of the object.
3-5.4 Explain the relationship between the motion of an object and the pull of gravity.
3-5.5 Recall that vibrating objects produce sound and that vibrations can be transferred from one material to another.
3-5.6 Compare the pitch and volume of different sounds.
3-5.7 Recognize ways to change the volume of sounds.
3-5.8 Explain how the vibration of an object affects pitch.

Grade 4

Overview

Science in grade four focuses on providing students with the opportunity to learn age-appropriate concepts and skills in the life, earth, and physical sciences and to acquire scientific attitudes and habits of mind. The students' study of science includes observing, measuring, recording, questioning, analyzing, identifying, and drawing conclusions. Through their explorations, students develop an understanding of and an ability to apply the components of the scientific method. Specifically, fourth graders explore the sciences within the framework of the following topics: "Organisms and Their Environments" (patterns of behavior and changes in the environment); "Astronomy" (Earth, Sun, Moon and planets); "Weather" (water cycle, clouds, and severe weather); and "Properties of Light and Electricity" (reflection, refraction, and series and parallel circuits).

The science standards for grade four provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of student's individual differences. Students are actively engaged in their learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 4

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 4-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

4-1.1 Classify observations as either quantitative or qualitative.
4-1.2 Use appropriate instruments and tools (including a compass, an anemometer, mirrors, and a prism) safely and accurately when conducting simple investigations.
4-1.3 Summarize the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained).
4-1.4 Distinguish among observations, predictions, and inferences.
4-1.5 Recognize the correct placement of variables on a line graph.
4-1.6 Construct and interpret diagrams, tables, and graphs made from recorded measurements and observations.
4-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 4

Organisms and Their Environments

Standard 4-2: The student will demonstrate an understanding of the characteristics and patterns of behavior that allow organisms to survive in their own distinct environments. (Life Science)

Indicators

4-2.1 Classify organisms into major groups (including plants or animals, flowering or nonflowering plants, and vertebrates [fish, amphibians, reptiles, birds, and mammals] or invertebrates) according to their physical characteristics.

4-2.2 Explain how the characteristics of distinct environments (including swamps, rivers and streams, tropical rain forests, deserts, and the polar regions) influence the variety of organisms in each.

4-2.3 Explain how humans and other animals use their senses and sensory organs to detect signals from the environment and how their behaviors are influenced by these signals.

4-2.4 Distinguish between the characteristics of an organism that are inherited and those that are acquired over time.

4-2.5 Explain how an organism's patterns of behavior are related to its environment (including the kinds and the number of other organisms present, the availability of food and other resources, and the physical characteristics of the environment).

4-2.6 Explain how organisms cause changes in their environment.

GRADE 4

Astronomy

Standard 4-3: The student will demonstrate an understanding of the properties, movements, and locations of objects in the solar system. (Earth Science)

Indicators

4-3.1 Recall that Earth is one of many planets in the solar system that orbit the Sun.
4-3.2 Compare the properties (including the type of surface and atmosphere) and the location of Earth to the Sun, which is a star, and the Moon.
4-3.3 Explain how the Sun affects Earth.
4-3.4 Explain how the tilt of Earth's axis and the revolution around the Sun results in the seasons of the year.
4-3.5 Explain how the rotation of Earth results in day and night.
4-3.6 Illustrate the phases of the Moon and the Moon's effect on ocean tides.
4-3.7 Interpret the change in the length of shadows during the day in relation to the position of the Sun in the sky.
4-3.8 Recognize the purpose of telescopes.

GRADE 4

Weather

Standard 4-4: The student will demonstrate an understanding of weather patterns and phenomena. (Earth Science)

Indicators

4-4.1 Summarize the processes of the water cycle (including evaporation, condensation, precipitation, and runoff).

4-4.2 Classify clouds according to their three basic types (cumulus, cirrus, and stratus) and summarize how clouds form.

4-4.3 Compare daily and seasonal changes in weather conditions (including wind speed and direction, precipitation, and temperature) and patterns.

4-4.4 Summarize the conditions and effects of severe weather phenomena (including thunderstorms, hurricanes, and tornadoes) and related safety concerns.

4-4.5 Carry out the procedures for data collecting and measuring weather conditions (including wind speed and direction, precipitation, and temperature) by using appropriate tools and instruments.

4-4.6 Predict weather from data collected through observation and measurements.

GRADE 4

Properties of Light and Electricity

Standard 4-5: The student will demonstrate an understanding of the properties of light and electricity. (Physical Science)

Indicators

4-5.1 Summarize the basic properties of light (including brightness and colors).
4-5.2 Illustrate the fact that light, as a form of energy, is made up of many different colors.
4-5.3 Summarize how light travels and explain what happens when it strikes an object (including reflection, refraction, and absorption).
4-5.4 Compare how light behaves when it strikes transparent, translucent, and opaque materials.
4-5.5 Explain how electricity, as a form of energy, can be transformed into other forms of energy (including light, heat, and sound).
4-5.6 Summarize the functions of the components of complete circuits (including wire, switch, battery, and light bulb).
4-5.7 Illustrate the path of electric current in series and parallel circuits.
4-5.8 Classify materials as either conductors or insulators of electricity.
4-5.9 Summarize the properties of magnets and electromagnets (including polarity, attraction/repulsion, and strength).
4-5.10 Summarize the factors that affect the strength of an electromagnet.

Grade 5

Overview

Science in grade five focuses on scientific and technological problem solving and decision making as well as the skills of scientific inquiry: formulating usable questions and hypotheses, planning experiments and product design, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating the findings to others. Fifth-grade students actively investigate science concepts by predicting, observing, and recording the results of experiments, and they will generate ideas to solve problems. Specifically, students in the fifth grade learn about the life, earth, and physical sciences by exploring them within the framework of the following topics: "Ecosystems: Terrestrial and Aquatic" (characteristics and interactions); "Landforms and Oceans" (natural processes and the ocean floor); "Properties of Matter" (mixtures and solutions); and "Forces and Motion" (position, direction, and speed).

The science standards for students in grade five provide richness and a wide variety of learning experiences, materials, and instructional strategies to accommodate a broad range of students' individual differences. Students actively engage in learning by observing, interacting with materials and with people, and asking questions as they explore new concepts and expand their understanding.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively.* Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 5

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 5-1: The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Indicators

5-1.1 Identify questions suitable for generating a hypothesis.
5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.
5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
5-1.8 Use appropriate safety procedures when conducting investigations.

GRADE 5

Ecosystems: Terrestrial and Aquatic

Standard 5-2: The student will demonstrate an understanding of relationships among biotic and abiotic factors within terrestrial and aquatic ecosystems. (Life Science)

Indicators

5-2.1 Recall the cell as the smallest unit of life and identify its major structures (including cell membrane, cytoplasm, nucleus, and vacuole).

5-2.2 Summarize the composition of an ecosystem, considering both biotic factors (including populations to the level of microorganisms and communities) and abiotic factors.

5-2.3 Compare the characteristics of different ecosystems (including estuaries/salt marshes, oceans, lakes and ponds, forests, and grasslands).

5-2.4 Identify the roles of organisms as they interact and depend on one another through food chains and food webs in an ecosystem, considering producers and consumers (herbivores, carnivores, and omnivores), decomposers (microorganisms, termites, worms, and fungi), predators and prey, and parasites and hosts.

5-2.5 Explain how limiting factors (including food, water, space, and shelter) affect populations in ecosystems.

GRADE 5

Landforms and Oceans

Standard 5-3: The student will demonstrate an understanding of features, processes, and changes in Earth's land and oceans. (Earth Science)

Indicators

5-3.1 Explain how natural processes (including weathering, erosion, deposition, landslides, volcanic eruptions, earthquakes, and floods) affect Earth's oceans and land in constructive and destructive ways.
5-3.2 Illustrate the geologic landforms of the ocean floor (including the continental shelf and slope, the mid-ocean ridge, rift zone, trench, and the ocean basin).
5-3.3 Compare continental and oceanic landforms.
5-3.4 Explain how waves, currents, tides, and storms affect the geologic features of the ocean shore zone (including beaches, barrier islands, estuaries, and inlets).
5-3.5 Compare the movement of water by waves, currents, and tides.
5-3.6 Explain how human activity (including conservation efforts and pollution) has affected the land and the oceans of Earth.

GRADE 5

Properties of Matter

Standard 5-4: The student will demonstrate an understanding of properties of matter. (Physical Science)

Indicators

5-4.1 Recall that matter is made up of particles too small to be seen.
5-4.2 Compare the physical properties of the states of matter (including volume, shape, and the movement and spacing of particles).
5-4.3 Summarize the characteristics of a mixture, recognizing a solution as a kind of mixture.
5-4.4 Use the processes of filtration, sifting, magnetic attraction, evaporation, chromatography, and floatation to separate mixtures.
5-4.5 Explain how the solute and the solvent in a solution determine the concentration.
5-4.6 Explain how temperature change, particle size, and stirring affect the rate of dissolving.
5-4.7 Illustrate the fact that when some substances are mixed together, they chemically combine to form a new substance that cannot easily be separated.
5-4.8 Explain how the mixing and dissolving of foreign substances is related to the pollution of the water, air, and soil.

GRADE 5

Forces and Motion

Standard 5-5: The student will demonstrate an understanding of the nature of force and motion. (Physical Science)

Indicators

5-5.1 Illustrate the affects of force (including magnetism, gravity, and friction) on motion.
5-5.2 Summarize the motion of an object in terms of position, direction, and speed.
5-5.3 Explain how unbalanced forces affect the rate and direction of motion in objects.
5-5.4 Explain ways to change the effect that friction has on the motion of objects (including changing the texture of the surfaces, changing the amount of surface area involved, and adding lubrication).
5-5.5 Use a graph to illustrate the motion of an object.
5-5.6 Explain how a change of force or a change in mass affects the motion of an object.

Grade 6

Overview

The focus for science in grade six is to provide students with a foundation for hands-on experiences that allow for the active engagement and concrete examples that these students require in order to understand basic science concepts. Sixth graders continue to develop the investigative skills they have been acquiring since kindergarten, now expanding them to include the skill of differentiating between observation and inference. Specifically, students explore the life, earth, and physical sciences within the framework of the following topics: "Structures, Processes, and Responses of Plants" (structure and function of plants); "Structures, Processes, and Responses of Animals" (structure and function of animals); "Earth's Atmosphere and Weather" (atmospheric properties and processes); and "Conservation of Energy" (properties of energy, work, and machines).

The science standards for the sixth grade provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 6

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 6-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

6-1.1 Use appropriate tools and instruments (including a spring scale, beam balance, barometer, and sling psychrometer) safely and accurately when conducting a controlled scientific investigation.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

6-1.3 Classify organisms, objects, and materials according to their physical characteristics by using a dichotomous key.

6-1.4 Use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product).

6-1.5 Use appropriate safety procedures when conducting investigations.

GRADE 6

Structures, Processes, and Responses of Plants

Standard 6-2: The student will demonstrate an understanding of structures, processes, and responses of plants that allow them to survive and reproduce. (Life Science)

Indicators

6-2.1 Summarize the characteristics that all organisms share (including the obtainment and use of resources for energy, the response to stimuli, the ability to reproduce, and process of physical growth and development).

6-2.2 Recognize the hierarchical structure of the classification (taxonomy) of organisms (including the seven major levels or categories of living things—namely, kingdom, phylum, class, order, family, genus, and species).

6-2.3 Compare the characteristic structures of various groups of plants (including vascular or nonvascular, seed or spore-producing, flowering or cone-bearing, and monocot or dicot).

6-2.4 Summarize the basic functions of the structures of a flowering plant for defense, survival, and reproduction.

6-2.5 Summarize each process in the life cycle of flowering plants (including germination, plant development, fertilization, and seed production).

6-2.6 Differentiate between the processes of sexual and asexual reproduction of flowering plants.

6-2.7 Summarize the processes required for plant survival (including photosynthesis, respiration, and transpiration).

6-2.8 Explain how plants respond to external stimuli (including dormancy and the forms of tropism known as phototropism, gravitropism, hydrotropism, and thigmotropism).

6-2.9 Explain how disease-causing fungi can affect plants.

GRADE 6

Structures, Processes, and Responses of Animals

Standard 6-3: The student will demonstrate an understanding of structures, processes, and responses of animals that allow them to survive and reproduce. (Life Science)

Indicators

6-3.1 Compare the characteristic structures of invertebrate animals (including sponges, segmented worms, echinoderms, mollusks, and arthropods) and vertebrate animals (fish, amphibians, reptiles, birds, and mammals).

6-3.2 Summarize the basic functions of the structures of animals that allow them to defend themselves, to move, and to obtain resources.

6-3.3 Compare the response that a warm-blooded (endothermic) animal makes to a fluctuation in environmental temperature with the response that a cold-blooded (ectothermic) animal makes to such a fluctuation.

6-3.4 Explain how environmental stimuli cause physical responses in animals (including shedding, blinking, shivering, sweating, panting, and food gathering).

6-3.5 Illustrate animal behavioral responses (including hibernation, migration, defense, and courtship) to environmental stimuli.

6-3.6 Summarize how the internal stimuli (including hunger, thirst, and sleep) of animals ensure their survival.

6-3.7 Compare learned to inherited behaviors in animals.

GRADE 6

Earth's Atmosphere and Weather

Standard 6-4: The student will demonstrate an understanding of the relationship between Earth's atmospheric properties and processes and its weather and climate. (Earth Science)

Indicators

6-4.1 Compare the composition and structure of Earth's atmospheric layers (including the gases and differences in temperature and pressure within the layers).
6-4.2 Summarize the interrelationships among the dynamic processes of the water cycle (including precipitation, evaporation, transpiration, condensation, surface-water flow, and groundwater flow).
6-4.3 Classify shapes and types of clouds according to elevation and their associated weather conditions and patterns.
6-4.4 Summarize the relationship of the movement of air masses, high and low pressure systems, and frontal boundaries to storms (including thunderstorms, hurricanes, and tornadoes) and other weather conditions.
6-4.5 Use appropriate instruments and tools to collect weather data (including wind speed and direction, air temperature, humidity, and air pressure).
6-4.6 Predict weather conditions and patterns based on weather data collected from direct observations and measurements, weather maps, satellites, and radar.
6-4.7 Explain how solar energy affects Earth's atmosphere and surface (land and water).
6-4.8 Explain how convection affects weather patterns and climate.
6-4.9 Explain the influence of global winds and the jet stream on weather and climatic conditions.

GRADE 6

Conservation of Energy

Standard 6-5: The student will demonstrate an understanding of the law of conservation of energy and the properties of energy and work. (Physical Science)

Indicators

6-5.1 Identify the sources and properties of heat, solar, chemical, mechanical, and electrical energy.

6-5.2 Explain how energy can be transformed from one form to another (including the two types of mechanical energy, potential and kinetic, as well as chemical and electrical energy) in accordance with the law of conservation of energy.

6-5.3 Explain how magnetism and electricity are interrelated by using descriptions, models, and diagrams of electromagnets, generators, and simple electrical motors.

6-5.4 Illustrate energy transformations (including the production of light, sound, heat, and mechanical motion) in electrical circuits.

6-5.5 Illustrate the directional transfer of heat energy through convection, radiation, and conduction.

6-5.6 Recognize that energy is the ability to do work (force exerted over a distance).

6-5.7 Explain how the design of simple machines (including levers, pulleys, and inclined planes) helps reduce the amount of force required to do work.

6-5.8 Illustrate ways that simple machines exist in common tools and in complex machines.

Grade 7

Overview

Students in grade seven continue to deepen their knowledge of the life, earth, and physical sciences through more complex investigations and explanations. The concepts they study become increasingly abstract in a developmentally appropriate manner to allow for the slow, incremental development of these cognitively complex ideas. Seventh graders also continue to develop their investigative skills by generating their own questions, recognizing and explaining the relationships among variables, and critiquing the conclusions that are drawn from scientific investigations. Specifically, these students explore the sciences within the framework of the following topics: "Cells and Heredity" (structure and function of cells and heredity), "Human Body Systems and Disease" (functions and interconnections within the human body and the breakdown of these functions due to disease); "Ecology: The Biotic and Abiotic Environment" (interactions and responses between biotic and abiotic components and organisms); and "The Chemical Nature of Matter" (classifications and properties of matter, changes in matter).

The science standards for grade seven provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people, and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 7

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 7-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation.
7-1.2 Generate questions that can be answered through scientific investigation.
7-1.3 Explain the reasons for testing one independent variable at a time in a controlled scientific investigation.
7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation.
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.
7-1.6 Critique a conclusion drawn from a scientific investigation.
7-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 7

Cells and Heredity

Standard 7-2: The student will demonstrate an understanding of the structure and function of cells, cellular reproduction, and heredity. (Life Science)

Indicators

7-2.1 Summarize the structures and functions of the major components of plant and animal cells (including the cell wall, the cell membrane, the nucleus, chloroplasts, mitochondria, and vacuoles).
7-2.2 Compare the major components of plant and animal cells.
7-2.3 Compare the body shapes of bacteria (spiral, coccus, and bacillus) and the body structures that protists (euglena, paramecium, amoeba) use for food gathering and locomotion.
7-2.4 Explain how cellular processes (including respiration, photosynthesis in plants, mitosis, and waste elimination) are essential to the survival of the organism.
7-2.5 Summarize how genetic information is passed from parent to offspring by using the terms *genes*, *chromosomes*, *inherited traits*, *genotype*, *phenotype*, *dominant traits*, and *recessive traits.*
7-2.6 Use Punnett squares to predict inherited monohybrid traits.
7-2.7 Distinguish between inherited traits and those acquired from environmental factors.

GRADE 7

Human Body Systems and Disease

Standard 7-3: The student will demonstrate an understanding of the functions and interconnections of the major human body systems, including the breakdown in structure or function that disease causes. (Life Science)

Indicators

7-3.1 Summarize the levels of structural organization within the human body (including cells, tissues, organs, and systems).

7-3.2 Recall the major organs of the human body and their function within their particular body system.

7-3.3 Summarize the relationships of the major body systems (including the circulatory, respiratory, digestive, excretory, nervous, muscular, and skeletal systems).

7-3.4 Explain the effects of disease on the major organs and body systems (including infectious diseases such as colds and flu, AIDS, and athlete's foot and noninfectious diseases such as diabetes, Parkinson's, and skin cancer).

GRADE 7

Ecology: The Biotic and Abiotic Environment

Standard 7-4: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment. (Earth Science, Life Science)

Indicators

7-4.1 Summarize the characteristics of the levels of organization within ecosystems (including populations, communities, habitats, niches, and biomes).
7-4.2 Illustrate energy flow in food chains, food webs, and energy pyramids
7-4.3 Explain the interaction among changes in the environment due to natural hazards (including landslides, wildfires, and floods), changes in populations, and limiting factors (including climate and the availability of food and water, space, and shelter).
7-4.4 Explain the effects of soil quality on the characteristics of an ecosystem.
7-4.5 Summarize how the location and movement of water on Earth's surface through groundwater zones and surface-water drainage basins, called watersheds, are important to ecosystems and to human activities.
7-4.6 Classify resources as renewable or nonrenewable and explain the implications of their depletion and the importance of conservation.

GRADE 7

The Chemical Nature of Matter

Standard 7-5: The student will demonstrate an understanding of the classifications and properties of matter and the changes that matter undergoes. (Physical Science)

Indicators

7-5.1 Recognize that matter is composed of extremely small particles called atoms.
7-5.2 Classify matter as element, compound, or mixture on the basis of its composition.
7-5.3 Compare the physical properties of metals and nonmetals.
7-5.4 Use the periodic table to identify the basic organization of elements and groups of elements (including metals, nonmetals, and families).
7-5.5 Translate chemical symbols and the chemical formulas of common substances to show the component parts of the substances (including NaCl [table salt], H_2O [water], $C_6H_{12}O_6$ [simple sugar], O_2 [oxygen gas], CO_2 [carbon dioxide], and N_2 [nitrogen gas]).
7-5.6 Distinguish between acids and bases and use indicators (including litmus paper, pH paper, and phenolphthalein) to determine their relative pH.
7-5.7 Identify the reactants and products in chemical equations.
7-5.8 Explain how a balanced chemical equation supports the law of conservation of matter.
7-5.9 Compare physical properties of matter (including melting or boiling point, density, and color) to the chemical property of reactivity with a certain substance (including the ability to burn or to rust).
7-5.10 Compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).

Grade 8

Overview

The focus of the grade-eight science standards is on providing students with the hands-on experiences that give them the active engagement and the concrete examples they require in order to understand basic science concepts. The development of eighth graders' science skills culminates with their designing an entire controlled scientific investigation, constructing explanations and drawing conclusions from data, and generating questions for further study. Specifically, students explore the life, earth, and physical sciences within the framework of the following topics: "Earth's Biological History" (Earth's biological diversity over time); "Earth's Structure and Processes" (materials and processes that alter the structure of Earth); "Astronomy: Earth and Space Systems" (characteristics, structure, and motions of celestial bodies in the universe); "Forces and Motion" (effects of forces on the motion of an object); and "Waves" (properties and behaviors of waves).

The science standards for grade eight provide the foundation for a course that is based on a rich and wide variety of learning experiences that actively engage students and accommodate a broad range of student learning styles through varied materials and instructional strategies. Students should observe, interact with materials and with people and ask questions as they explore new concepts and expand their knowledge.

The skills and tools listed in the scientific inquiry sections will be assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

The science standards in grades three through eight will be the basis for the development of the science test questions for the Palmetto Achievement Challenge Tests (PACT). The PACT is based on the broad standards that address the life, earth, and physical sciences at each grade level. Individual test questions will be aligned with the indicators and will not go beyond the scope and intent of the more specific information in the indicators. While standards at lower grade levels will not be directly assessed, they may be used to formulate multiple-choice distracter items.

GRADE 8

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard 8-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

8-1.1 Design a controlled scientific investigation.
8-1.2 Recognize the importance of a systematic process for safely and accurately conducting investigations.
8-1.3 Construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.
8-1.4 Generate questions for further study on the basis of prior investigations.
8-1.5 Explain the importance of and requirements for replication of scientific investigations.
8-1.6 Use appropriate tools and instruments (including convex lenses, plane mirrors, color filters, prisms, and slinky springs) safely and accurately when conducting a controlled scientific investigation.
8-1.7 Use appropriate safety procedures when conducting investigations.

GRADE 8

Earth's Biological History

Standard 8-2: The student will demonstrate an understanding of Earth's biological diversity over time. (Life Science, Earth Science)

Indicators

8-2.1 Explain how biological adaptations of populations enhance their survival in a particular environment.

8-2.2 Summarize how scientists study Earth's past environment and diverse life-forms by examining different types of fossils (including molds, casts, petrified fossils, preserved and carbonized remains of plants and animals, and trace fossils).

8-2.3 Explain how Earth's history has been influenced by catastrophes (including the impact of an asteroid or comet, climatic changes, and volcanic activity) that have affected the conditions on Earth and the diversity of its life-forms.

8-2.4 Recognize the relationship among the units—era, epoch, and period—into which the geologic time scale is divided.

8-2.5 Illustrate the vast diversity of life that has been present on Earth over time by using the geologic time scale.

8-2.6 Infer the relative age of rocks and fossils from index fossils and the ordering of the rock layers.

8-2.7 Summarize the factors, both natural and man-made, that can contribute to the extinction of a species.

GRADE 8

Earth's Structure and Processes

Standard 8-3: The student will demonstrate an understanding of materials that determine the structure of Earth and the processes that have altered this structure. (Earth Science)

Indicators

8-3.1 Summarize the three layers of Earth—crust, mantle, and core—on the basis of relative position, density, and composition.

8-3.2 Explain how scientists use seismic waves—primary, secondary, and surface waves—and Earth's magnetic fields to determine the internal structure of Earth.

8-3.3 Infer an earthquake's epicenter from seismographic data.

8-3.4 Explain how igneous, metamorphic, and sedimentary rocks are interrelated in the rock cycle.

8-3.5 Summarize the importance of minerals, ores, and fossil fuels as Earth resources on the basis of their physical and chemical properties.

8-3.6 Explain how the theory of plate tectonics accounts for the motion of the lithospheric plates, the geologic activities at the plate boundaries, and the changes in landform areas over geologic time.

8-3.7 Illustrate the creation and changing of landforms that have occurred through geologic processes (including volcanic eruptions and mountain-building forces).

8-3.8 Explain how earthquakes result from forces inside Earth.

8-3.9 Identify and illustrate geologic features of South Carolina and other regions of the world through the use of imagery (including aerial photography and satellite imagery) and topographic maps.

GRADE 8

Astronomy: Earth and Space Systems

Standard 8-4: The student will demonstrate an understanding of the characteristics, structure, and predictable motions of celestial bodies. (Earth Science)

Indicators

8-4.1 Summarize the characteristics and movements of objects in the solar system (including planets, moons, asteroids, comets, and meteors).
8-4.2 Summarize the characteristics of the surface features of the Sun: photosphere, corona, sunspots, prominences, and solar flares.
8-4.3 Explain how the surface features of the Sun may affect Earth.
8-4.4 Explain the motions of Earth and the Moon and the effects of these motions as they orbit the Sun (including day, year, phases of the Moon, eclipses, and tides).
8-4.5 Explain how the tilt of Earth's axis affects the length of the day and the amount of heating on Earth's surface, thus causing the seasons of the year.
8-4.6 Explain how gravitational forces are influenced by mass and distance.
8-4.7 Explain the effects of gravity on tides and planetary orbits.
8-4.8 Explain the difference between mass and weight by using the concept of gravitational force.
8-4.9 Recall the Sun's position in the universe, the shapes and composition of galaxies, and the distance measurement unit (light year) needed to identify star and galaxy locations.
8-4.10 Compare the purposes of the tools and the technology that scientists use to study space (including various types of telescopes, satellites, space probes, and spectroscopes).

GRADE 8

Forces and Motion

Standard 8-5: The student will demonstrate an understanding of the effects of forces on the motion of an object. (Physical Science)

Indicators

8-5.1 Use measurement and time-distance graphs to represent the motion of an object in terms of its position, direction, or speed.
8-5.2 Use the formula for average speed, v = d/t, to solve real-world problems.
8-5.3 Analyze the effects of forces (including gravity and friction) on the speed and direction of an object.
8-5.4 Predict how varying the amount of force or mass will affect the motion of an object.
8-5.5 Analyze the resulting effect of balanced and unbalanced forces on an object's motion in terms of magnitude and direction.
8-5.6 Summarize and illustrate the concept of inertia.

GRADE 8

Waves

Standard 8-6: The student will demonstrate an understanding of the properties and behaviors of waves. (Physical Science)

Indicators

8-6.1 Recall that waves transmit energy but not matter.
8-6.2 Distinguish between mechanical and electromagnetic waves.
8-6.3 Summarize factors that influence the basic properties of waves (including frequency, amplitude, wavelength, and speed).
8-6.4 Summarize the behaviors of waves (including refraction, reflection, transmission, and absorption).
8-6.5 Explain hearing in terms of the relationship between sound waves and the ear.
8-6.6 Explain sight in terms of the relationship between the eye and the light waves emitted or reflected by an object.
8-6.7 Explain how the absorption and reflection of light waves by various materials result in the human perception of color.
8-6.8 Compare the wavelength and energy of waves in various parts of the electromagnetic spectrum (including visible light, infrared, and ultraviolet radiation).

HIGH SCHOOL CORE AREA STANDARDS

Physical Science

Overview

The academic standards for Physical Science establish the scientific inquiry skills and core content for all Physical Science classes in South Carolina schools. The course should provide students with a conceptual understanding of the world around them—a basic knowledge of the physical universe that should serve as the foundation for other high school science courses.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content for Physical Science classes that are taught in their schools. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the particular objectives of the individual classes. All Physical Science classes must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. In other words, students should spend more of their class time choosing the right method to solve a problem and less time solving problems that merely call for repetitive procedures.

Physical Science is a laboratory course (minimum of 30 percent hands-on investigation) that integrates principles of chemistry and physics. Physical science laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations in both the chemistry and physics portions of the course.

The standards in the physical science core area will be the basis for the development of the items on the state-required end-of-course examination for Physical Science. The skills and tools listed in the scientific inquiry sections will be assessed independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

PHYSICAL SCIENCE

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard PS-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

PS-1.1 Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.

PS-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

PS-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

PS-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

PS-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas and dimensional analysis), graphs, models, and/or technology.

PS-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

PS-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

PS-1.8 Compare the processes of scientific investigation and technological design.

PS-1.9 Use appropriate safety procedures when conducting investigations.

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-2: The student will demonstrate an understanding of the structure and properties of atoms.

Indicators

PS-2.1 Compare the subatomic particles (protons, neutrons, electrons) of an atom with regard to mass, location, and charge, and explain how these particles affect the properties of an atom (including identity, mass, volume, and reactivity).

PS-2.2 Illustrate the fact that the atoms of elements exist as stable or unstable isotopes.

PS-2.3 Explain the trends of the periodic table based on the elements' valence electrons and atomic numbers.

PS-2.4 Use the atomic number and the mass number to calculate the number of protons, neutrons, and/or electrons for a given isotope of an element.

PS-2.5 Predict the charge that a representative element will acquire according to the arrangement of electrons in its outer energy level.

PS-2.6 Compare fission and fusion (including the basic processes and the fact that both fission and fusion convert a fraction of the mass of interacting particles into energy and release a great amount of energy).

PS-2.7 Explain the consequences that the use of nuclear applications (including medical technologies, nuclear power plants, and nuclear weapons) can have.

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-3: The student will demonstrate an understanding of various properties and classifications of matter.

Indicators

PS-3.1 Distinguish chemical properties of matter (including reactivity) from physical properties of matter (including boiling point, freezing/melting point, density [with density calculations], solubility, viscosity, and conductivity).

PS-3.2 Infer the practical applications of organic and inorganic substances on the basis of their chemical and physical properties.

PS-3.3 Illustrate the difference between a molecule and an atom.

PS-3.4 Classify matter as a pure substance (either an element or a compound) or as a mixture (either homogeneous or heterogeneous) on the basis of its structure and/or composition.

PS-3.5 Explain the effects of temperature, particle size, and agitation on the rate at which a solid dissolves in a liquid.

PS-3.6 Compare the properties of the four states of matter—solid, liquid, gas, and plasma—in terms of the arrangement and movement of particles.

PS-3.7 Explain the processes of phase change in terms of temperature, heat transfer, and particle arrangement.

PS-3.8 Classify various solutions as acids or bases according to their physical properties, chemical properties (including neutralization and reaction with metals), generalized formulas, and pH (using pH meters, pH paper, and litmus paper).

PHYSICAL SCIENCE

Chemistry: Structure and Properties of Matter

Standard PS-4: The student will demonstrate an understanding of chemical reactions and the classifications, structures, and properties of chemical compounds.

Indicators

PS-4.1 Explain the role of bonding in achieving chemical stability.

PS-4.2 Explain how the process of covalent bonding provides chemical stability through the sharing of electrons.

PS-4.3 Illustrate the fact that ions attract ions of opposite charge from all directions and form crystal lattices.

PS-4.4 Classify compounds as crystalline (containing ionic bonds) or molecular (containing covalent bonds) based on whether their outer electrons are transferred or shared.

PS-4.5 Predict the ratio by which the representative elements combine to form binary ionic compounds, and represent that ratio in a chemical formula.

PS-4.6 Distinguish between chemical changes (including the formation of gas or reactivity with acids) and physical changes (including changes in size, shape, color, and/or phase).

PS-4.7 Summarize characteristics of balanced chemical equations (including conservation of mass and changes in energy in the form of heat—that is, exothermic or endothermic reactions).

PS-4.8 Summarize evidence (including the evolution of gas; the formation of a precipitate; and/or changes in temperature, color, and/or odor) that a chemical reaction has occurred.

PS-4.9 Apply a procedure to balance equations for a simple synthesis or decomposition reaction.

PS-4.10 Recognize simple chemical equations (including single replacement and double replacement) as being balanced or not balanced.

PS-4.11 Explain the effects of temperature, concentration, surface area, and the presence of a catalyst on reaction rates.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-5: The student will demonstrate an understanding of the nature of forces and motion.

Indicators

PS-5.1 Explain the relationship among distance, time, direction, and the velocity of an object.
PS-5.2 Use the formula $v = d/t$ to solve problems related to average speed or velocity.
PS-5.3 Explain how changes in velocity and time affect the acceleration of an object.
PS-5.4 Use the formula $a = (v_f - v_i)/t$ to determine the acceleration of an object.
PS-5.5 Explain how acceleration due to gravity affects the velocity of an object as it falls.
PS-5.6 Represent the linear motion of objects on distance-time graphs.
PS-5.7 Explain the motion of objects on the basis of Newton's three laws of motion: inertia; the relationship among force, mass, and acceleration; and action and reaction forces.
PS-5.8 Use the formula $F = ma$ to solve problems related to force.
PS-5.9 Explain the relationship between mass and weight by using the formula $F_W = ma_g$.
PS-5.10 Explain how the gravitational force between two objects is affected by the mass of each object and the distance between them.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-6: The student will demonstrate an understanding of the nature, conservation, and transformation of energy.

Indicators

PS-6.1 Explain how the law of conservation of energy applies to the transformation of various forms of energy (including mechanical energy, electrical energy, chemical energy, light energy, sound energy, and thermal energy).

PS-6.2 Explain the factors that determine potential and kinetic energy and the transformation of one to the other.

PS-6.3 Explain work in terms of the relationship among the force applied to an object, the displacement of the object, and the energy transferred to the object.

PS-6.4 Use the formula W = Fd to solve problems related to work done on an object.

PS-6.5 Explain how objects can acquire a static electric charge through friction, induction, and conduction.

PS-6.6 Explain the relationships among voltage, resistance, and current in Ohm's law.

PS-6.7 Use the formula V = IR to solve problems related to electric circuits.

PS-6.8 Represent an electric circuit by drawing a circuit diagram that includes the symbols for a resistor, switch, and voltage source.

PS-6.9 Compare the functioning of simple series and parallel electrical circuits.

PS-6.10 Compare alternating current (AC) and direct current (DC) in terms of the production of electricity and the direction of current flow.

PS-6.11 Explain the relationship of magnetism to the movement of electric charges in electromagnets, simple motors, and generators.

PHYSICAL SCIENCE

Physics: The Interactions of Matter and Energy

Standard PS-7: The student will demonstrate an understanding of the nature and properties of mechanical and electromagnetic waves.

Indicators

PS-7.1 Illustrate ways that the energy of waves is transferred by interaction with matter (including transverse and longitudinal/compressional waves).

PS-7.2 Compare the nature and properties of transverse and longitudinal/compressional mechanical waves.

PS-7.3 Summarize characteristics of waves (including displacement, frequency, period, amplitude, wavelength, and velocity as well as the relationships among these characteristics).

PS-7.4 Use the formulas $v = f\lambda$ and $v = d/t$ to solve problems related to the velocity of waves.

PS-7.5 Summarize the characteristics of the electromagnetic spectrum (including range of wavelengths, frequency, energy, and propagation without a medium).

PS-7.6 Summarize reflection and interference of both sound and light waves and the refraction and diffraction of light waves.

PS-7.7 Explain the Doppler effect conceptually in terms of the frequency of the waves and the pitch of the sound.

Biology

Overview

The biology standards provide students with a basic knowledge of living organisms and the interaction of these organisms with the natural world. The standards establish the scientific inquiry skills and core content for all biology courses in South Carolina schools. Biology courses should serve as the foundation for higher-level science courses and should give students the science skills necessary for life science–related technical careers.

Teachers, schools, and districts should use these standards to make decisions concerning the structure and content of Biology 1 and Applied Biology 1 and 2. Educators must also determine how all biology courses in their schools, as well as individual classes, may go beyond the standards. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the objectives of the particular courses. All biology courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning.

All biology courses are laboratory courses (minimum of 30 percent hands-on investigation). Biology laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The standards in the biology core area will be the basis for the development of the items on the state-required end-of-course examination for Biology 1 and Applied Biology 2. The skills and tools listed in the scientific inquiry sections will be assessed independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators will be assessed *cumulatively*. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—in all their earlier grades. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

BIOLOGY

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard B-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

B-1.1 Generate hypotheses based on credible, accurate, and relevant sources of scientific information.
B-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and/or technology.
B-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
B-1.8 Compare the processes of scientific investigation and technological design.
B-1.9 Use appropriate safety procedures when conducting investigations.

BIOLOGY

Standard B-2: The student will demonstrate an understanding of the structure and function of cells and their organelles.

Indicators

B-2.1 Recall the three major tenets of cell theory (all living things are composed of one or more cells; cells are the basic units of structure and function in living things; and all presently existing cells arose from previously existing cells).

B-2.2 Summarize the structures and functions of organelles found in a eukaryotic cell (including the nucleus, mitochondria, chloroplasts, lysosomes, vacuoles, ribosomes, endoplasmic reticulum [ER], Golgi apparatus, cilia, flagella, cell membrane, nuclear membrane, cell wall, and cytoplasm).

B-2.3 Compare the structures and organelles of prokaryotic and eukaryotic cells.

B-2.4 Explain the process of cell differentiation as the basis for the hierarchical organization of organisms (including cells, tissues, organs, and organ systems).

B-2.5 Explain how active, passive, and facilitated transport serve to maintain the homeostasis of the cell.

B-2.6 Summarize the characteristics of the cell cycle: interphase (called G1, S, G2); the phases of mitosis (called prophase, metaphase, anaphase, and telophase); and plant and animal cytokinesis.

B-2.7 Summarize how cell regulation controls and coordinates cell growth and division and allows cells to respond to the environment, and recognize the consequences of uncontrolled cell division.

B-2.8 Explain the factors that affect the rates of biochemical reactions (including pH, temperature, and the role of enzymes as catalysts).

BIOLOGY

Standard B-3: The student will demonstrate an understanding of the flow of energy within and between living systems.

Indicators

B-3.1 Summarize the overall process by which photosynthesis converts solar energy into chemical energy and interpret the chemical equation for the process.

B-3.2 Summarize the basic aerobic and anaerobic processes of cellular respiration and interpret the chemical equation for cellular respiration.

B-3.3 Recognize the overall structure of adenosine triphosphate (ATP)—namely, adenine, the sugar ribose, and three phosphate groups—and summarize its function (including the ATP-ADP [adenosine diphosphate] cycle).

B-3.4 Summarize how the structures of organic molecules (including proteins, carbohydrates, and fats) are related to their relative caloric values.

B-3.5 Summarize the functions of proteins, carbohydrates, and fats in the human body.

B-3.6 Illustrate the flow of energy through ecosystems (including food chains, food webs, energy pyramids, number pyramids, and biomass pyramids).

BIOLOGY

Standard B-4: The student will demonstrate an understanding of the molecular basis of heredity.

Indicators

B-4.1 Compare DNA and RNA in terms of structure, nucleotides, and base pairs.
B-4.2 Summarize the relationship among DNA, genes, and chromosomes.
B-4.3 Explain how DNA functions as the code of life and the blueprint for proteins.
B-4.4 Summarize the basic processes involved in protein synthesis (including transcription and translation).
B-4.5 Summarize the characteristics of the phases of meiosis I and II.
B-4.6 Predict inherited traits by using the principles of Mendelian genetics (including segregation, independent assortment, and dominance).
B-4.7 Summarize the chromosome theory of inheritance and relate that theory to Gregor Mendel's principles of genetics.
B-4.8 Compare the consequences of mutations in body cells with those in gametes.
B-4.9 Exemplify ways that introduce new genetic characteristics into an organism or a population by applying the principles of modern genetics.

BIOLOGY

Standard B-5: The student will demonstrate an understanding of biological evolution and the diversity of life.

Indicators

B-5.1 Summarize the process of natural selection.
B-5.2 Explain how genetic processes result in the continuity of life-forms over time.
B-5.3 Explain how diversity within a species increases the chances of its survival.
B-5.4 Explain how genetic variability and environmental factors lead to biological evolution.
B-5.5 Exemplify scientific evidence in the fields of anatomy, embryology, biochemistry, and paleontology that underlies the theory of biological evolution.
B-5.6 Summarize ways that scientists use data from a variety of sources to investigate and critically analyze aspects of evolutionary theory.
B-5.7 Use a phylogenetic tree to identify the evolutionary relationships among different groups of organisms.

BIOLOGY

Standard B-6: The student will demonstrate an understanding of the interrelationships among organisms and the biotic and abiotic components of their environments.

Indicators

B-6.1 Explain how the interrelationships among organisms (including predation, competition, parasitism, mutualism, and commensalism) generate stability within ecosystems.

B-6.2 Explain how populations are affected by limiting factors (including density-dependent, density-independent, abiotic, and biotic factors).

B-6.3 Illustrate the processes of succession in ecosystems.

B-6.4 Exemplify the role of organisms in the geochemical cycles (including the cycles of carbon, nitrogen, and water).

B-6.5 Explain how ecosystems maintain themselves through naturally occurring processes (including maintaining the quality of the atmosphere, generating soils, controlling the hydrologic cycle, disposing of wastes, and recycling nutrients).

B-6.6 Explain how human activities (including population growth, technology, and consumption of resources) affect the physical and chemical cycles and processes of Earth.

Chemistry

Overview

The standards for chemistry establish scientific inquiry skills and core content for all chemistry courses in South Carolina schools. In chemistry, students acquire a fundamental knowledge of the substances in our world—their composition, properties, and interactions—that should not only serve them as a foundation for the more advanced science courses in secondary and postsecondary education but should also provide them with the science skills that are necessary in chemistry-oriented technical careers.

In order for students to achieve these goals, chemistry courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should therefore use these standards to make decisions concerning the structure and content of all their courses in chemistry and to make choices regarding additional content, activities, and learning strategies that will be determined by the objectives of the particular courses.

All chemistry courses are laboratory courses (minimum of 30 percent hands-on investigation). Chemistry laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

CHEMISTRY

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard C-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

C-1.1 Apply established rules for significant digits, both in reading a scientific instrument and in calculating a derived quantity from measurement.

C-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

C-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

C-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

C-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas, scientific notation, and dimensional analysis), graphs, models, and/or technology.

C-1.6 Evaluate the results of a scientific investigation in terms of whether they verify or refute the hypothesis and what the possible sources of error are.

C-1.7 Evaluate a technological design or product on the basis of designated criteria.

C-1.8 Use appropriate safety procedures when conducting investigations.

CHEMISTRY

Standard C-2: Students will demonstrate an understanding of atomic structure and nuclear processes.

Indicators

C-2.1 Illustrate electron configurations by using orbital notation for representative elements.
C-2.2 Summarize atomic properties (including electron configuration, ionization energy, electron affinity, atomic size, and ionic size).
C-2.3 Summarize the periodic table's property trends (including electron configuration, ionization energy, electron affinity, atomic size, ionic size, and reactivity).
C-2.4 Compare the nuclear reactions of fission and fusion to chemical reactions (including the parts of the atom involved and the relative amounts of energy released).
C-2.5 Compare alpha, beta, and gamma radiation in terms of mass, charge, penetrating power, and the release of these particles from the nucleus.
C-2.6 Explain the concept of half-life, its use in determining the age of materials, and its significance to nuclear waste disposal.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-2.7 Apply the predictable rate of nuclear decay (half-life) to determine the age of materials.
C-2.8 Analyze a decay series chart to determine the products of successive nuclear reactions and write nuclear equations for disintegration of specified nuclides.
C-2.9 Use the equation $E = mc^2$ to determine the amount of energy released during nuclear reactions.

CHEMISTRY

Standard C-3: The student will demonstrate an understanding of the structures and classifications of chemical compounds.

Indicators

C-3.1 Predict the type of bonding (ionic or covalent) and the shape of simple compounds by using Lewis dot structures and oxidation numbers.
C-3.2 Interpret the names and formulas for ionic and covalent compounds.
C-3.3 Explain how the types of intermolecular forces present in a compound affect the physical properties of compounds (including polarity and molecular shape).
C-3.4 Explain the unique bonding characteristics of carbon that have resulted in the formation of a large variety of organic structures.
C-3.5 Illustrate the structural formulas and names of simple hydrocarbons (including alkanes and their isomers and benzene rings).

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-3.6 Identify the basic structure of common polymers (including proteins, nucleic acids, plastics, and starches).
C-3.7 Classify organic compounds in terms of their functional group.
C-3.8 Explain the effect of electronegativity and ionization energy on the type of bonding in a molecule.
C-3.9 Classify polymerization reactions as addition or condensation.
C-3.10 Classify organic reactions as addition, elimination, or condensation.

CHEMISTRY

Standard C-4: The student will demonstrate an understanding of the types, the causes, and the effects of chemical reactions.

Indicators

C-4.1 Analyze and balance equations for simple synthesis, decomposition, single replacement, double replacement, and combustion reactions.
C-4.2 Predict the products of acid-base neutralization and combustion reactions.
C-4.3 Analyze the energy changes (endothermic or exothermic) associated with chemical reactions.
C-4.4 Apply the concept of moles to determine the number of particles of a substance in a chemical reaction, the percent composition of a representative compound, the mass proportions, and the mole-mass relationships.
C-4.5 Predict the percent yield, the mass of excess, and the limiting reagent in chemical reactions.
C-4.6 Explain the role of activation energy and the effects of temperature, particle size, stirring, concentration, and catalysts in reaction rates.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-4.7 Summarize the oxidation and reduction processes (including oxidizing and reducing agents).
C-4.8 Illustrate the uses of electrochemistry (including electrolytic cells, voltaic cells, and the production of metals from ore by electrolysis).
C-4.9 Summarize the concept of chemical equilibrium and Le Châtelier's principle.
C-4.10 Explain the role of collision frequency, the energy of collisions, and the orientation of molecules in reaction rates.

CHEMISTRY

Standard C-5: The student will demonstrate an understanding of the structure and behavior of the different phases of matter.

Indicators

C-5.1 Explain the effects of the intermolecular forces on the different phases of matter.
C-5.2 Explain the behaviors of gas; the relationship among pressure, volume, and temperature; and the significance of the Kelvin (absolute temperature) scale, using the kinetic-molecular theory as a model.
C-5.3 Apply the gas laws to problems concerning changes in pressure, volume, or temperature (including Charles's law, Boyle's law, and the combined gas law).
C-5.4 Illustrate and interpret heating and cooling curves (including how boiling and melting points can be identified and how boiling points vary with changes in pressure).

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-5.5 Analyze the energy changes involved in calorimetry by using the law of conservation of energy as it applies to temperature, heat, and phase changes (including the use of the formulas $q = mc\Delta T$ [temperature change] and $q = mLv$ and $q = mLf$ [phase change] to solve calorimetry problems).
C-5.6 Use density to determine the mass, volume, or number of particles of a gas in a chemical reaction.
C-5.7 Apply the ideal gas law ($pV = nRT$) to solve problems.
C-5.8 Analyze a product for purity by following the appropriate assay procedures.
C-5.9 Analyze a chemical process to account for the weight of all reagents and solvents by following the appropriate material balance procedures.

CHEMISTRY

Standard C-6: The student will demonstrate an understanding of the nature and properties of various types of chemical solutions.

Indicators

C-6.1 Summarize the process by which solutes dissolve in solvents, the dynamic equilibrium that occurs in saturated solutions, and the effects of varying pressure and temperature on solubility.
C-6.2 Compare solubility of various substances in different solvents (including polar and nonpolar solvents and organic and inorganic substances).
C-6.3 Illustrate the colligative properties of solutions (including freezing point depression and boiling point elevation and their practical uses).
C-6.4 Carry out calculations to find the concentration of solutions in terms of molarity and percent weight (mass).
C-6.5 Summarize the properties of salts, acids, and bases.
C-6.6 Distinguish between strong and weak common acids and bases.
C-6.7 Represent common acids and bases by their names and formulas.

The following indicators should be selected as appropriate to a particular course for additional content and depth:

C-6.8 Use the hydronium or hydroxide ion concentration to determine the pH and pOH of aqueous solutions.
C-6.9 Explain how the use of a titration can determine the concentration of acid and base solutions
C-6.10 Interpret solubility curves to determine saturation at different temperatures.
C-6.11 Use a variety of procedures for separating mixtures (including distillation, crystallization filtration, paper chromatography, and centrifuge).
C-6.12 Use solubility rules to write net ionic equations for precipitation reactions in aqueous solution.
C-6.13 Use the calculated molality of a solution to calculate the freezing point depression and the boiling point elevation of a solution.
C-6.14 Represent neutralization reactions and reactions between common acids and metals by using chemical equations.
C-6.15 Analyze the composition of a chemical sample by using gas chromatography.

Physics

Overview

The standards for physics establish the scientific inquiry skills and core content for all physics courses in South Carolina schools. In these courses, students acquire a fundamental knowledge of motion, matter, and energy that should not only serve them as the foundation for their study of science in institutions of higher education but should also provide them with the science skills that are necessary in physics-oriented technical careers. A total of *seven* high school core area standards for physics must be taught: the *required* standards for physics are standards 1 through 5; any *two* of standards 6 through 10 are required in addition. The decision about which two of standards 6 through 10 to address in any particular physics course should be based on the objectives for that course.

In order for students to achieve these goals, physics courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should therefore use these standards to make decisions concerning the structure and content of all their courses in physics and to make choices regarding additional content, activities, and learning strategies that will be determined by the objectives of the particular courses.

All physics courses are laboratory courses (minimum of 30 percent hands-on investigation). Physics laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

PHYSICS

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard P-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

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Indicators

P-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

P-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

P-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

P-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

P-1.5 Organize and interpret the data from a controlled scientific investigation by using (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

P-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

P-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

P-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

P-1.9 Communicate and defend a scientific argument or conclusion.

P-1.10 Use appropriate safety procedures when conducting investigations.

PHYSICS

Standard P-2: The student will demonstrate an understanding of the principles of force and motion and relationships between them.

Indicators

P-2.1 Represent vector quantities (including displacement, velocity, acceleration, and force) and use vector addition.

P-2.2 Apply formulas for velocity or speed and acceleration to one and two-dimensional problems.

P-2.3 Interpret the velocity or speed and acceleration of one and two-dimensional motion on distance-time, velocity-time or speed-time, and acceleration-time graphs.

P-2.4 Interpret the resulting motion of objects by applying Newton's three laws of motion: inertia; the relationship among net force, mass, and acceleration (using F = ma); and action and reaction forces.

P-2.5 Explain the factors that influence the dynamics of falling objects and projectiles.

P-2.6 Apply formulas for velocity and acceleration to solve problems related to projectile motion.

P-2.7 Use a free-body diagram to determine the net force and component forces acting upon an object.

P-2.8 Distinguish between static and kinetic friction and the factors that affect the motion of objects.

P-2.9 Explain how torque is affected by the magnitude, direction, and point of application of force.

P-2.10 Explain the relationships among speed, velocity, acceleration, and force in rotational systems.

PHYSICS

Standard P-3: The student will demonstrate an understanding of the conservation, transfer, and transformation of mechanical energy.

Indicators

P-3.1 Apply energy formulas to determine potential and kinetic energy and explain the transformation from one to the other.

P-3.2 Apply the law of conservation of energy to the transfer of mechanical energy through work.

P-3.3 Explain, both conceptually and quantitatively, how energy can transfer from one system to another (including work, power, and efficiency).

P-3.4 Explain, both conceptually and quantitatively, the factors that influence periodic motion.

P-3.5 Explain the factors involved in producing a change in momentum (including impulse and the law of conservation of momentum in both linear and rotary systems).

P-3.6 Compare elastic and inelastic collisions in terms of conservation laws.

PHYSICS

Standard P-4: The student will demonstrate an understanding of the properties of electricity and magnetism and the relationships between them.

Indicators

P-4.1 Recognize the characteristics of static charge and explain how a static charge is generated.

P-4.2 Use diagrams to illustrate an electric field (including point charges and electric field lines).

P-4.3 Summarize current, potential difference, and resistance in terms of electrons.

P-4.4 Compare how current, voltage, and resistance are measured in a series and in a parallel electric circuit and identify the appropriate units of measurement.

P-4.5 Analyze the relationships among voltage, resistance, and current in a complex circuit by using Ohm's law to calculate voltage, resistance, and current at each resistor, any branch, and the overall circuit.

P-4.6 Differentiate between alternating current (AC) and direct current (DC) in electrical circuits.

P-4.7 Carry out calculations for electric power and electric energy for circuits.

P-4.8 Summarize the function of electrical safety components (including fuses, surge protectors, and breakers).

P-4.9 Explain the effects of magnetic forces on the production of electrical currents and on current carrying wires and moving charges.

P-4.10 Distinguish between the function of motors and generators on the basis of the use of electricity and magnetism by each.

P-4.11 Predict the cost of operating an electrical device by determining the amount of electrical power and electrical energy in the circuit.

PHYSICS

Standard P-5: The student will demonstrate an understanding of the properties and behaviors of mechanical and electromagnetic waves.

Indicators

P-5.1 Analyze the relationships among the properties of waves (including energy, frequency, amplitude, wavelength, period, phase, and speed).
P-5.2 Compare the properties of electromagnetic and mechanical waves.
P-5.3 Analyze wave behaviors (including reflection, refraction, diffraction, and constructive and destructive interference).
P-5.4 Distinguish the different properties of waves across the range of the electromagnetic spectrum.
P-5.5 Illustrate the interaction of light waves with optical lenses and mirrors by using Snell's law and ray diagrams.
P-5.6 Summarize the operation of lasers and compare them to incandescent light.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-6: The student will demonstrate an understanding of the properties and behaviors of sound.

Indicators

P-6.1 Summarize the production of sound and its speed and transmission through various media.
P-6.2 Explain how frequency and intensity affect the parts of the sonic spectrum.
P-6.3 Explain pitch, loudness, and tonal quality in terms of wave characteristics that determine what is heard.
P-6.4 Compare intensity and loudness.
P-6.5 Apply formulas to determine the relative intensity of sound.
P-6.6 Apply formulas in order to solve for resonant wavelengths in problems involving open and closed tubes.
P-6.7 Explain the relationship among frequency, fundamental tones, and harmonics in producing music.
P-6.8 Explain how musical instruments produce resonance and standing waves.
P-6.9 Explain how the variables of length, width, tension, and density affect the resonant frequency, harmonics, and pitch of a vibrating string.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-7: The student will demonstrate an understanding of the properties and behaviors of light and optics.

Indicators

P-7.1 Explain the particulate nature of light as evidenced in the photoelectric effect.
P-7.2 Use the inverse square law to determine the change in intensity of light with distance.
P-7.3 Illustrate the polarization of light.
P-7.4 Summarize the operation of fiber optics in terms of total internal reflection.
P-7.5 Summarize image formation in microscopes and telescopes (including reflecting and refracting).
P-7.6 Summarize the production of continuous, emission, or absorption spectra.
P-7.7 Compare color by transmission to color by reflection.
P-7.8 Compare color mixing in pigments to color mixing in light.
P-7.9 Illustrate the diffraction and interference of light.
P-7.10 Identify the parts of the eye and explain their function in image formation.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-8: The student will demonstrate an understanding of nuclear physics and modern physics.

Indicators

P-8.1 Compare the strong and weak nuclear forces in terms of their roles in radioactivity.
P-8.2 Compare the nuclear binding energy to the energy released during a nuclear reaction, given the atomic masses of the constituent particles.
P-8.3 Predict the resulting isotope of a given alpha, beta, or gamma emission.
P-8.4 Apply appropriate procedures to balance nuclear equations (including fusion, fission, alpha decay, beta decay, and electron capture).
P-8.5 Interpret a representative nuclear decay series.
P-8.6 Explain the relationship between mass and energy that is represented in the equation $E = mc^2$ according to Einstein's special theory of relativity.
P-8.7 Compare the value of time, length, and momentum in the reference frame of an object moving at relativistic velocity to those values measured in the reference frame of an observer by applying Einstein's special theory of relativity.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-9: The student will demonstrate an understanding of the principles of fluid mechanics.

Indicators

P-9.1 Predict the behavior of fluids (including changing forces) in pneumatic and hydraulic systems.
P-9.2 Apply appropriate procedures to solve problems involving pressure, force, volume, and area.
P-9.3 Explain the factors that affect buoyancy.
P-9.4 Explain how the rate of flow of a fluid is affected by the size of the pipe, friction, and the viscosity of the fluid.
P-9.5 Explain how depth and fluid density affect pressure.
P-9.6 Apply fluid formulas to solve problems involving work and power.
P-9.7 Exemplify the relationship between velocity and pressure by using Bernoulli's principle.

PHYSICS

***Two* of physics standards 6 through 10 must be taught in addition to standards 1 through 5.**

Standard P-10: The student will demonstrate an understanding of the principles of thermodynamics.

Indicators

P-10.1 Summarize the first and second laws of thermodynamics.
P-10.2 Explain the relationship among internal energy, heat, and work.
P-10.3 Exemplify the concept of entropy.
P-10.4 Explain thermal expansion in solids, liquids, and gases in terms of kinetic theory and the unique behavior of water.
P-10.5 Differentiate heat and temperature in terms of molecular motion.
P-10.6 Summarize the concepts involved in phase change.
P-10.7 Apply the concepts of heat capacity, specific heat, and heat exchange to solve calorimetry problems.
P-10.8 Summarize the functioning of heat transfer mechanisms (including engines and refrigeration systems).

Earth Science Overview

The standards for earth science establish the scientific inquiry skills and core content for all earth science courses in South Carolina schools. Earth science courses should provide students with a basic knowledge of the natural world that will serve as the foundation for more advanced secondary and postsecondary courses and will also give them the science skills necessary for earth-science oriented technical careers.

In order for students to achieve these goals, earth science courses must include inquiry-based instruction, allowing students to engage in problem solving, decision making, critical thinking, and applied learning. Teachers, schools, and districts should use the academic standards for earth science to make decisions concerning the structure and content of all their earth science courses and to determine how these courses may go beyond the standards. These decisions will involve choices regarding additional content, activities, and learning strategies and will depend on the objectives of the individual courses.

All earth science courses are laboratory courses (minimum of 30 percent hands-on investigation). Earth science laboratories will need to be stocked with all of the materials and apparatuses necessary to complete investigations.

The skills and tools listed in the scientific inquiry sections have been assessed on statewide tests independently from the content knowledge in the respective grade or high school core area under which they are listed. Moreover, scientific inquiry standards and indicators have been assessed *cumulatively*. Therefore, as students progress through this course, they are expected to know the content of the scientific inquiry indicators—including the use of tools—from all their previous grades and science courses. A table of the scientific inquiry standards and indicators for kindergarten through grade twelve is provided in appendix A, which teachers are urged to print out and keep as a ready reference.

EARTH SCIENCE

Scientific Inquiry

The skills of scientific inquiry, including a knowledge of the use of tools, will be assessed cumulatively on statewide tests. Students will therefore be responsible for the scientific inquiry indicators from all of their earlier grade levels. A table of the K–12 scientific inquiry standards and indicators is provided in appendix A.

Standard ES-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

ES-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

ES-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

ES-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

ES-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

ES-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

ES-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

ES-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

ES-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

ES-1.9 Communicate and defend a scientific argument or conclusion.

ES-1.10 Use appropriate safety procedures when conducting investigations.

EARTH SCIENCE

Astronomy

Standard ES-2: Students will demonstrate an understanding of the structure and properties of the universe.

Indicators

ES-2.1 Summarize the properties of the solar system that support the theory of its formation along with the planets.

ES-2.2 Identify properties and features of the Moon that make it unique among other moons in the solar system.

ES-2.3 Summarize the evidence that supports the big bang theory and the expansion of the universe (including the red shift of light from distant galaxies and the cosmic background radiation).

ES-2.4 Explain the formation of elements that results from nuclear fusion occurring within stars or supernova explosions.

ES-2.5 Classify stars by using the Hertzsprung-Russell diagram.

ES-2.6 Compare the information obtained through the use of x-ray, radio, and visual (reflecting and refracting) telescopes.

ES-2.7 Summarize the life cycles of stars.

ES-2.8 Explain how gravity and motion affect the formation and shapes of galaxies (including the Milky Way).

ES-2.9 Explain how technology and computer modeling have increased our understanding of the universe.

EARTH SCIENCE

Solid Earth

Standard ES-3: Students will demonstrate an understanding of the internal and external dynamics of solid Earth.

Indicators

ES-3.1 Summarize theories and evidence of the origin and formation of Earth's systems by using the concepts of gravitational force and heat production.

ES-3.2 Explain the differentiation of the structure of Earth's layers into a core, mantle, and crust based on the production of internal heat from the decay of isotopes and the role of gravitational energy.

ES-3.3 Summarize theory of plate tectonics (including the role of convection currents, the action at plate boundaries, and the scientific evidence for the theory).

ES-3.4 Explain how forces due to plate tectonics cause crustal changes as evidenced in earthquake activity, volcanic eruptions, and mountain building.

ES-3.5 Analyze surface features of Earth in order to identify geologic processes (including weathering, erosion, deposition, and glaciation) that are likely to have been responsible for their formation.

ES-3.6 Explain how the dynamic nature of the rock cycle accounts for the interrelationships among igneous, sedimentary, and metamorphic rocks.

ES-3.7 Classify minerals and rocks on the basis of their physical and chemical properties and the environment in which they were formed.

ES-3.8 Summarize the formation of ores and fossil fuels and the impact on the environment that the use of these fuels has had.

EARTH SCIENCE

Earth's Atmosphere

Standard ES-4: The student will demonstrate an understanding of the dynamics of Earth's atmosphere.

Indicators

ES-4.1 Summarize the thermal structures, the gaseous composition, and the location of the layers of Earth's atmosphere.

ES-4.2 Summarize the changes in Earth's atmosphere over geologic time (including the importance of photosynthesizing organisms to the atmosphere).

ES-4.3 Summarize the cause and effects of convection within Earth's atmosphere.

ES-4.4 Attribute global climate patterns to geographic influences (including latitude, topography, elevation, and proximity to water).

ES-4.5 Explain the relationship between the rotation of Earth and the pattern of wind belts.

ES-4.6 Summarize possible causes of and evidence for past and present global climate changes.

ES-4.7 Summarize the evidence for the likely impact of human activities on the atmosphere (including ozone holes, greenhouse gases, acid rain, and photochemical smog).

ES-4.8 Predict weather conditions and storms (including thunderstorms, hurricanes, and tornados) on the basis of the relationship among the movement of air masses, high and low pressure systems, and frontal boundaries.

EARTH SCIENCE

Earth's Hydrosphere

Standard ES-5: The student will demonstrate an understanding of Earth's freshwater and ocean systems.

Indicators

ES-5.1 Summarize the location, movement, and energy transfers involved in the movement of water on Earth's surface (including lakes, surface-water drainage basins [watersheds], freshwater wetlands, and groundwater zones).
ES-5.2 Illustrate the characteristics of the succession of river systems.
ES-5.3 Explain how karst topography develops as a result of groundwater processes.
ES-5.4 Compare the physical and chemical properties of seawater and freshwater.
ES-5.5 Explain the results of the interaction of the shore with waves and currents.
ES-5.6 Summarize the advantages and disadvantages of devices used to control and prevent coastal erosion and flooding.
ES-5.7 Explain the effects of the transfer of solar energy and geothermal energy on the oceans of Earth (including the circulation of ocean currents and chemosynthesis).
ES-5.8 Analyze environments to determine possible sources of water pollution (including industrial waste, agriculture, domestic waste, and transportation devices).

EARTH SCIENCE

The Paleobiosphere

Standard ES-6: Students will demonstrate an understanding of the dynamic relationship between Earth's conditions over geologic time and the diversity of its organisms.

Indicators

ES-6.1 Summarize the conditions of Earth that enable the planet to support life.

ES-6.2 Recall the divisions of the geologic time scale and illustrate the changes (in complexity and/or diversity) of organisms that have existed across these time units.

ES-6.3 Summarize how fossil evidence reflects the changes in environmental conditions on Earth over time.

ES-6.4 Match dating methods (including index fossils, ordering of rock layers, and radiometric dating) with the most appropriate application for estimating geologic time.

ES-6.5 Infer explanations concerning the age of the universe and the age of Earth on the basis of scientific evidence.

APPENDIX A

Scientific Inquiry Standards and Indicators
Kindergarten through Grade Twelve

Scientific inquiry standards and indicators will be assessed cumulatively on statewide tests. Therefore, as students progress through the grade levels, they are responsible for the scientific inquiry indicators—including a knowledge of the use of tools—from all their earlier grades. In accordance with that fact, only those tools that have not been identified in the earlier grades are listed at each successive grade level.

K–12 Scientific Inquiry Standards and Indicators

Kindergarten

Standard K-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

K-1.1 Identify observed objects or events by using the senses.
K-1.2 Use tools (including magnifiers and eyedroppers) safely, accurately, and appropriately when gathering specific data.
K-1.3 Predict and explain information or events based on observation or previous experience.
K-1.4 Compare objects by using nonstandard units of measurement.
K-1.5 Use appropriate safety procedures when conducting investigations.

Grade 1

Standard 1-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

1-1.1 Compare, classify, and sequence objects by number, shape, texture, size, color, and motion, using standard English units of measurement where appropriate
1-1.2 Use tools (including rulers) safely, accurately, and appropriately when gathering specific data.
1-1.3 Carry out simple scientific investigations when given clear directions.
1-1.4 Use appropriate safety procedures when conducting investigations.

Grade 2

Standard 2-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

2-1.1 Carry out simple scientific investigations to answer questions about familiar objects and events.
2-1.2 Use tools (including thermometers, rain gauges, balances, and measuring cups) safely, accurately, and appropriately when gathering specific data.
2-1.3 Represent and communicate simple data and explanations through drawings, tables, pictographs, bar graphs, and oral and written language.
2-1.4 Infer explanations regarding scientific observations and experiences.
2-1.5 Use appropriate safety procedures when conducting investigations.

Grade 3

Standard 3-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific

investigation.

Indicators

3-1.1 Classify objects by two of their properties (attributes).
3-1.2 Classify objects or events in sequential order.
3-1.3 Generate questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation.
3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.
3-1.5 Use tools (including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, graduated cylinders, and graduated syringes) safely, accurately, and appropriately when gathering specific data.
3-1.6 Infer meaning from data communicated in graphs, tables, and diagrams.
3-1.7 Explain why similar investigations might produce different results.
3-1.8 Use appropriate safety procedures when conducting investigations.

Grade 4

Standard 4-1: The student will demonstrate an understanding of scientific inquiry, including the processes, skills, and mathematical thinking necessary to conduct a simple scientific investigation.

Indicators

4-1.1 Classify observations as either quantitative or qualitative.
4-1.2 Use appropriate instruments and tools (including a compass, an anemometer, mirrors, and a prism) safely and accurately when conducting simple investigations.
4-1.3 Summarize the characteristics of a simple scientific investigation that represent a fair test (including a question that identifies the problem, a prediction that indicates a possible outcome, a process that tests one manipulated variable at a time, and results that are communicated and explained).
4-1.4 Distinguish among observations, predictions, and inferences.
4-1.5 Recognize the correct placement of variables on a line graph.
4-1.6 Construct and interpret diagrams, tables, and graphs made from recorded measurements and observations.
4-1.7 Use appropriate safety procedures when conducting investigations.

Grade 5

Standard 5-1: The student will demonstrate an understanding of scientific inquiry, including the foundations of technological design and the processes, skills, and mathematical thinking necessary to conduct a controlled scientific investigation.

Indicators

5-1.1 Identify questions suitable for generating a hypothesis.
5-1.2 Identify independent (manipulated), dependent (responding), and controlled variables in an experiment.
5-1.3 Plan and conduct controlled scientific investigations, manipulating one variable at a time.
5-1.4 Use appropriate tools and instruments (including a timing device and a 10x magnifier) safely and accurately when conducting a controlled scientific investigation.
5-1.5 Construct a line graph from recorded data with correct placement of independent (manipulated) and dependent (responding) variables.
5-1.6 Evaluate results of an investigation to formulate a valid conclusion based on evidence and communicate the findings of the evaluation in oral or written form.
5-1.7 Use a simple technological design process to develop a solution or a product, communicating the design by using descriptions, models, and drawings.
5-1.8 Use appropriate safety procedures when conducting investigations.

K–12 Scientific Inquiry Standards and Indicators

Grade 6

Standard 6-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

6-1.1 Use appropriate tools and instruments (including a spring scale, beam balance, barometer, and sling psychrometer) safely and accurately when conducting a controlled scientific investigation.

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.

6-1.3 Use a technological design process to plan and produce a solution to a problem or a product (including identifying a problem, designing a solution or a product, implementing the design, and evaluating the solution or the product).

6-1.4 Use appropriate safety procedures when conducting investigations.

Grade 7

Standard 7-1: The student will demonstrate an understanding of technological design and scientific inquiry, including process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

Indicators

7-1.1 Use appropriate tools and instruments (including a microscope) safely and accurately when conducting a controlled scientific investigation.

7-1.2 Generate questions that can be answered through scientific investigation.

7-1.3 Explain the reasons for testing one independent variable at a time in a controlled scientific investigation.

7-1.4 Explain the importance that repeated trials and a well-chosen sample size have with regard to the validity of a controlled scientific investigation.

scientific

Grade 3

Standard 3-1: The student will demonstrate an understanding of scientific inquiry (including the processes, skills, and mathematical thinking necessary to conduct a simple investigation. (Inquiry)

Indicators

3-1.1 Classify objects by two properties (attributes).

3-1.2 Classify objects or events in sequential order.

3-1.3 Generate questions ("what if" or "how") about objects, organisms, and events in the environment that will be used to conduct a simple investigation.

3-1.4 Predict the outcome of a simple investigation and compare the result with the prediction.

3-1.5 Use tools including beakers, meter tapes and sticks, forceps/tweezers, tuning forks, and graduated cylinders/syringes safely, accurately, and as appropriate for gathering specific data.

3-1.6 Infer from data communicated in graphs, tables, and diagrams.

3-1.7 Explain why similar investigations might produce different results.

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stigations.

8-1.3 Construct explanations and conclusions from interpretations of data obtained during a controlled scientific investigation.

8-1.4 Generate questions for further study on the basis of prior investigations.

8-1.5 Explain the importance of and requirements for replication of scientific investigations.

8-1.6 Use appropriate tools and instruments (including convex lenses, plane mirrors, color filters, prisms, and slinky springs) safely and accurately when conducting a controlled scientific investigation.

8-1.7 Use appropriate safety procedures when conducting investigations.

Physical Science

Standard PS-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

PS-1.1 Generate hypotheses on the basis of credible, accurate, and relevant sources of scientific information.

K–12 Scientific Inquiry Standards and Indicators

PS-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
PS-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
PS-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
PS-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas and dimensional analysis), graphs, models, and/or technology.
PS-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
PS-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
PS-1.8 Compare the processes of scientific investigation and technological design.
PS-1.9 Use appropriate safety procedures when conducting investigations.

Biology

Standard B-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

B-1.1 Generate hypotheses based on credible, accurate, and relevant sources of scientific information.
B-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
B-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
B-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
B-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics, graphs, models, and/or technology.
B-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
B-1.7 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
B-1.8 Compare the processes of scientific investigation and technological design.
B-1.9 Use appropriate safety procedures when conducting investigations.

K–12 Scientific Inquiry Standards and Indicators

Chemistry

Standard C-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

C-1.1 Apply established rules for significant digits, both in reading a scientific instrument and in calculating a derived quantity from measurement.

C-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

C-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

C-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

C-1.5 Organize and interpret the data from a controlled scientific investigation by using mathematics (including formulas, scientific notation, and dimensional analysis), graphs, models, and/or technology.

C-1.6 Evaluate the results of a scientific investigation in terms of whether they verify or refute the hypothesis and what the possible sources of error are.

C-1.7 Evaluate a technological design or product on the basis of designated criteria.

C-1.8 Use appropriate safety procedures when conducting investigations.

Physics

Standard P-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

P-1.1 Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.

P-1.2 Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.

P-1.3 Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.

P-1.4 Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.

P-1.5 Organize and interpret the data from a controlled scientific investigation by using (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.

P-1.6 Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.

P-1.7 Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.

P-1.8 Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).

P-1.9 Communicate and defend a scientific argument or conclusion.

P-1.10 Use appropriate safety procedures when conducting investigations.

Earth Science

Standard ES-1: The student will demonstrate an understanding of how scientific inquiry and technological design, including mathematical analysis, can be used appropriately to pose questions, seek answers, and develop solutions.

Indicators

K–12 Scientific Inquiry Standards and Indicators	
ES-1.1	Apply established rules for significant digits, both in reading scientific instruments and in calculating derived quantities from measurement.
ES-1.2	Use appropriate laboratory apparatuses, technology, and techniques safely and accurately when conducting a scientific investigation.
ES-1.3	Use scientific instruments to record measurement data in appropriate metric units that reflect the precision and accuracy of each particular instrument.
ES-1.4	Design a scientific investigation with appropriate methods of control to test a hypothesis (including independent and dependent variables), and evaluate the designs of sample investigations.
ES-1.5	Organize and interpret the data from a controlled scientific investigation by using mathematics (including calculations in scientific notation, formulas, and dimensional analysis), graphs, tables, models, diagrams, and/or technology.
ES-1.6	Evaluate the results of a controlled scientific investigation in terms of whether they refute or verify the hypothesis.
ES-1.7	Evaluate conclusions based on qualitative and quantitative data (including the impact of parallax, instrument malfunction, or human error) on experimental results.
ES-1.8	Evaluate a technological design or product on the basis of designated criteria (including cost, time, and materials).
ES-1.9	Communicate and defend a scientific argument or conclusion.
ES-1.10	Use appropriate safety procedures when conducting investigations.

APPENDIX B

Revised Bloom's Taxonomy

In 1956, Benjamin Bloom and his colleagues published the *Taxonomy of Educational Objectives: The Classification of Educational Goals*, a groundbreaking book that classified educational goals according to the cognitive processes that learners must use in order to attain those goals. The work, which was enthusiastically received, was utilized by teachers to analyze learning in the classroom for nearly fifty years.

However, research during that time span generated new ideas and information about how learners learn and how teachers teach. Education practice is very different today. Even the measurement of achievement has changed; teachers now live in a standards-based world defined by state accountability systems.

In order to reflect the new data and insights about teaching and learning that the past forty-five years of research have yielded—and to refocus educators' attention on the value of the original Bloom's taxonomy—Lorin Anderson and David Krathwohl led a team of colleagues in revising and enhancing that system to make it more usable for aligning standards, instruction, and assessment in today's schools. The results of their work were published in 2001 as *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Allyn and Bacon)—a book that is important to educators because it provides the common understanding of expectations that is critical for improving student achievement in all subjects.

The revised taxonomy is two-dimensional, identifying both the kind of knowledge to be learned (knowledge dimension) and the kind of learning expected from students (cognitive processes) to help teachers and administrators improve alignment and rigor in the classroom. This taxonomy will assist educators to improve instruction, to ensure that their lessons and assessments are aligned with one another and with the state standards, that their lessons are cognitively rich, and that instructional opportunities are not missed.

Science goes well beyond simple recognition and the memorization of facts that many people mistake for scientific literacy. Therefore, many of the main verbs in the indicators of the South Carolina science standards reflect the cognitive processes described in the revised Bloom's taxonomy under the category *understand*. This category requires *interpreting, exemplifying, classifying, summarizing, inferring, comparing,* and *explaining* from students—understanding rather than rote memorization of materials. Students might have to *compare* two organisms or *explain* how variations in habitats affect the survival of an organism. Several indicators require students to demonstrate two even higher categories of cognitive processes—*analyze* and *evaluate*—by *organizing* and *critiquing* data and/or the results of scientific investigation, for example.

Tables 1 and 2 on the following pages are reproduced from Anderson and Krathwohl's *Taxonomy for Learning, Teaching, and Assessing,* pages 46 and 67, respectively. Table 3, "A Taxonomy for Teaching, Learning, and Assessing," describes both dimensions of the taxonomy: types and subtypes of knowledge described in table 1 and the cognitive categories and processes

described in table 2. This matrix is provided as a template for teachers to use in analyzing their instruction as they seek to align standards, units/lessons/activities, and assessments. Examples and more information about specific uses of the matrix can be found in the *Taxonomy for Learning.*

Table 1: The Knowledge Dimension

MAJOR TYPES AND SUBTYPES		EXAMPLES
A. FACTUAL KNOWLEDGE—The basic elements students must know to be acquainted with a discipline or solve problems in it		
AA.	Knowledge of terminology	Technical vocabulary, musical symbols
AB.	Knowledge of specific details and elements	Major natural resources, reliable sources of information
B. CONCEPTUAL KNOWLEDGE—The interrelationships among the basic elements within a larger structure that enable them to function together		
BA.	Knowledge of classifications and categories	Periods of geological time, forms of business ownership
BB.	Knowledge of principles and generalizations	Pythagorean theorem, law of supply and demand
BC.	Knowledge of theories, models, and structures	Theory of evolution, structure of Congress
C. PROCEDURAL KNOWLEDGE—How to do something, methods and inquiry, and criteria for using skills, algorithms, techniques, and methods		
CA.	Knowledge of subject-specific skills and algorithms	Skills used in painting with watercolors, whole-number division algorithm
CB.	Knowledge of subject-specific techniques and methods	Interviewing techniques, scientific method
CC.	Knowledge of criteria for determining when to use appropriate procedures	Criteria used to determine when to apply a procedure involving Newton's second law, criteria used to judge the feasibility of using a particular method to estimate business costs
D. METACOGNITIVE KNOWLEDGE—Knowledge of cognition in general as well as awareness and knowledge of one's own cognition		
DA.	Strategic knowledge	Knowledge of outlining as a means of capturing the structure of a unit of subject matter in a textbook, knowledge of the use of heuristics
DB.	Knowledge about cognitive tasks including appropriate contextual and conditional knowledge	Knowledge of the types of tests particular teachers administer, knowledge of the cognitive demands of different tasks
DC.	Self-knowledge	Knowledge that critiquing essays is a personal strength, whereas writing essays is a personal weakness; awareness of one's own knowledge level

Table 2: The Cognitive Process Dimension

Categories & Cognitive Processes	Alternative Names	Definitions and Examples
1. REMEMBER—Retrieve relevant knowledge from long-term memory		
1.1 Recognizing	Identifying	Locating knowledge in long-term memory that is consistent with presented material (e.g., Recognize the dates of important events in United States history)
1.2 Recalling	Retrieving	Retrieving relevant knowledge from long-term memory (e.g., Recall the dates of important events in United States history)
2. UNDERSTAND—Construct meaning from instructional messages including oral, written, and graphic communication		
2.1 Interpreting	Clarifying, paraphrasing, representing, translating	Changing from one form of representation (e.g., numerical) to another (e.g., verbal) (e.g., Paraphrase important speeches and documents)
2.2 Exemplifying	Illustrating, instantiating	Finding a specific example or illustration of a concept or principle (e.g., Give examples of various artistic painting styles)
2.3 Classifying	Categorizing, subsuming	Determining that something belongs to a category (e.g., Classify observed or described cases of mental disorders)
2.4 Summarizing	Abstracting, generalizing	Abstracting a general theme or major point(s) (e.g., Write a short summary of events portrayed on a videotape)
2.5 Inferring	Concluding, extrapolating, interpolating, predicting	Drawing a logical conclusion from presented information (e.g., In learning a foreign language, infer grammatical principles from examples)
2.6 Comparing	Contrasting, mapping, matching	Detecting correspondences between two ideas, objects, and the like (e.g., Compare historical events to contemporary situations)
2.7 Explaining	Constructing models	Constructing a cause-and-effect model of a system (e.g., Explain the causes of important 18th Century events in France)
3. APPLY—Carry out or use a procedure in a given situation		
3.1 Executing	Carrying out	Applying a procedure to a familiar task (e.g., Divide one whole number by another whole number, both with multiple digits)
3.2 Implementing	Using	Applying a procedure to an unfamiliar task (e.g., Use Newton's Second Law in situations in which it is appropriate)

Table 2: The Cognitive Process Dimension

Categories & Cognitive Processes	Alternative Names	Definitions and Examples
4. ANALYZE—Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose		
4.1 Differentiating	Discriminating, distinguishing, focusing, selecting	Distinguishing relevant from irrelevant parts or important from unimportant parts of presented material (e.g., Distinguish between relevant and irrelevant numbers in a mathematical word problem)
4.2 Organizing	Finding coherence, integrating, outlining, parsing, structuring	Determining how elements fit or function within a structure (e.g., Structure evidence in a historical description into evidence for and against a particular historical explanation)
4.3 Attributing	Deconstructing	Determine a point of view, bias, values, or intent underlying presented material (e.g., Determine the point of view of the author of an essay in terms of his or her political perspective)
5. EVALUATE—Make judgments based on criteria and standards		
5.1 Checking	Coordinating, detecting, monitoring, testing	Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented (e.g., Determine if a scientist's conclusions follow from observed data)
5.2 Critiquing	Judging	Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem (e.g., Judge which of two methods is the best way to solve a given problem)
6. CREATE—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure		
6.1 Generating	Hypothesizing	Coming up with alternative hypotheses based on criteria (e.g., Generate hypotheses to account for an observed phenomenon)
6.2 Planning	Designing	Devising a procedure for accomplishing some task (e.g., Plan a research paper on a given historical topic)
6.3 Producing	Constructing	Inventing a product (e.g., Build habitats for a specific purpose)

Table 3: A Taxonomy for Teaching, Learning, and Assessing

THE KNOWLEDGE DIMENSION	THE COGNITIVE PROCESS DIMENSION					
	1. Remember—Retrieve relevant knowledge from long-term memory 1.1 Recognizing 1.2 Recalling	**2. Understand**—Construct meaning from instructional messages including oral, written, and graphic communication 2.1 Interpreting 2.2 Exemplifying 2.3 Classifying 2.4 Summarizing 2.5 Inferring 2.6 Comparing 2.7 Explaining	**3. Apply**—Carry out or use a procedure in a given situation 3.1 Executing 3.2 Implementing	**4. Analyze**—Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose 4.1 Differentiating 4.2 Organizing 4.3 Attributing	**5. Evaluate**—Make judgments based on criteria and standards 5.1 Checking 5.2 Critiquing	**6. Create**—Put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure 6.1 Generating 6.2 Planning 6.3 Producing
A. Factual Knowledge—The basic elements that students must know to be acquainted with a discipline or solve problems in it AA. Knowledge of terminology AB. Knowledge of specific details and elements						
B. Conceptual Knowledge—The interrelationships among the basic elements within a larger structure that enable them to function together BA. Knowledge of classifications and categories BB. Knowledge of principles and generalizations BC. Knowledge of theories, models, and structures						
C. Procedural Knowledge—How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods CA. Knowledge of subject-specific skills and algorithms CB. Knowledge of subject-specific techniques and methods CC. Knowledge of criteria for determining when to use appropriate procedures						
D. Metacognitive Knowledge—Knowledge of cognition in general as well as awareness of one's own cognition DA. Strategic knowledge DB. Knowledge about cognitive tasks (including appropriate contextual and conditional knowledge DC. Self-knowledge						

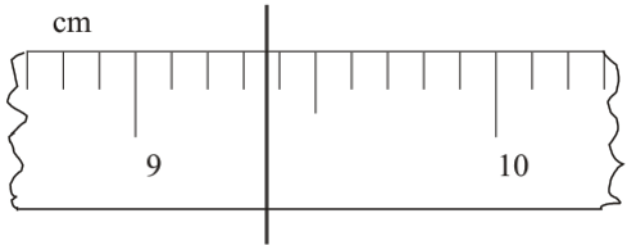
APPENDIX C

Science Standards Glossary

Some of the terms and phrases that are used in the science standards have multiple definitions or interpretations. In any case, the definition of scientific terms should be refined as students become more cognitively adept. In the classroom, teachers should use the definition most appropriate for the immediate context—particular students, grade level, and subject area.

The following definitions explain certain key terms that are not specifically defined within the text of the standards or the indicators:

Glossary	
abiotic	A term that refers to nonliving factors in the environment such as light and temperature.
accuracy	The degree to which the reading from a scientific instrument agrees with an accepted value. The accuracy of a scientific measuring tool can be checked by ensuring that the instrument reads *zero* when it should and by comparing the reading of the instrument to an established standard.
biotic	A term that refers to living organisms or to something that is produced or caused by living organisms. Antonym *abiotic*.
conceptual	A term that places the emphasis on scientific concepts rather than on mathematical relationships.
controlled scientific investigation	An experiment in which the variables are managed so that the results of the experiment will be reliable.
dependent variable	The respondent or outcome variable in an investigation; the variable that the experimenter hypothesizes will be affected by manipulations in the independent variable.
derived quantity	A quantity that has a unit that is a combination of base units. Grams and milliliters are base units (for mass and volume respectively). Density is a derived quantity because the units for density are grams per milliliter (g/ml).
dimensional analysis	A method for converting a given result from one unit of measure to another unit of measure (e.g., if one wishes to convert the length of a line from centimeters to meters).
fair test	An experiment in which only one variable is manipulated.
hypothesis	A prediction based on observations and inferences that may be tested by one or more experiments.

Glossary	
independent variable	The manipulated variable in an investigation; the variable the experimenter hypothesizes will affect the dependent variable.
precision	The degree to which an instrument can be read with certainty plus one final digit, which is uncertain (estimate). All measurements in science should be recorded to include all digits including the estimated digit. On the metric ruler below, the distance between the markings is 0.1 cm. In order to correctly represent this measurement, to the precision of the instrument, one might write 9.37 cm or 9.38 cm (or whatever is judged to be closest); thus the 0.01 cm place is uncertain. 
qualitative	A term that refers to the nature—the characteristics and attributes—of a substance, object, or event rather than the amount.
quantitative	A term that refers to measurement or amount rather than to characteristics or attributes.
representative elements	The elements in groups 1–2 and 13–18 on the periodic table. These elements are also known as the "main group" elements because they represent the entire range of chemical properties and a wide range of physical properties.
simple investigation	An experiment with a single independent and dependent variable.