Teaching to Standards: Science
by the Attainment Company

Alignment to

SOUTH CAROLINA SCIENCE ACADEMIC STANDARDS

Note:
Standards that Teaching to Standards: Science aligns to are indicated with yellow highlights.

South Carolina Department of Education
Columbia, South Carolina

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

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

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

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).

PHYSICAL SCIENCE

Scientific Inquiry

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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.

High School

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.

High School 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.

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.

High School 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).

Scientific Inquiry

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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.