InspireData Standards Match: Virginia

Standards of Learning:
Science

Meeting curriculum standards is a major focus in education today. This document highlights the correlation of InspireData® with the Science Standards of Learning for Virginia Public Schools.

The InspireData Standards Match is designed to demonstrate the many ways InspireData supports the standards and to give educators ideas for using this tool to meet learning goals across the curriculum.

How to read the InspireData Standards Match:

- Yellow highlight indicates a standard or objective that is supported by the use of InspireData.
- Green note annotation includes the names of a InspireData template that corresponds to the highlighted standard. These templates are a part of the software program and act as starters or frameworks for student work.

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Grade Four

The fourth-grade standards stress the importance of using information, analyzing data, and validating experimental results. Defining variables in experimentation is emphasized, and making simple predictions from picture, bar, and basic line graphs is underscored. Questioning and hypothesizing become more detailed at this level. Students are introduced to basic principles of electricity and to the concept of motion. Relationships are investigated in the interactions among the Earth, moon, and sun and among plants and animals and their environments. In examining weather phenomena and conditions, students identify various factors, make predictions based on data, and evaluate the results. The importance of natural resources in Virginia is emphasized.

Scientific Investigation, Reasoning, and Logic

4.1 The student will plan and conduct investigations in which
- a) distinctions are made among observations, conclusions, inferences, and predictions;
- b) hypotheses are formulated based on cause-and-effect relationships;
- c) variables that must be held constant in an experimental situation are defined;
- d) appropriate instruments are selected to measure linear distance, volume, mass, and temperature;
- e) appropriate metric measures are used to collect, record, and report data;
- f) data are displayed using bar and basic line graphs;
- g) numerical data that are contradictory or unusual in experimental results are recognized; and
- h) predictions are made based on data from picture graphs, bar graphs, and basic line graphs.

Force, Motion, and Energy

4.2 The student will investigate and understand characteristics and interaction of moving objects. Key concepts include
- a) motion is described by an object's direction and speed;
- b) forces cause changes in motion;
- c) friction is a force that opposes motion; and
- d) moving objects have kinetic energy.

4.3 The student will investigate and understand the characteristics of electricity. Key concepts include
- a) conductors and insulators;
- b) basic circuits (open/closed, parallel/series);
- c) static electricity;
- d) the ability of electrical energy to be transformed into heat, light, and mechanical energy;
- e) simple electromagnets and magnetism; and
- f) historical contributions in understanding electricity.

Life Processes

4.4 The student will investigate and understand basic plant anatomy and life processes. Key concepts include

a) the structures of typical plants (leaves, stems, roots, and flowers);
b) processes and structures involved with reproduction (pollination, stamen, pistil, sepal, embryo, spore, and seed);
c) photosynthesis (sunlight, chlorophyll, water, carbon dioxide, oxygen, and sugar); and
d) dormancy.

Living Systems

4.5 The student will investigate and understand how plants and animals in an ecosystem interact with one another and the nonliving environment. Key concepts include

a) behavioral and structural adaptations;
b) organization of communities;
c) flow of energy through food webs;
d) habitats and niches;
e) life cycles; and
f) influence of human activity on ecosystems.

Interrelationships in Earth/Space Systems

4.6 The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include

a) weather measurements and meteorological tools (air pressure – barometer, wind speed – anemometer, rainfall – rain gauge, and temperature – thermometer); and
b) weather phenomena (fronts, clouds, and storms).

Earth Patterns, Cycles, and Change

4.7 The student will investigate and understand the relationships among the Earth, moon, and sun. Key concepts include

a) the motions of the Earth, moon, and sun (revolution and rotation);
b) the causes for the Earth's seasons and phases of the moon;
c) the relative size, position, age, and makeup of the Earth, moon, and sun; and
d) historical contributions in understanding the Earth-moon-sun system.

Resources

4.8 The student will investigate and understand important Virginia natural resources. Key concepts include

a) watershed and water resources;
b) animals and plants;
c) minerals, rocks, ores, and energy sources; and
d) forests, soil, and land.

Grade Five

The fifth-grade standards emphasize the importance of selecting appropriate instruments for measuring and recording observations. The organization, analysis, and application of data continue to be an important focus of classroom inquiry. Science skills from preceding grades, including questioning, using and validating evidence, and systematic experimentation, are reinforced at this level. Students are introduced to more detailed concepts of sound and light and the tools used for studying them. Key concepts of matter, including those about atoms, molecules, elements, and compounds, are studied, and the properties of matter are defined in greater detail. The cellular makeup of organisms and the distinguishing characteristics of groups of organisms are stressed. Students learn about the characteristics of the oceans and the Earth's changing surface.

The fifth-grade standards focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

5.1 The student will plan and conduct investigations in which
- a) rocks, minerals, and organisms are identified using a classification key;
- b) estimations of length, mass, and volume are made;
- c) appropriate instruments are selected and used for making quantitative observations of length, mass, volume, and elapsed time;
- d) accurate measurements are made using basic tools (thermometer, meter stick, balance, graduated cylinder);
- e) data are collected, recorded, and reported using the appropriate graphical representation (graphs, charts, diagrams);
- f) predictions are made using patterns, and simple graphical data are extrapolated;
- g) manipulated and responding variables are identified; and
- h) an understanding of the nature of science is developed and reinforced.

Force, Motion, and Energy

5.2 The student will investigate and understand how sound is transmitted and is used as a means of communication. Key concepts include
- a) frequency, waves, wavelength, vibration;
- b) the ability of different media (solids, liquids, and gases) to transmit sound; and
- c) uses and applications (voice, sonar, animal sounds, and musical instruments).

5.3 The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include
a) the visible spectrum and light waves;
b) refraction of light through water and prisms;
c) reflection of light from reflective surfaces (mirrors);
d) opaque, transparent, and translucent; and
e) historical contributions in understanding light.

Matter

5.4 The student will investigate and understand that matter is anything that has mass, takes up space, and occurs as a solid, liquid, or gas. Key concepts include
a) atoms, elements, molecules, and compounds;
b) mixtures including solutions; and
c) the effect of heat on the states of matter.

Living Systems

5.5 The student will investigate and understand that organisms are made of cells and have distinguishing characteristics. Key concepts include
a) basic cell structures and functions;
b) kingdoms of living things;
c) vascular and nonvascular plants; and
d) vertebrates and invertebrates.

Interrelationships in Earth/Space Systems

5.6 The student will investigate and understand characteristics of the ocean environment. Key concepts include
a) geological characteristics (continental shelf, slope, rise);
b) physical characteristics (depth, salinity, major currents); and
c) biological characteristics (ecosystems).

Earth Patterns, Cycles, and Change

5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key concepts include
a) the rock cycle including identification of rock types;
b) Earth history and fossil evidence;
c) the basic structure of the Earth's interior;
d) plate tectonics (earthquakes and volcanoes);
e) weathering and erosion; and
f) human impact.

Grade Six

The sixth-grade standards continue to emphasize data analysis and experimentation. Methods are studied for testing the validity of predictions and conclusions. Scientific methodology, focusing on precision in stating hypotheses and defining dependent and independent variables, is strongly reinforced. The concept of change is explored through the study of transformations of energy and matter. The standards present an integrated focus on the role of the sun's energy in the Earth's systems, on water in the environment, on air and atmosphere, and on basic chemistry concepts. A more detailed understanding of the solar system and space exploration becomes a focus of instruction. Natural resource management, its relation to public policy, and cost/benefit tradeoffs in conservation policies are introduced.

The sixth-grade standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

Scientific Investigation, Reasoning, and Logic

6.1 The student will plan and conduct investigations in which
- a) observations are made involving fine discrimination between similar objects and organisms;
- b) a classification system is developed based on multiple attributes;
- c) precise and approximate measurements are recorded;
- d) scale models are used to estimate distance, volume, and quantity;
- e) hypotheses are stated in ways that identify the independent (manipulated) and dependent (responding) variables;
- f) a method is devised to test the validity of predictions and inferences;
- g) one variable is manipulated over time, using many repeated trials;
- h) data are collected, recorded, analyzed, and reported using appropriate metric measurements;
- i) data are organized and communicated through graphical representation (graphs, charts, and diagrams);
- j) models are designed to explain a sequence; and
- k) an understanding of the nature of science is developed and reinforced.

Force, Motion, and Energy

6.2 The student will investigate and understand basic sources of energy, their origins, transformations, and uses. Key concepts include
- a) potential and kinetic energy;
- b) the role of the sun in the formation of most energy sources on Earth;
- c) nonrenewable energy sources (fossil fuels including petroleum, natural gas, and coal);
- d) renewable energy sources (wood, wind, hydro, geothermal, tidal, and solar); and
- e) energy transformations (heat/light to mechanical, chemical, and electrical energy).

6.3 The student will investigate and understand the role of solar energy in driving most natural processes within the atmosphere, the hydrosphere, and on the Earth's surface. Key concepts include

a) the Earth's energy budget;
b) the role of radiation and convection in the distribution of energy;
c) the motion of the atmosphere and the oceans;
d) cloud formation; and
e) the role of heat energy in weather-related phenomena including thunderstorms and hurricanes.

Matter

6.4 The student will investigate and understand that all matter is made up of atoms. Key concepts include

a) atoms are made up of electrons, protons, and neutrons;
b) atoms of any element are alike but are different from atoms of other elements;
c) elements may be represented by chemical symbols;
d) two or more atoms may be chemically combined;
e) compounds may be represented by chemical formulas;
f) chemical equations can be used to model chemical changes; and
g) a limited number of elements comprise the largest portion of the solid Earth, living matter, the oceans, and the atmosphere.

6.5 The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include

a) water as the universal solvent;
b) the properties of water in all three states;
c) the action of water in physical and chemical weathering;
d) the ability of large bodies of water to store heat and moderate climate;
e) the origin and occurrence of water on Earth;
f) the importance of water for agriculture, power generation, and public health; and
g) the importance of protecting and maintaining water resources.

6.6 The student will investigate and understand the properties of air and the structure and dynamics of the Earth's atmosphere. Key concepts include

a) air as a mixture of gaseous elements and compounds;
b) air pressure, temperature, and humidity;
c) how the atmosphere changes with altitude;
d) natural and human-caused changes to the atmosphere;
e) the relationship of atmospheric measures and weather conditions;
f) basic information from weather maps including fronts, systems, and basic measurements; and
g) the importance of protecting and maintaining air quality.

Living Systems

6.7 The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include
- a) the health of ecosystems and the abiotic factors of a watershed;
- b) the location and structure of Virginia's regional watershed systems;
- c) divides, tributaries, river systems, and river and stream processes;
- d) wetlands;
- e) estuaries;
- f) major conservation, health, and safety issues associated with watersheds; and
- g) water monitoring and analysis using field equipment including hand-held technology.

Interrelationships in Earth/Space Systems

6.8 The student will investigate and understand the organization of the solar system and the relationships among the various bodies that comprise it. Key concepts include
- a) the sun, moon, Earth, other planets and their moons, meteors, asteroids, and comets;
- b) relative size of and distance between planets;
- c) the role of gravity;
- d) revolution and rotation;
- e) the mechanics of day and night and the phases of the moon;
- f) the unique properties of Earth as a planet;
- g) the relationship of the Earth's tilt and the seasons;
- h) the cause of tides; and
- i) the history and technology of space exploration.

Resources

6.9 The student will investigate and understand public policy decisions relating to the environment. Key concepts include
- a) management of renewable resources (water, air, soil, plant life, animal life);
- b) management of nonrenewable resources (coal, oil, natural gas, nuclear power, mineral resources);
- c) the mitigation of land-use and environmental hazards through preventive measures; and
- d) cost/benefit tradeoffs in conservation policies.

Life Science

The Life Science standards emphasize a more complex understanding of change, cycles, patterns, and relationships in the living world. Students build on basic principles related to these concepts by exploring the cellular organization and the classification of organisms; the dynamic relationships among organisms, populations, communities, and ecosystems; and change as a result of the transmission of genetic information from generation to generation. Inquiry skills at this level include organization and mathematical analysis of data, manipulation of variables in experiments, and identification of sources of experimental error.

The Life Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

LS.1 The student will plan and conduct investigations in which
- a) data are organized into tables showing repeated trials and means;
- b) variables are defined;
- c) metric units (SI—International System of Units) are used;
- d) models are constructed to illustrate and explain phenomena;
- e) sources of experimental error are identified;
- f) dependent variables, independent variables, and constants are identified;
- g) variables are controlled to test hypotheses, and trials are repeated;
- h) continuous line graphs are constructed, interpreted, and used to make predictions;
- i) interpretations from a set of data are evaluated and defended; and
- j) an understanding of the nature of science is developed and reinforced.

LS.2 The student will investigate and understand that all living things are composed of cells. Key concepts include
- a) cell structure and organelles (cell membrane, cell wall, cytoplasm, vacuole, mitochondrion, endoplasmic reticulum, nucleus, and chloroplast);
- b) similarities and differences between plant and animal cells;
- c) development of cell theory; and
- d) cell division (mitosis and meiosis).

LS.3 The student will investigate and understand that living things show patterns of cellular organization. Key concepts include
- a) cells, tissues, organs, and systems; and
- b) life functions and processes of cells, tissues, organs, and systems (respiration, removal of wastes, growth, reproduction, digestion, and cellular transport).

LS.4 The student will investigate and understand that the basic needs of organisms must be met in order to carry out life processes. Key concepts include
- a) plant needs (light, water, gases, and nutrients);
- b) animal needs (food, water, gases, shelter, space); and
- c) factors that influence life processes.

LS.5 The student will investigate and understand how organisms can be classified. Key concepts include
a) the distinguishing characteristics of kingdoms of organisms;
b) the distinguishing characteristics of major animal and plant phyla; and
c) the characteristics of the species.

LS.6 The student will investigate and understand the basic physical and chemical processes of photosynthesis and its importance to plant and animal life. Key concepts include
a) energy transfer between sunlight and chlorophyll;
b) transformation of water and carbon dioxide into sugar and oxygen; and
c) photosynthesis as the foundation of virtually all food webs.

LS.7 The student will investigate and understand that organisms within an ecosystem are dependent on one another and on nonliving components of the environment. Key concepts include
a) the carbon, water, and nitrogen cycles;
b) interactions resulting in a flow of energy and matter throughout the system;
c) complex relationships within terrestrial, freshwater, and marine ecosystems; and
d) energy flow in food webs and energy pyramids.

LS.8 The student will investigate and understand that interactions exist among members of a population. Key concepts include
a) competition, cooperation, social hierarchy, territorial imperative; and
b) influence of behavior on a population.

LS.9 The student will investigate and understand interactions among populations in a biological community. Key concepts include
a) the relationships among producers, consumers, and decomposers in food webs;
b) the relationship between predators and prey;
c) competition and cooperation;
d) symbiotic relationships; and
e) niches.

LS.10 The student will investigate and understand how organisms adapt to biotic and abiotic factors in an ecosystem. Key concepts include
a) differences between ecosystems and biomes;
b) characteristics of land, marine, and freshwater ecosystems; and
c) adaptations that enable organisms to survive within a specific ecosystem.

LS.11 The student will investigate and understand that ecosystems, communities, populations, and organisms are dynamic and change over time (daily, seasonal, and long term). Key concepts include
a) phototropism, hibernation, and dormancy;
b) factors that increase or decrease population size; and
c) eutrophication, climate changes, and catastrophic disturbances.

LS.12 The student will investigate and understand the relationships between ecosystem dynamics and human activity. Key concepts include

a) food production and harvest;
b) change in habitat size, quality, or structure;
c) change in species competition;
d) population disturbances and factors that threaten or enhance species survival; and
e) environmental issues (water supply, air quality, energy production, and waste management).

LS.13 The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key concepts include

a) the role of DNA;
b) the function of genes and chromosomes;
c) genotypes and phenotypes;
d) factors affecting the expression of traits;
e) characteristics that can and cannot be inherited;
f) genetic engineering and its applications; and
g) historical contributions and significance of discoveries related to genetics.

LS.14 The student will investigate and understand that organisms change over time. Key concepts include

a) the relationships of mutation, adaptation, natural selection, and extinction;
b) evidence of evolution of different species in the fossil record; and
c) how environmental influences, as well as genetic variation, can lead to diversity of organisms.

Physical Science

The Physical Science standards continue to build on skills of systematic investigation with a clear focus on variables and repeated trials. Validating conclusions using evidence and data becomes increasingly important at this level. Students will plan and conduct research involving both classroom experimentation and literature reviews from written and electronic resources. Research methods and skills highlight practical problems and questions. Students will share their work, using written reports and other presentations.

The Physical Science standards stress an in-depth understanding of the nature and structure of matter and the characteristics of energy. The standards place considerable emphasis on the technological application of physical science principles. Major areas covered by the standards include the organization and use of the periodic table; physical and chemical changes; nuclear reactions; temperature and heat; sound; light; electricity and magnetism; and work, force, and motion.

The Physical Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

PS.1 The student will plan and conduct investigations in which

a) chemicals and equipment are used safely;
b) length, mass, volume, density, temperature, weight, and force are accurately measured and reported using metric units (SI—International System of Units);
c) conversions are made among metric units, applying appropriate prefixes;
d) triple beam and electronic balances, thermometers, metric rulers, graduated cylinders, and spring scales are used to gather data;
e) numbers are expressed in scientific notation where appropriate;
f) research skills are utilized using a variety of resources;
g) independent and dependent variables, constants, controls, and repeated trials are identified;
h) data tables showing the independent and dependent variables, derived quantities, and the number of trials are constructed and interpreted;
i) data tables for descriptive statistics showing specific measures of central tendency, the range of the data set, and the number of repeated trials are constructed and interpreted;
j) frequency distributions, scattergrams, line plots, and histograms are constructed and interpreted;
k) valid conclusions are made after analyzing data;
l) research methods are used to investigate practical problems and questions;
m) experimental results are presented in appropriate written form; and
n) an understanding of the nature of science is developed and reinforced.

PS.2 The student will investigate and understand the basic nature of matter. Key concepts include
a) the particle theory of matter;
b) elements, compounds, mixtures, acids, bases, and salts;
c) solids, liquids, and gases;
d) characteristics of types of matter based on physical and chemical properties;
e) physical properties (shape, density, solubility, odor, melting point, boiling point, color); and
f) chemical properties (acidity, basicity, combustibility, reactivity).

PS.3 The student will investigate and understand the modern and historical models of atomic structure. Key concepts include
a) the contributions of Dalton, Thomson, Rutherford, and Bohr in understanding the atom; and
b) the modern model of atomic structure.

PS.4 The student will investigate and understand the organization and use of the periodic table of elements to obtain information. Key concepts include
a) symbols, atomic number, atomic mass, chemical families (groups), and periods;
b) classification of elements as metals, metalloids, and nonmetals; and
c) simple compounds (formulas and the nature of bonding).

PS.5 The student will investigate and understand changes in matter and the relationship of these changes to the Law of Conservation of Matter and Energy. Key concepts include
a) physical changes;
b) nuclear reactions (products of fusion and fission and the effect of these products on humans and the environment); and
c) chemical changes (types of reactions, reactants, and products; and balanced equations).

PS.6 The student will investigate and understand states and forms of energy and how energy is transferred and transformed. Key concepts include
a) potential and kinetic energy;
b) mechanical, chemical, and electrical energy; and
c) heat, light, and sound.

PS.7 The student will investigate and understand temperature scales, heat, and heat transfer. Key concepts include
a) Celsius and Kelvin temperature scales and absolute zero;
b) phase change, freezing point, melting point, boiling point, vaporization, and condensation;
c) conduction, convection, and radiation; and
d) applications of heat transfer (heat engines, thermostats, refrigeration, and heat pumps).

PS.8 The student will investigate and understand characteristics of sound and technological applications of sound waves. Key concepts include
a) wavelength, frequency, speed, and amplitude;
b) resonance;
c) the nature of mechanical waves; and
d) technological applications of sound.

PS.9 The student will investigate and understand the nature and technological applications of light. Key concepts include
a) the wave behavior of light (reflection, refraction, diffraction, and interference);
b) images formed by lenses and mirrors; and
c) the electromagnetic spectrum.

PS.10 The student will investigate and understand scientific principles and technological applications of work, force, and motion. Key concepts include

a) speed, velocity, and acceleration;
b) Newton's laws of motion;
c) work, force, mechanical advantage, efficiency, and power; and
d) applications (simple machines, compound machines, powered vehicles, rockets, and restraining devices).

PS.11 The student will investigate and understand basic principles of electricity and magnetism. Key concepts include

a) static electricity, current electricity, and circuits;
b) magnetic fields and electromagnets; and
c) motors and generators.

Earth Science

The Earth Science standards connect the study of the Earth's composition, structure, processes, and history; its atmosphere, fresh water, and oceans; and its environment in space. The standards emphasize historical contributions in the development of scientific thought about the Earth and space. The standards stress the interpretation of maps, charts, tables, and profiles; the use of technology to collect, analyze, and report data; and the utilization of science skills in systematic investigation. Problem solving and decision making are an integral part of the standards, especially as they relate to the costs and benefits of utilizing the Earth's resources. Major topics of study include plate tectonics, the rock cycle, Earth history, the oceans, the atmosphere, weather and climate, and the solar system and universe.

The Earth Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

ES.1 The student will plan and conduct investigations in which

a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;
b) technologies including computers, probeware, and global positioning systems (GPS), are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
c) scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted;
d) variables are manipulated with repeated trials; and
e) a scientific viewpoint is constructed and defended (the nature of science).

ES.2 The student will demonstrate scientific reasoning and logic by

a) analyzing how science explains and predicts the interactions and dynamics of complex Earth systems;
b) recognizing that evidence is required to evaluate hypotheses and explanations;
c) comparing different scientific explanations for a set of observations about the Earth;
d) explaining that observation and logic are essential for reaching a conclusion; and
e) evaluating evidence for scientific theories.

ES.3 The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include

a) maps (bathymetric, geologic, topographic, and weather) and star charts;
b) imagery (aerial photography and satellite images);
c) direction and measurements of distance on any map or globe; and
d) location by latitude and longitude and topographic profiles.

ES.4 The student will investigate and understand the characteristics of the Earth and the solar system. Key concepts include

a) position of the Earth in the solar system;
b) sun-Earth-moon relationships (seasons, tides, and eclipses);
c) characteristics of the sun, planets and their moons, comets, meteors, and asteroids; and
d) the history and contributions of the space program.

ES.5 The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include

a) hardness, color and streak, luster, cleavage, fracture, and unique properties; and
b) uses of minerals.

ES.6 The student will investigate and understand the rock cycle as it relates to the origin and transformation of rock types and how to identify common rock types based on mineral composition and textures. Key concepts include

a) igneous (intrusive and extrusive) rocks;
b) sedimentary (clastic and chemical) rocks; and
c) metamorphic (foliated and unfoliated) rocks.

ES.7 The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include

a) fossil fuels, minerals, rocks, water, and vegetation;
b) advantages and disadvantages of various energy sources;
c) resources found in Virginia;
d) making informed judgments related to resource use and its effects on Earth systems; and
e) environmental costs and benefits.

ES.8 The student will investigate and understand geologic processes including plate tectonics. Key concepts include

a) how geologic processes are evidenced in the physiographic provinces of Virginia including the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau;
b) processes (faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation) and their resulting features; and
c) tectonic processes (subduction, rifting and sea floor spreading, and continental collision).

ES.9 The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

a) processes of soil development;
b) development of karst topography;
c) identification of groundwater zones including the water table, zone of saturation, and zone of aeration;
d) identification of other sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;
e) dependence on freshwater resources and the effects of human usage on water quality; and
f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries.

ES.10 The student will investigate and understand that many aspects of the history and evolution of the Earth and life can be inferred by studying rocks and fossils. Key concepts include

a) traces and remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks;
b) superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock;
c) absolute and relative dating have different applications but can be used together to determine the age of rocks and structures; and
d) rocks and fossils from many different geologic periods and epochs are found in Virginia.

ES.11 The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include

a) physical and chemical changes (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations);
b) importance of environmental and geologic implications;
c) systems interactions (density differences, energy transfer, weather, and climate);
d) features of the sea floor (continental margins, trenches, mid-ocean ridges, and abyssal plains) as reflections of tectonic processes; and
e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

ES.12 The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include

a) scientific evidence for atmospheric changes over geologic time;
b) current theories related to the effects of early life on the chemical makeup of the atmosphere;
c) comparison of the Earth's atmosphere to that of other planets;
d) atmospheric regulation mechanisms including the effects of density differences and energy transfer; and
e) potential atmospheric compositional changes due to human, biologic, and geologic activity.

ES.13 The student will investigate and understand that energy transfer between the sun and the Earth and its atmosphere drives weather and climate on Earth. Key concepts include

a) observation and collection of weather data;
b) prediction of weather patterns;
c) severe weather occurrences, such as tornadoes, hurricanes, and major storms; and
d) weather phenomena and the factors that affect climate including radiation and convection.

ES.14 The student will investigate and understand scientific concepts related to the origin and evolution of the universe. Key concepts include

a) nebulae;
b) the origin of stars and star systems;
c) stellar evolution;
d) galaxies; and
e) cosmology including the big bang theory.

Biology

The Biology standards are designed to provide students with a detailed understanding of living systems. Emphasis continues to be placed on the skills necessary to examine alternative scientific explanations, actively conduct controlled experiments, analyze and communicate information, and gather and use information in scientific literature. The history of biological thought and the evidence that supports it are explored, providing the foundation for investigating biochemical life processes, cellular organization, mechanisms of inheritance, dynamic relationships among organisms, and the change in organisms through time. The importance of scientific research that validates or challenges ideas is emphasized at this level. All students are expected to achieve the content of the biology standards.

The Biology standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

BIO.1 The student will plan and conduct investigations in which

a) observations of living organisms are recorded in the lab and in the field;
b) hypotheses are formulated based on direct observations and information from scientific literature;
c) variables are defined and investigations are designed to test hypotheses;
d) graphing and arithmetic calculations are used as tools in data analysis;
e) conclusions are formed based on recorded quantitative and qualitative data;
f) sources of error inherent in experimental design are identified and discussed;
g) validity of data is determined;
h) chemicals and equipment are used in a safe manner;
i) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results;
j) research utilizes scientific literature;
k) differentiation is made between a scientific hypothesis and theory;
l) alternative scientific explanations and models are recognized and analyzed; and
m) a scientific viewpoint is constructed and defended (the nature of science).

BIO.2 The student will investigate and understand the history of biological concepts. Key concepts include

a) evidence supporting the cell theory;
b) scientific explanations of the development of organisms through time (biological evolution);
c) evidence supporting the germ theory of infectious disease;
d) development of the structural model of DNA; and
e) the collaborative efforts of scientists, past and present.

BIO.3 The student will investigate and understand the chemical and biochemical principles essential for life. Key concepts include

a) water chemistry and its impact on life processes;
b) the structure and function of macromolecules;
c) the nature of enzymes; and
d) the capture, storage, transformation, and flow of energy through the processes of photosynthesis and respiration.

BIO.4 The student will investigate and understand relationships between cell structure and function. Key concepts include

a) characteristics of prokaryotic and eukaryotic cells;
b) exploring the diversity and variation of eukaryotes;
c) similarities between the activities of a single cell and a whole organism; and
d) the cell membrane model (diffusion, osmosis, and active transport).

BIO.5 The student will investigate and understand life functions of archaebacteria, monerans (eubacteria), protists, fungi, plants, and animals including humans. Key concepts include

a) how their structures and functions vary between and within the kingdoms;
b) comparison of their metabolic activities;
c) analyses of their responses to the environment;
d) maintenance of homeostasis;
e) human health issues, human anatomy, body systems, and life functions; and
f) how viruses compare with organisms.

BIO.6 The student will investigate and understand common mechanisms of inheritance and protein synthesis. Key concepts include

a) cell growth and division;
b) gamete formation;
c) cell specialization;
d) prediction of inheritance of traits based on the Mendelian laws of heredity;
e) genetic variation (mutation, recombination, deletions, additions to DNA);
f) the structure, function, and replication of nucleic acids (DNA and RNA);
g) events involved in the construction of proteins;
h) use, limitations, and misuse of genetic information; and
i) exploration of the impact of DNA technologies.

BIO.7 The student will investigate and understand bases for modern classification systems. Key concepts include

a) structural similarities among organisms;
b) fossil record interpretation;
c) comparison of developmental stages in different organisms;
d) examination of biochemical similarities and differences among organisms; and
e) systems of classification that are adaptable to new scientific discoveries.

BIO.8 The student will investigate and understand how populations change through time. Key concepts include

a) evidence found in fossil records;
b) how genetic variation, reproductive strategies, and environmental pressures impact the survival of populations;
c) how natural selection leads to adaptations;
d) emergence of new species; and
e) scientific explanations for biological evolution.

BIO.9 The student will investigate and understand dynamic equilibria within populations, communities, and ecosystems. Key concepts include

a) interactions within and among populations including carrying capacities, limiting factors, and growth curves;
b) nutrient cycling with energy flow through ecosystems;
c) succession patterns in ecosystems;
d) the effects of natural events and human activities on ecosystems; and
e) analysis of the flora, fauna, and microorganisms of Virginia ecosystems including the Chesapeake Bay and its tributaries.

Chemistry

The Chemistry standards are designed to provide students with a detailed understanding of the interaction of matter and energy. This interaction is investigated through the use of laboratory techniques, manipulation of chemical quantities, and problem-solving applications. Scientific methodology is employed in experimental and analytical investigations, and concepts are illustrated with practical applications that should include examples from environmental, nuclear, organic, and biochemistry content areas.

Technology, including graphing calculators, computers, and probeware, are employed where feasible. Students will understand and use safety precautions with chemicals and equipment. The standards emphasize qualitative and quantitative study of substances and the changes that occur in them. In meeting the chemistry standards, students will be encouraged to share their ideas, use the language of chemistry, discuss problem-solving techniques, and communicate effectively.

The Chemistry standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

CH.1 The student will investigate and understand that experiments in which variables are measured, analyzed, and evaluated produce observations and verifiable data. Key concepts include

a) designated laboratory techniques;
b) safe use of chemicals and equipment;
c) proper response to emergency situations;
d) manipulation of multiple variables, using repeated trials;
e) accurate recording, organization, and analysis of data through repeated trials;
f) mathematical and procedural error analysis;
g) mathematical manipulations (SI units, scientific notation, linear equations, graphing, ratio and proportion, significant digits, dimensional analysis);
h) use of appropriate technology including computers, graphing calculators, and probeware, for gathering data and communicating results; and
i) construction and defense of a scientific viewpoint (the nature of science).

CH.2 The student will investigate and understand that the placement of elements on the periodic table is a function of their atomic structure. The periodic table is a tool used for the investigations of

a) average atomic mass, mass number, and atomic number;
b) isotopes, half lives, and radioactive decay;
c) mass and charge characteristics of subatomic particles;
d) families or groups;
e) series and periods;
f) trends including atomic radii, electronegativity, shielding effect, and ionization energy;
g) electron configurations, valence electrons, and oxidation numbers;
h) chemical and physical properties; and
i) historical and quantum models.

CH.3 The student will investigate and understand how conservation of energy and matter is expressed in chemical formulas and balanced equations. Key concepts include

a) nomenclature;
b) balancing chemical equations;
c) writing chemical formulas (molecular, structural, and empirical; and Lewis diagrams);
d) bonding types (ionic and covalent);
e) reaction types (synthesis, decomposition, single and double replacement, oxidation-reduction, neutralization, exothermic, and endothermic); and
f) reaction rates and kinetics (activation energy, catalysis, and degree of randomness).

CH.4 The student will investigate and understand that quantities in a chemical reaction are based on molar relationships. Key concepts include

a) Avogadro's principle and molar volume;
b) stoichiometric relationships;
c) partial pressure;
d) gas laws;
e) solution concentrations;
f) chemical equilibrium; and
g) acid/base theory: strong electrolytes, weak electrolytes, and nonelectrolytes; dissociation and ionization; pH and pOH; and the titration process.

CH.5 The student will investigate and understand that the phases of matter are explained by kinetic theory and forces of attraction between particles. Key concepts include

a) pressure, temperature, and volume;
b) vapor pressure;
c) phase changes;
d) molar heats of fusion and vaporization;
e) specific heat capacity; and
f) colligative properties.

Physics

The Physics standards emphasize a more complex understanding of experimentation, the analysis of data, and the use of reasoning and logic to evaluate evidence. The use of mathematics, including algebra and trigonometry, is important, but conceptual understanding of physical systems remains a primary concern. Students build on basic physical science principles by exploring in depth the nature and characteristics of energy and its dynamic interaction with matter. Key areas covered by the standards include force and motion, energy transformations, wave phenomena and the electromagnetic spectrum, light, electricity, fields, and non-Newtonian physics. The standards stress the practical application of physics in other areas of science and technology and how physics affects our world.

The Physics standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

PH.1 The student will plan and conduct investigations in which

a) the components of a system are defined;
b) instruments are selected and used to extend observations and measurements of mass, volume, temperature, heat exchange, energy transformations, motion, fields, and electric charge;
c) information is recorded and presented in an organized format;
d) metric units are used in all measurements and calculations;
e) the limitations of the experimental apparatus and design are recognized;
f) the limitations of measured quantities are recognized through the appropriate use of significant figures or error ranges;
g) data gathered from non-SI instruments are incorporated through appropriate conversions; and
h) appropriate technology including computers, graphing calculators, and probeware, is used for gathering and analyzing data and communicating results.

PH.2 The student will investigate and understand how to analyze and interpret data. Key concepts include

a) a description of a physical problem is translated into a mathematical statement in order to find a solution;
b) relationships between physical quantities are determined using the shape of a curve passing through experimentally obtained data;
c) the slope of a linear relationship is calculated and includes appropriate units;
d) interpolated, extrapolated, and analyzed trends are used to make predictions; and
e) analysis of systems employs vector quantities utilizing trigonometric and graphical methods.

PH.3 The student will investigate and understand how to demonstrate scientific reasoning and logic. Key concepts include

a) analysis of scientific sources to develop and refine research hypotheses;
b) analysis of how science explains and predicts relationships;
c) evaluation of evidence for scientific theories;
d) examination of how new discoveries result in modification of existing theories or establishment of new paradigms; and
e) construction and defense of a scientific viewpoint (the nature of science).

PH.4 The student will investigate and understand how applications of physics affect the world. Key concepts include

a) examples from the real world; and
b) exploration of the roles and contributions of science and technology.

PH.5 The student will investigate and understand the interrelationships among mass, distance, force, and time through mathematical and experimental processes. Key concepts include

a) linear motion;
b) uniform circular motion;
c) projectile motion;
d) Newton's laws of motion;
e) gravitation;
f) planetary motion; and
g) work, power, and energy.

PH.6 The student will investigate and understand that quantities including mass, energy, momentum, and charge are conserved. Key concepts include

a) kinetic and potential energy;
b) elastic and inelastic collisions; and
c) electric power.

PH.7 The student will investigate and understand properties of fluids. Key concepts include

a) density and pressure;
b) variation of pressure with depth;
c) Archimedes' principle of buoyancy;
d) Pascal's principle;
e) fluids in motion; and
f) Bernoulli's principle.

PH.8 The student will investigate and understand that energy can be transferred and transformed to provide usable work. Key concepts include

a) transformation of energy among forms including mechanical, thermal, electrical, gravitational, chemical, and nuclear; and
b) efficiency of systems.

PH.9 The student will investigate and understand how to use models of transverse and longitudinal waves to interpret wave phenomena. Key concepts include

a) wave characteristics (period, wavelength, frequency, amplitude, and phase);
b) fundamental wave processes (reflection, refraction, diffraction, interference, polarization, Doppler effect); and
c) light and sound in terms of wave models.

PH.10 The student will investigate and understand that different frequencies and wavelengths in the electromagnetic spectrum are phenomena ranging from radio waves through visible light to gamma radiation. Key concepts include

a) the properties and behaviors of radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays; and
b) current applications based on the wave properties of each band.

PH.11 The student will investigate and understand, in describing optical systems, how light behaves in the fundamental processes of reflection, refraction, and image formation. Key concepts include

a) application of the laws of reflection and refraction;
b) construction and interpretation of ray diagrams;
c) development and use of mirror and lens equations; and
d) predictions of type, size, and position of real and virtual images.

PH.12 The student will investigate and understand how to use the field concept to describe the effects of gravitational, electric, and magnetic forces. Key concepts include

a) inverse square laws (Newton's law of universal gravitation and Coulomb's law); and
b) operating principles of motors, generators, transformers, and cathode ray tubes.

PH.13 The student will investigate and understand how to diagram and construct basic electrical circuits and explain the function of various circuit components. Key concepts include

a) Ohm's law;
b) series, parallel, and combined circuits; and
c) circuit components including resistors, batteries, generators, fuses, switches, and capacitors.

PH.14 The student will investigate and understand that extremely large and extremely small quantities are not necessarily described by the same laws as those studied in Newtonian physics. Key concepts include

a) wave/particle duality;
b) wave properties of matter;
c) matter/energy equivalence;
d) quantum mechanics and uncertainty;
e) relativity;
f) nuclear physics;
g) solid state physics;
h) superconductivity; and
i) radioactivity.