Science Standards of Learning

Curriculum Framework 2010

Grade Four

Board of Education
Commonwealth of Virginia

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The 2010 *Science Curriculum Framework* can be found in PDF and Microsoft Word file formats on the Virginia Department of Education's Web site at http://www.doe.virginia.gov.

Virginia *Science Standards of Learning* Curriculum Framework 2010
Introduction

The *Science Standards of Learning* Curriculum Framework amplifies the *Science Standards of Learning for Virginia Public Schools* and defines the content knowledge, skills, and understandings that are measured by the Standards of Learning tests. The Science Curriculum Framework provides additional guidance to school divisions and their teachers as they develop an instructional program appropriate for their students. It assists teachers as they plan their lessons by identifying essential understandings and defining the essential content knowledge, skills, and processes students need to master. This supplemental framework delineates in greater specificity the minimum content that all teachers should teach and all students should learn.

School divisions should use the *Science Curriculum Framework* as a resource for developing sound curricular and instructional programs. This framework should not limit the scope of instructional programs. Additional knowledge and skills that can enrich instruction and enhance students' understanding of the content identified in the Standards of Learning should be included as part of quality learning experiences.

The Curriculum Framework serves as a guide for Standards of Learning assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the Curriculum Framework. Students are expected to continue to apply knowledge and skills from Standards of Learning presented in previous grades as they build scientific expertise.

The Board of Education recognizes that school divisions will adopt a K–12 instructional sequence that best serves their students. The design of the Standards of Learning assessment program, however, requires that all Virginia school divisions prepare students to demonstrate achievement of the standards for elementary and middle school by the time they complete the grade levels tested. The high school end-of-course Standards of Learning tests, for which students may earn verified units of credit, are administered in a locally determined sequence.

Each topic in the *Science Standards of Learning* Curriculum Framework is developed around the Standards of Learning. The format of the Curriculum Framework facilitates teacher planning by identifying the key concepts, knowledge and skills that should be the focus of instruction for each standard. The Curriculum Framework is divided into two columns: Understanding the Standard (K-5); Essential Understandings (middle and high school); and Essential Knowledge, Skills, and Processes. The purpose of each column is explained below.

Understanding the Standard (K-5)
This section includes background information for the teacher. It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. This section may also contain suggestions and resources that will help teachers plan instruction focusing on the standard.

Essential Understandings (middle and high school)
This section delineates the key concepts, ideas and scientific relationships that all students should grasp to demonstrate an understanding of the Standards of Learning.

Essential Knowledge, Skills and Processes (K-12)
Each standard is expanded in the Essential Knowledge, Skills, and Processes column. What each student should know and be able to do in each standard is outlined. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. It is meant to be the key knowledge and skills that define the standard.

Grade Four
Science Strand

Scientific Investigation, Reasoning, and Logic

This strand represents a set of systematic inquiry skills that defines what a student will be able to do when conducting activities and investigations and represents the student understanding of the nature of science. The various skill categories are described in the "Investigate and Understand" section of the Introduction to the *Science Standards of Learning*, and the skills in science standard 4.1 represent more specifically what a student should be able to do as a result of science experiences in fourth grade. Across the grade levels, the skills in the "Scientific Investigation, Reasoning, and Logic" strand form a nearly continuous sequence of investigative skills and an understanding of the nature of science. It is important that the classroom teacher understand how the skills in standard 4.1 are a key part of this sequence (i.e., K.1, K.2, 1.1, 2.1, 3.1, 4.1, 5.1, and 6.1). The fourth-grade curriculum should ensure that skills from preceding grades are continuously reinforced and developed.

4.1	The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) distinctions are made among observations, conclusions, inferences, and predictions; b) objects or events are classified and arranged according to characteristics or properties; c) appropriate instruments are selected and used to measure length, mass, volume, and temperature in metric units; d) appropriate instruments are selected and used to measure elapsed time; e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources; f) independent and dependent variables are identified; g) constants in an experimental situation are identified; h) hypotheses are developed as cause and effect relationships; i) data are collected, recorded, analyzed, and displayed using bar and basic line graphs; j) numerical data that are contradictory or unusual in experimental results are recognized; k) data are communicated with simple graphs, pictures, written statements, and numbers; l) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and m) current applications are used to reinforce science concepts.

Overview

The skills described in standard 4.1 are intended to define the "investigate" component of all of the other fourth-grade standards (4.2–4.9). The intent of standard 4.1 is that students will continue to develop a range of inquiry skills, achieve proficiency with those skills in the context of the concepts developed at the fourth-grade level, and strengthen their understanding of the nature of science. **Standard 4.1 does not require a discrete unit be taught on scientific investigation and the nature of science because the skills that make up the standard should be incorporated in all the other fourth-grade standards.** It is also intended that by developing these skills, students will achieve greater understanding of scientific inquiry and the nature of science as well as more fully grasp the content-related concepts.

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Understanding the Standard
(Background Information for Instructor Use Only)

- The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts:
  a) the natural world is understandable;
  b) science is based on evidence, both observational and experimental;
  c) science is a blend of logic and innovation;
  d) scientific ideas are durable yet subject to change as new data are collected;
  e) science is a complex social endeavor; and
  f) scientists try to remain objective and engage in peer review to help avoid bias.

  In grade four, an emphasis should be placed on concepts a, b, c, d, and e.
- Science assumes that the natural world is understandable. Scientific inquiry can provide explanations about nature. This expands students' thinking from just a knowledge of facts to understanding how facts are relevant to everyday life.
- Science demands evidence. Scientists develop their ideas based on

Essential Knowledge, Skills, and Processes

In order to meet this standard, it is expected that students will

- differentiate among simple observations, conclusions, inferences, and predictions, and correctly apply the terminology in oral and written work.
- analyze a set of 20 or fewer objects or pictures. Sort them into categories to organize the data (qualitative or quantitative); and construct bar graphs and line graphs depicting the distribution of those data based on characteristics or properties.
- use millimeters, centimeters, meters, kilometers, grams, kilograms, milliliters, liters, and degrees Celsius in measurement.
- choose the appropriate instruments, including centimeter rulers, meter sticks, scales, balances, graduated cylinders, beakers, and Celsius thermometers, for making basic metric measures.
- measure elapsed time using a stopwatch or a clock.
- make predictions, inferences, and draw conclusions using a variety of sources such as picture graphs, bar graphs, and basic line graphs.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
evidence and they change their ideas when new evidence becomes available or the old evidence is viewed in a different way. • Science uses both logic and innovation. Innovation has always been an important part of science. Scientists draw upon their creativity to visualize how nature works, using analogies, metaphors, and mathematics. • Scientific ideas are durable yet subject to change as new data are collected. The main body of scientific knowledge is very stable and grows by being corrected slowly and having its boundaries extended gradually. Scientists themselves accept the notion that scientific knowledge is always open to improvement and can never be declared absolutely certain. New questions arise, new theories are proposed, new instruments are invented, and new techniques are developed. • Science is a complex social endeavor. It is a complex social process for producing knowledge about the natural world. Scientific knowledge represents the current consensus among scientists as to what is the best explanation for phenomena in the natural world. This consensus does not arise automatically, since scientists with different backgrounds from all over the world may interpret the same data differently. To build a	• analyze the variables in a simple experiment. Identify the independent variable and the dependent variable. Decide which other variable(s) must be held constant (not allowed to change) in order for the investigation to represent a fair test. • create a plausible hypothesis, stated in terms of cause (if) and effect (then), from a set of basic observations that can be tested. Hypotheses can be stated in terms such as: "If the water temperature is increased, then the amount of sugar that can be dissolved in it will increase." • organize and analyze data from a simple experiment. Construct bar graphs and line graphs depicting the data. • judge which, if any, data in a simple set of results (generally 10 or fewer in number) appear to be contradictory or unusual. • present results of a simple experiment using graphs, pictures, statements, and numbers. • construct a physical model to clarify an explanation, demonstrate a relationship, or solve a need.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
consensus, scientists communicate their findings to other scientists and attempt to replicate one another's findings. In order to model the work of professional scientists, it is essential for fourth-grade students to engage in frequent discussions with peers about their understanding of their investigations. • An observation is what you see, feel, taste, hear, or smell. Scientists construct knowledge from observations and inferences, not observations alone. To communicate an observation accurately, one must provide a clear description of exactly what is observed and nothing more. Those conducting investigations need to understand the difference between what is seen and what inferences, conclusions, or interpretations can be drawn from the observation. • An inference is a tentative explanation based on background knowledge and available data. • A scientific prediction tells what may happen in some future situation. It is based on the application of scientific principles and factual information. • Accurate observations and evidence are necessary to draw realistic and plausible conclusions. A conclusion is a summary statement based on the	

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
results of an investigation. • Conclusions are drawn by making judgments after considering all the information you have gathered. Conclusions are based on details and facts. • Systematic investigations require standard measures (metric), consistent and reliable tools, and organized reporting of data. The way the data are displayed can make it easier to uncover important information. This can assist in making reliable scientific forecasts of future events. • Elapsed time is the amount of time that has passed between two given times. (*See Grade Four Mathematics Curriculum Framework, Standard 4.9, page 24.*) • An experiment is a fair test driven by a hypothesis. A fair test is one in which only one variable is compared. • A hypothesis is a prediction about the relationship between variables. A hypothesis is an educated guess/prediction about what will happen based on what you already know and what you have already learned from your research. It must be worded so that it is "testable."	

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• In order to conduct an experiment, one must recognize all of the potential variables or changes that can affect its outcome. • An independent variable is the factor in an experiment that is altered by the experimenter. The independent variable is purposely changed or manipulated. • A dependent variable is the factor in an experiment that changes as a result of the manipulation of the independent variable. • The constants in an experiment are those things that are purposefully not changed and remain the same throughout the experiment. • In science, it is important that experiments and the observations recorded are repeatable. There are two different types of data – qualitative and quantitative. Qualitative data deal with descriptions and data that can be observed, but not measured. Quantitative data are data that can be counted or measured and the results can be recorded using numbers. Quantitative data can be represented visually in graphs and charts. Quantitative data define whereas qualitative data describe. Quantitative data are more valuable in science because they allow direct comparisons between observations made by different people or at different times.	

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Understanding the Standard
(Background Information for Instructor Use Only)

Example of Qualitative vs. Quantitative Data

Main Street Elementary School Science Club

Qualitative	Quantitative
• Friendly • Like science • Positive about school	• 10 fourth-grade students and 12 fifth-grade students • 14 girls, 8 boys • 92 percent participated in the divisionwide science fair last year

- It is important for students to apply the science content they have learned to current events and applications.

Essential Knowledge, Skills, and Processes

Grade Four
Science Strand

Force, Motion, and Energy

This strand focuses on student understanding of what force, motion, and energy are and how the concepts are connected. The major topics developed in this strand include magnetism, types of motion, simple and compound machines, and energy forms and transformations, especially electricity, sound, and light. This strand includes science standards K.3, 1.2, 2.2, 3.2, 4.2, 4.3, 5.2, 5.3, 6.2, and 6.3.

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

Overview

This standard is introduced in first grade and prepares students for a more in-depth study of energy in eighth grade. This standard focuses on the characteristics of moving objects. Key concepts include the effect of forces, such as friction, on moving objects. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• The position of an object can be described by locating it relative to another object or to the background. • Tracing and measuring an object's position over time can describe its motion. • Speed describes how fast an object is moving. • Energy may exist in two states: kinetic or potential. • Kinetic energy is the energy of motion. • A force is any push or pull that causes an object to move, stop, or change speed or direction. • The greater the force, the greater the change in motion will be. The more massive an object, the less effect a given force will have on the object. • Friction is the resistance to motion created by two objects moving against each other. Friction creates heat. • Unless acted on by a force, objects in motion tend to stay in motion and objects at rest remain at rest.	In order to meet this standard, it is expected that students will • describe the position of an object. • collect and display in a table and line graph time and position data for a moving object. • explain that speed is a measure of motion. • interpret data to determine if the speed of an object is increasing, decreasing, or remaining the same. • identify the forces that cause an object's motion. • describe the direction of an object's motion: up, down, forward, backward. • infer that objects have kinetic energy. • design an investigation to test the following hypothesis: "If the mass of an object increases, then the force needed to move it will increase." • design an investigation to determine the effect of friction on moving objects. Write a testable hypothesis and identify the dependent variable, the independent variable, and the constants. Conduct a fair test, collect and record the data, analyze the data, and report the results of the data.

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

Overview

This standard focuses on the characteristics of electricity as related to circuits and circuit components, magnetism, static charges, and historical contributions important to the understanding of electricity. As electrical energy is an integral part of modern civilization (e.g., powering our computers; lighting, heating and cooling our homes and businesses; and making the information age possible), it is critical that students begin to understand basic electricity concepts. This standard will be the basis for a more in-depth study in the eighth grade. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• A continuous flow of negative charges (electrons) creates an electric current. The pathway taken by an electric current is a circuit. Closed circuits allow the movement of electrical energy. Open circuits prevent the movement of electrical energy. • Electrical energy moves through materials that are conductors (metals). Insulators (rubber, plastic, wood) do not conduct electricity well. • Among conducting materials, the rate at which energy flows depends on the material's resistance. • In a series circuit, there is only one pathway for the current, but in a parallel circuit there are two or more pathways for it. • Rubbing certain materials together creates static electricity. • Lightning is the discharge of static electricity in the atmosphere. • Electrical energy can be transformed into light or motion, and can produce thermal energy. • Certain iron-bearing metals attract other such metals (also nickel and cobalt). • Lines of force extend from the poles of a magnet in an arched pattern defining the area over which magnetic force is exerted. • An electric current creates a magnetic field, and a moving magnetic field creates an electric current. • A current flowing through a wire creates a magnetic field. Wrapping a	In order to meet this standard, it is expected that students will • apply the terms insulators, conductors, open and closed in describing electrical circuits. • differentiate between an open and closed electric circuit. • use the dry cell symbols (–) and (+). • create and diagram a functioning series circuit using dry cells, wires, switches, bulbs, and bulb holders. • create and diagram a functioning parallel circuit using dry cells, wires, switches, bulbs, and bulb holders. • differentiate between a parallel and series circuit. • describe the types of energies (i.e., thermal, radiant, and mechanical) that are transformed by various household appliances (e.g., lamp, toaster, fan). • create a diagram of a magnetic field using a magnet. • compare and contrast a permanent magnet and an electromagnet. • explain how electricity is generated by a moving magnetic field. • design an investigation using static electricity to attract or repel a variety of materials. • explain how static electricity is created and occurs in nature. • construct a simple electromagnet using a wire, nail, or other iron-

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
wire around certain iron-bearing metals (iron nail) and creating a closed circuit is an example of a simple electromagnet. • Benjamin Franklin, Michael Faraday, and Thomas Edison made important discoveries about electricity.	bearing object, and a dry cell. • design and perform an investigation to determine the strength of an electromagnet. (The independent variable could be the number of coils of wire and the dependent variable could be the number of paperclips the magnet can attract.) • describe the contributions of Ben Franklin, Michael Faraday, and Thomas Edison to the understanding and harnessing of electricity.

Grade Four
Science Strand

Life Processes

This strand focuses on the life processes of plants and animals and the specific needs of each. The major topics developed in the strand include basic needs and life processes of organisms, their physical characteristics, orderly changes in life cycles, behavioral and physical adaptations, and survival and perpetuation of species. This strand includes science standards K.6, K.7, 1.4, 1.5, 2.4, 3.4, and 4.4.

4.4	The student will investigate and understand basic plant anatomy and life processes. Key concepts include a) the structures of typical plants and the function of each structure; b) processes and structures involved with plant reproduction; c) photosynthesis; and d) adaptations allow plants to satisfy life needs and respond to the environment.

Overview

This standard focuses on the basic life processes and anatomy of plants. It represents a more in-depth treatment of the plant structures and the processes associated with plant reproduction. Photosynthesis is introduced in this standard. Closely related standards from previous grades include K.6, 1.4, and 2.4. This standard also is closely connected with concepts presented in science standard 4.5. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• For many typical green plants, there are anatomical structures that perform certain basic functions. For example, roots anchor the plants and take water and nutrients from the soil. Plant stems provide support and allow movement of water and nutrients. • Plants can be divided into two general groups: those that produce seeds and those that produce spores. • Many seed-producing plants have roots, stems, leaves, and flowers. • Seeds vary considerably in size. Orchids, for example, produce seeds as small as dust particles. The coconut is one of the largest seeds in the plant kingdom. In many seeds, the protective outer seed coat is resistant to physical damage and may also contain waxes and oils that help prevent water loss. • The embryo within the seed begins as a single cell, the zygote. The basic organs of the plant body can be found in the embryo. In some seeds the embryonic leaves are quite large, filling most of the volume of the seed. The embryonic leaves are a major source of stored food for the embryo. Beans are an example of plants with large embryonic leaves. In many other plants the embryonic leaves are relatively small, and the embryo is nourished by a tissue called endosperm. • Pollination is part of the reproductive process of flowering plants. Pollination is the process by which pollen is transferred from the stamens to the stigma. • The stamen and pistil are reproductive parts of the flower. The sepals are the small leaves that form the housing of the developing flower. • Some plants reproduce with spores. These include ferns and mosses.	In order to meet this standard, it is expected that students will • analyze a common plant: identify the roots, stems, leaves, and flowers, and explain the function of each. • create a model/diagram illustrating the parts of a flower and its reproductive processes. Explain the model/diagram using the following terminology: pollination, stamen, stigma, pistil, sepal, embryo, spore, seed. • compare and contrast different ways plants are pollinated. • explain that ferns and mosses reproduce with spores rather than seeds. • explain the process of photosynthesis, using the following terminology: sunlight, chlorophyll, water, carbon dioxide, oxygen, and sugar. • explain the role of adaptations of common plants to include dormancy, response to light, and response to moisture.

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Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• Green plants produce their own food through the process of photosynthesis. Green plants use chlorophyll to produce food (sugar), using carbon dioxide, water, enzymes and other chemicals, and sunlight. Leaves are the primary food-producing part of these plants. • Oxygen is released during photosynthesis. • Plants adapt to changes in their environment in order to survive. Dormancy is a plant adaptation. Dormancy is a period of suspended life processes brought on by changes in the environment.	

Grade Four
Science Strand

Living Systems

This strand begins in second grade and builds from basic to more complex understandings of a system, both at the ecosystem level and at the level of the cell. The concept of kingdoms of living things and a general classifying of organisms are also presented. The other major topics developed in the strand include the types of relationships among organisms in a food chain, different types of environments and the organisms they support, and the relationship between organisms and their nonliving environment. This strand includes science standards 2.5, 3.5, 3.6, 4.5, 5.5, and 6.7.

4.5	The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem. Key concepts include a) plant and animal adaptations; b) organization of populations, communities, and ecosystems and how they interrelate; c) flow of energy through food webs; d) habitats and niches; e) changes in an organism's niche at various stages in its life cycle; and f) influences of human activity on ecosystems.

Overview

This standard focuses on the relationships among plants, animals, and the nonliving environment and brings together several elements of both Life Processes and Living Systems. This standard assumes students have a basic understanding that all living organisms are interrelated and dependent in some way on other living organisms and their environment. Plants and animals in ecological systems live in a web of interdependence in which each species contributes to the functioning of the overall system. Organisms live in a habitat to which they are structurally and behaviorally adapted. Certain conditions within environments determine which organisms and communities succeed there. This standard builds upon previous standards 1.5, 2.4, 2.5. 3.4, 3.5 and 3.6. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

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f) influences of human activity on ecosystems.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• Organisms have structural adaptations or physical attributes that help them meet a life need. • Organisms also have behavioral adaptations, or certain types of activities they perform, which help them meet a life need. • All the organisms of the same species that live in the same place at the same time are a population. • Populations of species that live in the same place at the same time together make up a community. • The organization of communities is based on the utilization of the energy from the sun within a given ecosystem. The greatest amount of energy in a community is in the producers. • Within a community, organisms are dependent on the survival of other organisms. Energy is passed from one organism to another. • All the populations and the nonliving components in an environment that interact with each other form an ecosystem. • The sun's energy cycles through ecosystems from producers through consumers and back into the nutrient pool through decomposers. • A habitat is the place or kind of place in which an animal or plant naturally lives. An organism's habitat provides food, water, shelter, and space. The size of the habitat depends on the organism's needs. • A niche is the function that an organism performs in the food web of	In order to meet this standard, it is expected that students will • distinguish between structural (physical) and behavioral adaptations. • investigate and infer the function of basic adaptations. • understand that adaptations allow an organism to succeed in a given environment. • explain how different organisms use their unique adaptations to meet their needs. • describe why certain communities exist in given habitats. • illustrate the food webs in a local area. • compare and contrast the niches of several different organisms within the community. • compare and contrast the differing ways an organism interacts with its surroundings at various stages of its life cycle. Specific examples include a frog and a butterfly. • differentiate among positive and negative influences of human activity on ecosystems.

4.5	The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem. Key concepts include a) plant and animal adaptations; b) organization of populations, communities, and ecosystems and how they interrelate; c) flow of energy through food webs; d) habitats and niches; e) changes in an organism's niche at various stages in its life cycle; and f) influences of human activity on ecosystems.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
that community. A niche also includes everything else the organism does and needs in its environment. No two types of organisms occupy exactly the same niche in a community. • The organization of a community is defined by the interrelated niches within it. • During its life cycle, an organism's role in the community — its niche — may change. For example, what an animal eats, what eats it, and other relationships will change. • Humans can have a major impact on ecosystems.	

Grade Four
Science Strand

Interrelationships in Earth/Space Systems

This strand focuses on student understanding of how Earth systems are connected and how Earth interacts with other members of the solar system. The topics developed include shadows; relationships between the sun and Earth; weather types, patterns, and instruments; properties of soil; characteristics of the ocean environment; and organization of the solar system. This strand includes science standards K.8, 1.6, 2.6, 3.7, 4.6, 5.6, and 6.8.

4.6	The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include a) weather phenomena; b) weather measurements and meteorological tools; and c) use of weather measurements and weather phenomena to make weather predictions.

Overview

This standard focuses on weather conditions and a more technical understanding of the tools and methods used to forecast future atmospheric conditions. Weather is introduced in science standard 2.6. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

4.6 The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include
a) weather phenomena;
b) weather measurements and meteorological tools; and
c) use of weather measurements and weather phenomena to make weather predictions.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• Temperature is the measure of the amount of thermal energy in the atmosphere. • Air pressure is due to the weight of the air and is determined by several factors including the temperature of the air. • A front is the boundary between air masses of different temperature and humidity. • Cirrus, stratus, cumulus, and cumulo-nimbus clouds are associated with certain weather conditions. • Cumulus clouds are fluffy and white with flat bottoms. They usually indicate fair weather. However, when they get larger and darker on the bottom, they become cumulo-nimbus clouds. Cumulo-nimbus clouds may produce thunderstorms. • Stratus clouds are smooth, gray clouds that cover the whole sky (block out direct sunlight). Light rain and drizzle are usually associated with stratus clouds. • Cirrus clouds are feathery clouds. They are associated with fair weather. Cirrus clouds often indicate that rain or snow will fall within several hours. • Extreme atmospheric conditions create various kinds of storms such as thunderstorms, hurricanes, and tornadoes. • Different atmospheric conditions create different types of precipitation. • Meteorologists gather data by using a variety of instruments. • Meteorologists use data to predict weather patterns. • A barometer measures air pressure.	In order to meet this standard, it is expected that students will • design an investigation in which a thermometer is used to compare air temperatures over a period of time. • analyze the changes in air pressure occurring over time, using a barometer, and predict what the changes mean in terms of changing weather patterns. • illustrate and label high and low pressures on a map. • differentiate between the types of weather associated with high and low pressure air masses. Illustrate and label high and low pressure air masses and warm and cold fronts. • differentiate between cloud types (i.e., cirrus, stratus, cumulus, and cumulo-nimbus clouds) and the associated weather. • compare and contrast the formation of different types of precipitation (e.g., rain, snow, sleet, and hail). • recognize a variety of storm types, describe the weather conditions associated with each, and explain when they occur (e.g., thunderstorms, hurricanes, and tornadoes). • analyze and report information about temperature and precipitation on weather maps. • measure wind speed, using an anemometer. • measure precipitation with a rain gauge. • design an investigation in which weather data are gathered using meteorological tools and charted to make weather predictions.

4.6	The student will investigate and understand how weather conditions and phenomena occur and can be predicted. Key concepts include a) weather phenomena; b) weather measurements and meteorological tools; and c) use of weather measurements and weather phenomena to make weather predictions.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• An anemometer measures wind speed. • A rain gauge measures the amount of precipitation. • A thermometer measures the temperature of the air.	

Grade Four
Science Strand

Earth Patterns, Cycles, and Change

This strand focuses on student understanding of patterns in nature, natural cycles, and changes that occur both quickly and slowly over time. An important idea represented in this strand is the relationship among Earth patterns, cycles, and change and their effects on living things. The topics developed include noting and measuring changes, weather and seasonal changes, the water cycle, cycles in the Earth-moon-sun system, our solar system, and change in Earth's surface over time. This strand includes science standards K.9, K.10, 1.7, 2.7, 3.8, 3.9, 4.7, 4.8, and 5.7.

4.7	The student will investigate and understand the organization of the solar system. Key concepts include a) the planets in the solar system; b) the order of the planets in the solar system; and c) the relative sizes of the planets.

Overview

This standard focuses on providing an introduction to our solar system. This includes the introduction to the planets in the solar system, their order in the solar system in relation to the sun, and the sizes of the planets in relation to the size of Earth. A more in-depth study of the solar system is in standard 6.8. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

4.7 The student will investigate and understand the organization of the solar system. Key concepts include
a) the planets in the solar system;
b) the order of the planets in the solar system; and
c) the relative sizes of the planets.

Understanding the Standard (Background Information for Instructor Use Only)	Essential Knowledge, Skills, and Processes
• Our solar system is ancient. Early astronomers believed that Earth was the center of the universe and all other heavenly bodies orbited around Earth. We now know that our sun is the center of our solar system and eight planets, a handful of dwarf planets, 170 named moons, dust, gas, and thousands of asteroids and comets orbit around the sun. • Our solar system is made up of eight planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. • Mercury, Venus, Earth, and Mars are considered terrestrial planets. Jupiter, Saturn, Uranus, and Neptune are called gas giants. • Mercury is closest to the sun and is a small, heavily cratered planet. Mercury looks like our moon. Since Pluto's reclassification from planet to dwarf planet, Mercury is now the smallest planet in our solar system. • Venus is second from the sun. It is similar to Earth in size and mass, and has a permanent blanket of clouds that trap so much heat that the temperatures on the surface of Venus are hot enough to melt lead. • Earth is third from the sun. Earth's atmosphere, the liquid water found on Earth, and its distance from the sun, among many other factors, make Earth a haven for life. • Mars is fourth from the sun. The atmosphere on Mars is thin and there is a vast network of canyons and riverbeds on the red planet. Scientists hypothesize that Mars once supported a wet, warm Earth-like climate. • Jupiter is fifth from the sun. Jupiter is the largest planet in the solar system and is considered a gas giant. Jupiter has no solid surface. • Saturn is sixth from the sun. Early scientists thought Saturn was the only planet with rings, but we now know that all four gas giants (Jupiter,	In order to meet this standard, it is expected that students will • name the eight planets and describe whether they are a terrestrial planet or a gas giant. • sequence the eight planets in the solar system based on their position from the sun. (Mercury is the first from the sun, Venus is the second, etc.) • sequence the eight planets in the solar system based on size (Jupiter is the largest, Saturn is next, etc.) • construct a simple model of the sun and the planets in our solar system.

4.7	The student will investigate and understand the organization of the solar system. Key concepts include a) the planets in the solar system; b) the order of the planets in the solar system; and c) the relative sizes of the planets.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
Saturn, Uranus, and Neptune) have rings. • Uranus is seventh from the sun. Uranus is a gas giant. • Neptune is eighth from the sun. Neptune appears blue through telescopes and is a gas giant. • The eight planets sorted by size from largest to smallest are: Jupiter, Saturn, Uranus, Neptune, Earth, Venus, Mars, and Mercury. • Pluto is no longer included in the list of planets in our solar system due to its small size and irregular orbit. Many astronomers questioned whether Pluto should be grouped with worlds like Earth and Jupiter. In 2006, this debate led the International Astronomical Union (IAU), the recognized authority in naming heavenly objects, to formally reclassify Pluto. On August 24, 2006, Pluto's status was officially changed from planet to dwarf planet. • A new distinct class of objects called "dwarf planets" was identified in 2006. It was agreed that "planets" and "dwarf planets" are two distinct classes of objects. The first members of the dwarf planet category are Ceres, Pluto and 2003 UB313, given the name Eris. More dwarf planets are expected to be announced by the IAU in the future. • What differentiates a dwarf planet from a planet? For the most part, they are identical, but there is one key difference: A dwarf planet has not "cleared the neighborhood" around its orbit, which means it has not become gravitationally dominant and it shares its orbital space with other bodies of a similar size. • Pluto is smaller than seven of the moons in our solar system and cannot be seen without a telescope.	

4.8	The student will investigate and understand the relationships among Earth, the moon, and the sun. Key concepts include a) the motions of Earth, the moon, and the sun; b) the causes for Earth's seasons; c) the causes for the phases of the moon; d) the relative size, position, age, and makeup of Earth, the moon, and the sun; and e) historical contributions in understanding the Earth-moon-sun system.

Overview

This standard focuses on the Earth-moon-sun system and includes knowledge related to the motions of this system and the results of our unique position in it. This includes the presence of an atmosphere, liquid water, and life. The standard is built on concepts developed in science standards K.8, 1.6, and 3.8 and that will be further expanded in 6.8. A more in-depth study of Earth's makeup is in standard 5.7. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

4.8 The student will investigate and understand the relationships among Earth, the moon, and the sun. Key concepts include
a) the motions of Earth, the moon, and the sun;
b) the causes for Earth's seasons;
c) the causes for the phases of the moon;
d) the relative size, position, age, and makeup of Earth, the moon, and the sun; and
e) historical contributions in understanding the Earth-moon-sun system.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• Earth completes one revolution around the sun every 365 ¼ days. The moon revolves around Earth about once every month. • Due to its axial tilt, Earth experiences seasons during its revolution around the sun. • The phases of the moon are caused by its position relative to Earth and the sun. The phases of the moon include the new, waxing crescent, first quarter, waxing gibbous, full, waning gibbous, last (third) quarter, and waning crescent. • The sun is an average-sized yellow star, about 110 times the diameter of Earth. The sun is approximately 4.6 billion years old. • Our moon is a small rocky satellite, having about one-quarter the diameter of Earth and one-eightieth its mass. It has extremes of temperature, virtually no atmosphere or life, and very little water. • Earth is one of eight planets that revolve around the sun and comprise the solar system. Earth, the third planet from the sun, is one of the four terrestrial inner planets. It is about 150 million kilometers from the sun. • Earth is a geologically active planet with a surface that is constantly changing. Unlike the other three inner planets (Mercury, Venus, and Mars), it has large amounts of life-supporting water and an oxygen-rich atmosphere. Earth's protective atmosphere blocks out most of the sun's damaging rays. • Our understanding of the solar system has changed from an Earth-centered model of Aristotle and Ptolemy to the sun-centered model of Copernicus and Galileo.	In order to meet this standard, it is expected that students will • differentiate between rotation and revolution. • describe how Earth's axial tilt causes the seasons. • model the formation of the eight moon phases, sequence the phases in order, and describe how the phases occur. • describe the major characteristics of the sun, including its approximate size, color, age, and overall composition. • create and describe a model of the Earth-moon-sun system with approximate scale distances and sizes. • compare and contrast the surface conditions of Earth, the moon, and the sun. • compare and contrast an Earth-centered to the sun-centered model of the solar system. • analyze the differences in what Aristotle, Ptolemy, Copernicus, and Galileo observed and what influenced their conclusions. • describe a contribution of the NASA Apollo missions to our understanding of the moon.

4.8	The student will investigate and understand the relationships among Earth, the moon, and the sun. Key concepts include a) the motions of Earth, the moon, and the sun; b) the causes for Earth's seasons; c) the causes for the phases of the moon; d) the relative size, position, age, and makeup of Earth, the moon, and the sun; and e) historical contributions in understanding the Earth-moon-sun system.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• The NASA Apollo missions added greatly to our understanding of the moon. • Our understanding of the sun, moon, and the solar system continues to change with new scientific discoveries.	

Grade Four
Science Strand

Earth Resources

This strand focuses on student understanding the role of resources in the natural world and how people can utilize those resources in a sustainable way. An important idea represented in this strand is the concept of management of resource use. This begins with basic ideas of conservation and proceeds to more abstract consideration of costs and benefits. The topics developed include conservation of materials, soil and plants as resources, energy use, water, Virginia's resources, and how public policy impacts the environment. This strand includes science standards K.11, 1.8, 2.8, 3.10, 3.11, 4.9, and 6.9.

4.9	The student will investigate and understand important Virginia natural resources. Key concepts include a) watersheds and water resources; b) animals and plants; c) minerals, rocks, ores, and energy sources; and d) forests, soil, and land.

Overview

Virginia has a rich variety of natural resources. These provide the raw materials for our daily lives and sustain our economy. Natural resources are finite and must be used wisely to ensure their continued availability. This concept of natural resources is introduced in 1.8 and extended in 6.9. It is intended that students will actively develop and utilize scientific investigation, reasoning, and logic skills (4.1) in the context of the key concepts presented in this standard.

4.9 The student will investigate and understand important Virginia natural resources. Key concepts include
a) watersheds and water resources;
b) animals and plants;
c) minerals, rocks, ores, and energy sources; and
d) forests, soil, and land.

Understanding the Standard (Background Information for Instructor Use Only)	**Essential Knowledge, Skills, and Processes**
• Virginia is rich in a wide variety of natural resources, including forests, arable (farmable) land, coal, sand and aggregates (rocks), wildlife and aquatic organisms, clean water and air, and beautiful scenery. • A watershed is an area over which surface water (and the materials it carries) flows to a single collection place. The Chesapeake Bay watershed covers approximately half of Virginia's land area. The other two major watershed systems are the Gulf of Mexico and the North Carolina Sounds. • Virginia's water resources include groundwater, lakes, reservoirs, rivers, bays, and the Atlantic Ocean. • Virginia has a great variety of plant and animal resources. • Natural and cultivated forests are a widespread resource in Virginia. • Virginia's soil and land support a great variety of life, provide space for many economic activities, and offer a variety of recreational opportunities.	In order to meet this standard, it is expected that students will • compare and contrast natural and human-made resources. • distinguish among rivers, lakes, and bays; describe characteristics of each; and name an example of each in Virginia. • create and interpret a model of a watershed. Evaluate the statement: "We all live downstream." • identify watershed addresses. • recognize the importance of Virginia's mineral resources, including coal, limestone, granite, and sand and gravel. • appraise the importance of natural and cultivated forests in Virginia. • describe a variety of soil and land uses important in Virginia.