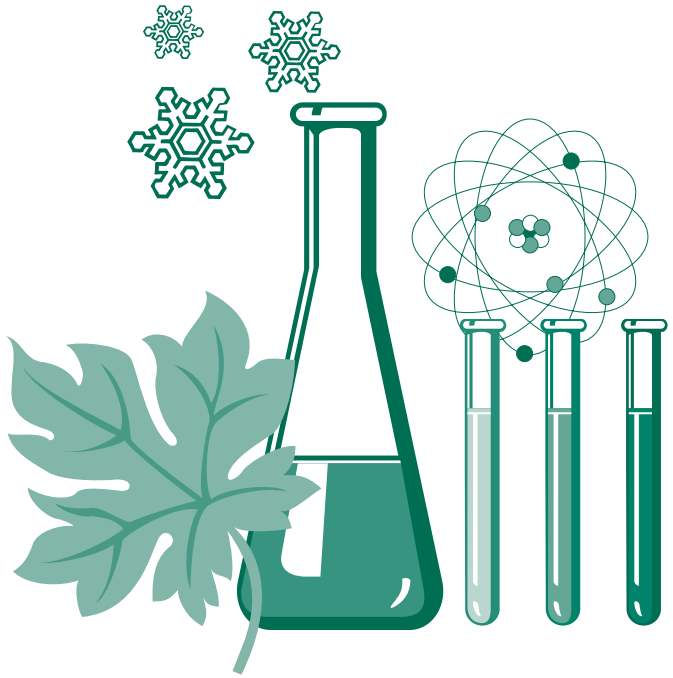

Science Standards of Learning Curriculum Framework

Grade Five

Commonwealth of Virginia
Board of Education
Richmond, Virginia

Grade Five
Science Strand

Scientific Investigation, Reasoning, and Logic

This strand represents a set of systematic inquiry skills that defines what a student should be able to do when conducting activities and investigations. 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 5.1 represent more specifically what a student should be able to do as a result of science experiences in fifth grade. Across the grade levels, the skills in the "Scientific Investigation, Reasoning, and Logic" strand form a nearly continuous sequence of investigative skills. (Please note Appendix, "Science Skills, Scope, & Sequence.") It is important that the classroom teacher understands how the skills in standard 5.1 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 fifth grade curriculum should ensure that skills from preceding grades are continuously reinforced and developed. It is also important to note that 25 percent of items on the third and fifth grade SOL assessments measure the skills defined in the "Scientific Investigation, Reasoning, and Logic" strand.

Standard 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.

Understanding the Standard

The skills in standard 5.1 are intended to define the "investigate" component of all of the other fifth grade standards (5.2–5.7). The intent of standard 5.1 is for students to continue to develop a range of inquiry skills and achieve proficiency with those skills in the context of the concepts developed at the fifth grade. Standard 5.1 does not require a discrete unit on scientific investigation because the inquiry skills that make up the standard should be incorporated in all the other fifth grade standards. It is also intended that by developing these skills, students will achieve a greater understanding of scientific inquiry and the nature of science and will more fully grasp the content-related concepts.

Standard 5.1

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Systematic investigations require standard measures and consistent and reliable tools. Metric measures are a standard way to make measurements and are recognized around the world. • A classification key is an important tool used to help identify objects and organisms. It consists of a branching set of choices organized in levels, with most levels of the key having two choices. Each level provides more specific descriptors, eventually leading to identification. • Systematic investigations require organized reporting of data. The way the data are displayed can make it easier to see important patterns, trends, and relationships. Bar graphs and line graphs are useful tools for reporting discrete data and continuous data, respectively. • A scientific *prediction* is a forecast about what *may* happen in some future situation. It is based on the application of factual information and principles and recognition of trends and patterns. • Estimation is a useful tool for making approximate measures and giving general descriptions. In order to make reliable estimates, one must have experience using the particular unit.	In order to meet this standard, it is expected that students should be able to • use classification keys to identify rocks, minerals, and organisms. • make plausible estimations of length, mass, and volume. • select and use the appropriate instruments, including centimeter rulers, meter sticks, graduated cylinders, balances, and stopwatches, for making basic measurements. • measure temperature, length, mass, and volume, using metric measures. This includes millimeters, centimeters, meters, kilometers, grams, kilograms, milliliters, liters, and degrees Celsius. • collect, record, and report data, using charts and tables, and translate numerical data into bar or line graphs. • make predictions based on trends in data. This requires the recognition of patterns and trends and determination of what those trends may represent. • analyze the variables in a simple experiment and identify the manipulated (independent) and responding (dependent) variables. • define/make observations and inferences.

Standard 5.1 (continued)

Overview	Essential Knowledge, Skills, and Processes
• Scientific conclusions are based both on verifiable observations (science is empirical) and on inferences. • *Observation* is the use of senses to collect information about the environment. *Inference* is the use of prior knowledge and experience to generate conclusions about those observations.	• distinguish between observations and inferences. • measure, record, identify, collect, and organize observations. Distinguish between qualitative and quantitative observations.

Grade Five
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.

Standard 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).

Understanding the Standard

This standard introduces the concept of what sound is and how sound is transmitted. The students are introduced to scientific vocabulary and the phenomena of frequency, waves, wavelength, and vibration in this standard. Students should make predictions about and experiment with the transmission of sound. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.2

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Sound is a form of energy produced and transmitted by vibrating matter. • Sound travels in waves and can be described by the wavelength and frequency of the waves. A *wave* is a disturbance moving through a medium (solid, liquid, or gas). • The *frequency* of sound is the number of vibrations in a given unit of time. • Sound is a compression wave moving outward from its source. The *wavelength* of sound is the distance between two compressions. • *Pitch* is determined by the frequency of a vibrating object. Objects vibrating faster have a higher pitch than objects vibrating slower. • Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together. Sound travels most slowly through gases because the molecules of a gas are farthest apart. • Some animals make and hear ranges of sound vibrations different from those that humans can make and hear. • Musical instruments vibrate to produce sound.	In order to meet this standard, it is expected that students should be able to • use the basic terminology of sound to describe what sound is, how it is formed, how it affects matter, and how it travels. • create and interpret a model or diagram of a compression wave. • explain why sound waves travel only where there is matter to transmit them. • explain the relationship between frequency and pitch. • design an investigation to determine what factors affect the pitch of a vibrating object. This includes vibrating strings, rubber bands, beakers/bottles of air and water, tubes (as in wind chimes), and other common materials. • compare and contrast sound traveling through a solid with sound traveling through the air. Explain how different media (solid, liquid, and gas) will affect the transmission of sound. • compare and contrast the sounds (voice) that humans make and hear to that of other animals. This includes bats, dogs, and whales. • compare and contrast how different kinds of musical instruments make sound. This includes string instruments, woodwinds, percussion instruments, and brass instruments.

Standard 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.

Understanding the Standard

Concepts related to light are introduced at the fifth grade level. Standard 5.3 focuses on the characteristics of visible light, tools that aid in the production and use of light, and the historical contributions of inventors and scientists. Instruction should center on the basic science concerning light energy and how we use light in our daily lives. A related science standard is 4.2, which focuses on forms of energy and provides a foundation for understanding that light is energy. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.3

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Visible light is a combination of several different wavelengths of light traveling together. These wavelengths are represented by the colors red, orange, yellow, green, blue, indigo, and violet (ROYGBIV). • Light waves are characterized by their wavelengths. In the visible spectrum, red has the longest wavelength, and violet has the shortest. Wavelengths get progressively shorter from red to violet. • Light travels in waves. Compared to sound, light travels extremely fast. It takes light from the sun less than 8½ minutes to travel 150 million kilometers to reach the Earth. • Unlike sound, light waves travel in straight paths called *rays* and do not need a medium through which to move. • Light travels in straight paths until it hits an object, where it bounces off (is reflected), is bent (is refracted), passes through the object (is transmitted), or is absorbed as heat. • The relative terms *transparent*, *translucent*, and *opaque* indicate the amount of light that passes through an object. • A prism can be used to refract visible light. When the different wavelengths of light in visible light pass through a prism, they are bent at different angles. The colors of light we see are red, orange, yellow, green, blue, indigo, and violet.	In order to meet this standard, it is expected that students should be able to • explain the relationships between wavelength and the color of light. Name the colors of the visible spectrum. • diagram and label a representation of a light wave, including wavelength, peak, and trough. • compare and contrast reflection and refraction, using water, prisms, and mirrors. • explain the terms *transparent*, *translucent*, and *opaque*, and give an example of each. • analyze the effects of a prism on white light and describe why this occurs. Explain why a rainbow occurs.

Grade Five
Science Strand

Matter

This strand focuses on the description, physical properties, and basic structure of matter. The major topics developed in this strand include concepts related to the basic description of objects, states of matter (solids, liquids, and gases – especially water), phase changes, mass and volume, and the structure of classification of matter. This strand includes science standards K.4, K.5, 1.3, 2.3, 3.3, 5.4, 6.4, 6.5, and 6.6.

Standard 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.

Understanding the Standard

This standard incorporates various characteristics of matter such as mass, volume, and the effect of heat on the three states of matter. Instruction should center on the basic structure of matter and how it behaves. This standard builds on standard 3.3, which provides a basis for understanding the structure of matter. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.4

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • All matter, regardless of its size, shape, or color, is made of particles (atoms and molecules) that are too small to be seen by the unaided eye. • There are more than 100 known elements that make up all matter. The smallest part of an element is an atom. • When two or more elements combine to form a new substance, it is called a *compound*. There are many different types of compounds because atoms of elements combine in many different ways (and in different whole number ratios) to form different compounds. Examples include water (H_2O) and table salt (NaCl). The smallest part of a compound is a molecule. • A *mixture* is a combination of two or more substances that do not lose their identifying characteristics when combined. A *solution* is a mixture in which one substance dissolves in another. • As its temperature increases, many kinds of matter change from a solid to a liquid to a gas. As its temperature decreases, that matter changes from a gas to a liquid to a solid.	In order to meet this standard, it is expected that students should be able to • construct and interpret models of atoms, elements, molecules, and compounds. • design an investigation to determine how heat affects the states of matter (e.g., water). Include in the design ways information will be recorded, what measures will be made, what instruments will be used, and ways the data will be graphed. • construct and interpret a sequence of models (diagrams) showing the activity of molecules in all three states of matter. • compare and contrast mixtures and solutions, elements and compounds, and atoms and molecules.

Grade Five
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.

Standard 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.

Understanding the Standard

This standard emphasizes the major categories of living things and builds on science standards 2.4 and 4.4. The use of a microscope may be applied to the study of plants, animals, and cells. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.5

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Living things are made of cells. Cells carry out all life processes. New cells come from existing cells. Cells are too small to be seen with the eye alone. By using a microscope, many parts of a cell can be seen. • Though plant and animal cells are similar, they are also different in shape and in some of their parts. Plant cells tend to be rectangular, while animal cells tend to be spherical or at times irregular. • Organisms that share similar characteristics can be organized into groups in order to help understand similarities and differences. • Living things can be categorized into kingdoms: monerans protists, fungi, plants, and animals. • Plants can be categorized as vascular (having special tissues to transport food and water — for example, trees and flowering plants) and nonvascular (not having tissues to transport food and water — for example, moss). Most plants are vascular. • Animals can be categorized as vertebrates (having backbones) or invertebrates (not having backbones).	In order to meet this standard, it is expected that students should be able to • draw, label, and describe the essential structures and functions of plant and animal cells. For plants, include the nucleus, cell wall, cell membrane, vacuole, chloroplasts, and cytoplasm. For animals, include the nucleus, cell membrane, vacuole, and cytoplasm. • design an investigation to make observations of cells. • compare and contrast plant and animal cells and identify their major parts and functions. • compare and contrast the distinguishing characteristics of the kingdoms of organisms. • group organisms into categories, using their characteristics: living things (kingdoms), plants (vascular and nonvascular), and animals (vertebrates or invertebrates). Name and describe two common examples of each group.

Grade Five
Science Strand

Interrelationships in Earth/Space Systems

This strand focuses on student understanding of how Earth systems are connected and how the Earth interacts with other members of the solar system. The topics developed include shadows; relationships between the sun and the 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.7, 1.6, 2.6, 3.7, 4.6, 5.6, and 6.8.

Standard 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).

Understanding the Standard

This standard extends the study of ecosystems to the ocean environment. It focuses on the major descriptive characteristics of oceans. Among the concepts are the geological characteristics of the ocean floor, the physical characteristics of ocean water, and the ecological characteristics of communities of marine organisms. Connections can be made to standards 5.2, 5.3, 5.4, 5.5, and 5.7. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.6

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Oceans cover about 70percent of the surface of the Earth. • Important features of the ocean floor near the continents are the continental shelf, the continental slope, and the continental rise. These areas are covered with thick layers of sediments (sand, mud, rocks). • The depth of the ocean varies. Ocean trenches are very deep, and the continental shelf is relatively shallow. • Ocean water is a complex mixture of gases (air) and dissolved solids (salts, especially sodium chloride). Marine organisms are dependent on dissolved gases for survival. The salinity of ocean water varies in some places depending on rates of evaporation and amount of runoff from nearby land. • The *basic motions* of ocean water are the waves, currents, and tides. • Ocean currents, including the Gulf Stream, are caused by wind patterns and the differences in water densities (due to salinity and temperature differences). Ocean currents affect the mixing of ocean waters. This can affect plant and animal populations. Currents also affect navigation routes. • As the depth of ocean water increases, the temperature decreases, the pressure increases, and the amount of light decreases. These factors influence the type of life forms that are present at a given depth.	In order to meet this standard, it is expected that students should be able to • explain key terminology related to the ocean environment. • create and interpret a model of the ocean floor and label and describe each of the major features. • research and describe the variation in depths associated with ocean features, including the continental shelf, slope, rise, the abyssal plain, and ocean trenches. • design an investigation (including models and simulations) related to physical characteristics of the ocean environment (depth, salinity, formation of waves, and currents, such as the Gulf Stream). • interpret graphical data related to physical characteristics of the ocean. • explain the formation of ocean currents and describe and locate the Gulf Stream. • design an investigation (including models and simulations) related to biologic characteristics of the ocean environment (ecological relationships). • interpret graphical data related to the biological characteristics of the ocean, such as the number of organisms vs. the depth of the water.

Standard 5.6 (continued)

Overview	Essential Knowledge, Skills, and Processes
• Plant-like plankton (phytoplankton) produce much of the Earth's oxygen and serve as the base of the ocean ecosystem. Plankton flourish in areas where nutrient-rich water upwells from the deep. Phytoplankton are eaten by animal-like plankton, swimming organisms, and those things that live on the ocean bottom.	• analyze how the physical characteristics (depth, salinity, and temperature) of the ocean affect where marine organism can live. • create and interpret a model of a basic marine food web, including floating organisms (plankton), swimming organisms, and organisms living on the ocean bottom.

Grade Five
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, and change in the Earth's surface over time. This strand includes science standards K.8, K.9, 1.7, 2.7, 3.8, 3.9, 4.7, and 5.7.

Standard 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.

Understanding the Standard

This standard focuses on the constantly changing nature of the Earth's surface and builds on concepts learned in standards 4.6 and 4.8. Among the important ideas presented in this standard are the rock cycle, fossil evidence of change over time, energy from within the Earth that drives tectonic plate movement, shifting tectonic plates that cause earthquakes and volcanoes, weathering and erosion, and human interaction with the Earth's surface. This standard can be related to several ideas found in science standard 5.6. It is intended that students will actively develop scientific investigation, reasoning, and logic skills (5.1) in the context of the key concepts presented in this standard.

Standard 5.7

Overview	Essential Knowledge, Skills, and Processes
The concepts developed in this standard include the following: • Rocks move and change over time due to heat and pressure within the Earth and to *weathering* and *erosion* at the surface. These and other processes constantly change rock from one type to another. • Rocks have properties that can be observed, tested, and described. Composition, grain size and textural features, color, and the presence of fossils help with identification. Classification keys (5.1) can aid this process. • Depending on how rocks are formed, they are classified as *sedimentary* (layers of sediment cemented together), *igneous* (melted and cooled, e.g., lava and magma), and *metamorphic* (changed by heat and pressure). • Scientific evidence indicates the Earth is very ancient — approximately 4.6 billion years old. The age of many rocks can be determined very reliably. Fossils provide information about life and conditions of the past. • Scientific evidence indicates that the Earth is composed of four concentric layers — crust, mantle, inner core, and outer core — each with its own distinct characteristics. The outer two layers are composed primarily of rocky material. The innermost layers are composed mostly of iron and nickel. Pressure and temperature increase with depth beneath the surface.	In order to meet this standard, it is expected that students should be able to • apply basic terminology (italic print in overview) to explain how the Earth surface is constantly changing. • draw and label the rock cycle and describe the major processes and rock types involved. • compare and contrast the origin of igneous, sedimentary, and metamorphic rocks. • identify rock samples (granite, gneiss, slate, limestone, shale, sandstone, and coal), using a rock classification key. • make plausible inferences about changes in the Earth over time based on fossil evidence. This includes the presence of fossils of organisms in sedimentary rocks of Virginia found in the Appalachians, Piedmont, and Coastal Plain/Tidewater. • describe the structure of Earth in terms of its major layers — crust, mantle, and inner and outer cores — and how the Earth's interior affects the surface. • differentiate among the three types of plate tectonic boundaries (divergent, convergent, and sliding) and how these relate to the changing surface of the Earth and the ocean floor (5.6).

Standard 5.7 (continued)

Overview	Essential Knowledge, Skills, and Processes
• The Earth's heat energy causes movement of material within the Earth. Large continent-size blocks (plates) move slowly about the Earth's surface, driven by that heat. • Most earthquakes and volcanoes are located at the boundary of the plates (faults). Plates can move together (convergent boundaries), apart (divergent boundaries), or slip past each other horizontally (sliding boundaries, also called strike-slip or transform boundaries). • Geological features in the oceans (including trenches and mid-ocean ridges) and on the continents (mountain ranges, including the Appalachian Mountains) are caused by current and past plate movements. • Rocks and other materials on the Earth's surface are constantly being broken down both chemically and physically. The products of weathering include clay, sand, rock fragments, and soluble substances. Weathered rock material can be moved by water and wind and deposited as sediment. • Humans have varying degrees of impact on the Earth's surface through their everyday activities. With careful planning, the impact on the land can be controlled.	• compare and contrast the origin of earthquakes and volcanoes and how they affect the Earth's surface. • design an investigation to locate, chart, and report weathering and erosion at home and on the school grounds. Create a plan to solve erosion problems that may be found. • differentiate between weathering and erosion. • design an investigation to determine the amount and kinds of weathered rock material found in soil. • describe how people change the Earth's surface and how negative changes can be controlled.