

2018 Virginia Science Standards of Learning Curriculum Framework



Board of Education
Commonwealth of Virginia

Copyright © 2019
by the
Virginia Department of Education
P.O. Box 2120
Richmond, Virginia 23218-2120
<http://www.doe.virginia.gov>

All rights reserved. Reproduction of these materials for instructional purposes in public school classrooms in Virginia is permitted.

Superintendent of Public Instruction

James F. Lane, Ed.D.

Assistant Superintendent of Learning

Gena Keller

Office of Science, Technology, Engineering, and Mathematics

Tina Manglicmot, Ed.D., Director
Anne Petersen, Ph.D., Science Coordinator
Joshua Bearman, Science Specialist
Myra Thayer, Science Specialist

NOTICE

The Virginia Department of Education does not discriminate on the basis of race, sex, color, national origin, religion, age, political affiliation, veteran status, or against otherwise qualified persons with disabilities in its programs and activities.

The *2018 Virginia Science Standards of Learning Curriculum Framework* can be found on the Virginia Department of Education's website at http://www.doe.virginia.gov/testing/sol/standards_docs/science/index.shtml.

2018 Virginia Science Standards of Learning Curriculum Framework

Introduction

The *2018 Virginia Science Standards of Learning Curriculum Framework* amplifies the *Science Standards of Learning for Virginia Public Schools* (SOL) and defines the content knowledge, skills, and understandings that provide a foundation in science concepts and practices. The 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 enduring understandings and defining the essential science and engineering practices students need to master. This framework delineates in greater specificity the minimum content requirements that all teachers should teach and all students should learn.

School divisions should use the 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 SOL should be included in quality learning experiences.

The framework serves as a guide for SOL assessment development. Assessment items may not and should not be a verbatim reflection of the information presented in the framework. Students are expected to continue to apply knowledge and skills from the SOL 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 SOL 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 SOL tests, for which students may earn verified units of credit, are administered in a locally determined sequence.

Each topic in the framework is developed around the SOL. The format of the framework facilitates teacher planning by identifying the enduring understandings and the scientific and engineering practices that should be the focus of instruction for each standard. The categories of scientific and engineering practices appear across all grade levels and content areas. Those categories are: asking questions and defining problems; planning and carrying out investigations; interpreting, analyzing, and evaluating data; constructing

and critiquing conclusions and explanations; developing and using models; and obtaining, evaluating, and communicating information. These science and engineering practices are embedded in instruction to support the development and application of science content.

Science and Engineering Practices

Science utilizes observation and experimentation along with existing scientific knowledge, mathematics, and engineering technologies to answer questions about the natural world. Engineering employs existing scientific knowledge, mathematics, and technology to create, design, and develop new devices, objects, or technology to meet the needs of society. By utilizing both scientific and engineering practices in the science classroom, students develop a deeper understanding and competence with techniques at the heart of each discipline.

Engineering Design Practices

Engineering design practices are similar to those used in an inquiry cycle; both use a system of problem solving and testing to come to a conclusion. However, unlike the inquiry cycle in which students ask a question and use the scientific method to answer it, in the engineering and design process, students use existing scientific knowledge to solve a problem. Both include research and experimentation; however, the engineering design process has a goal of solving a societal problem and may have multiple solutions. More information on the engineering and design process can be found at <https://www.eie.org/overview/engineering-design-process>.

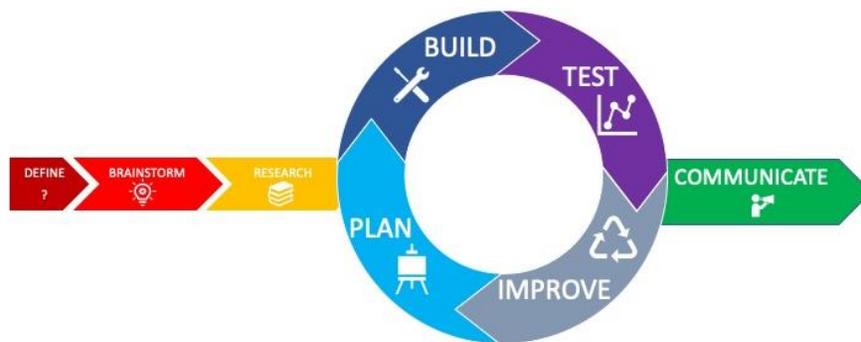


Figure 1: Engineering Design Process image based on the National Aeronautics and Space Administration (NASA) engineering design model.

The Engineering Design Process:

- Define: Define the problem, ask a question
- Imagine: Brainstorm possible solutions
- Research: Research the problem to determine the feasibility of possible solutions
- Plan: Plan a device/model to address the problem or answer the question
- Build: Build a device/model to address the problem or answer the question
- Test: Test the device/model in a series of trials
 - Does the design meet the criteria and constraints defined in the problem?
 - Yes? Go to Share (#8)
 - No? Go to Improve (#7)
- Improve: Using the results of the test, brainstorm improvements to the device/model; return to #3
- Share: Communicate your results to stakeholders and the public

Computational Thinking

The term *computational thinking* is used throughout this framework. Computational thinking is a way of solving problems that involves logically organizing and classifying data and using a series of steps (algorithms). Computational thinking is an integral part of Virginia’s computer science standards and is explained as such in the *Computer Science Standards of Learning*:

Computational thinking is an approach to solving problems that can be implemented with a computer. It involves the use of concepts, such as abstraction, recursion, and iteration, to process and analyze data, and to create real and virtual artifacts. Computational thinking practices such as abstraction, modeling, and decomposition connect with computer science concepts such as algorithms, automation, and data visualization. [Computer Science Teachers Association & Association for Computing Machinery]

Students engage in computational thinking in the science classroom when using both inquiry and the engineering design process. Computational thinking is used in laboratory experiences as students develop and follow procedures to conduct an investigation.

Structure of the 2018 Virginia Science Standards of Learning Curriculum Framework

The framework is divided into two columns: Enduring Understandings and Essential Knowledge and Practices. The purpose of each column is explained below.

Enduring Understandings

The Enduring Understandings highlight the key concepts and the big ideas of science that are applicable to the standard. These key concepts and big ideas build as students advance in their scientific and engineering understanding. The bullets provide the context of those big ideas at that grade or content level.

Essential Knowledge and Practices

Each standard is expanded in the Essential Knowledge and Practices column. What each student should know and be able to do as evidence of understanding of the standard is identified here. This is not meant to be an exhaustive list nor is a list that limits what is taught in the classroom. It is meant to be the key knowledge and practices that define the standard. Science and engineering practices are highlighted with a leaf bullet (see footer).

The *2018 Virginia Science Standards of Learning Curriculum Framework* is informed by the Next Generation Science Standards (<https://www.nextgenscience.org/>).

Grade Four

Our place in the solar system

Our solar system is a grand place, and in fourth grade science, students learn where we fit in this solar system. Starting with the solar system, and then moving to the planet Earth, the Commonwealth of Virginia, and finally their specific ecosystems, students examine how features of plants and animals support life. They also explore how living things interact with both living and nonliving components in their ecosystems. Throughout the elementary years, students will develop scientific skills, supported by mathematics and computational thinking, as they learn science content. In fourth grade, students will continue to develop skills in posing questions and predicting outcomes, planning and conducting simple investigations, collecting and analyzing data, constructing explanations, and communicating information about the natural world. Students continue to use the engineering design process to apply their scientific knowledge to solve problems.

Scientific and Engineering Practices

Engaging in the practices of science and engineering helps students understand how scientific knowledge develops; such direct involvement gives them an appreciation of the many ways to investigate, model, and explain the world. These scientific and engineering practices include the use of scientific skills and processes to explore the content of science as outlined in the *Science Standards of Learning*. The engineering design practices are the application of science content to solve a problem or design an object, tool, process, or system. These scientific and engineering practices are critical to science instruction and are to be embedded throughout the year.

4.1 The student will demonstrate an understanding of scientific and engineering practices by

a) asking questions and defining problems

- **identify scientific and non-scientific questions**
- **develop hypotheses as cause-and-effect relations**
- **define a simple design problem that can be solved through the development of an object, tool, process, or system**

b) planning and carrying out investigations

- **identify variables when planning an investigation**
- **collaboratively plan and conduct investigations**
- **use tools and/or materials to design and/or build a device that solves a specific problem**
- **take metric measurements using appropriate tools**

- measure elapsed time
- c) interpreting, analyzing, and evaluating data
 - organize and represent data in bar graphs and line graphs
 - interpret and analyze data represented in bar graphs and line graphs
 - compare two different representations of the same data (e.g., a set of data displayed on a chart and a graph)
 - analyze data from tests of an object or tool to determine whether it works as intended
- d) constructing and critiquing conclusions and explanations
 - use evidence (i.e., measurements, observations, patterns) to construct or support explanations and to make inferences
- e) developing and using models
 - develop and/or use models to explain natural phenomena
 - identify limitations of models
- f) obtaining, evaluating, and communicating information
 - read and comprehend reading-level-appropriate texts and/or other reliable media
 - communicate scientific information, design ideas, and/or solutions with others

Grade Four Science Content

Living Systems and Processes

- 4.2 The student will investigate and understand that plants and animals have structures that distinguish them from one another and play vital roles in their ability to survive. Key ideas include**
- a) the survival of plants and animals depends on photosynthesis;
 - b) plants and animals have different structures and processes for obtaining energy; and
 - c) plants and animals have different structures and processes for creating offspring.

Central Idea: Plants and animals have different processes and structures that allow them to carry out life processes such as obtaining energy and reproducing.

Vertical Alignment: In third grade, students are introduced to the concept that organisms have both physical features and behaviors that help them to survive in their environment (3.4). The process of photosynthesis is expanded in Life Science to include the energy transfer between sunlight and chlorophyll and the transformation of water and carbon dioxide into sugar and oxygen (LS.4). In

addition, students build on their understanding of how adaptations to the specific biotic and abiotic conditions within their environment make them better able to survive (LS.11).

Enduring Understandings	Essential Knowledge and Processes
<p>Organisms are composed of parts that function as a system to carry out life processes such as obtaining energy and reproducing.</p> <ul style="list-style-type: none"> • Green plants produce their own food through the process of photosynthesis. They use the green pigment, chlorophyll, along with carbon dioxide, water, and sunlight to produce food (sugar). The leaf is the primary food-producing part of these plants. Oxygen is released during photosynthesis (4.2 a, b). • Photosynthesis enables plants to trap energy from the sun and convert it into sugar that can be used by organisms (4.2 a). • Because animals are not capable of producing their own food, they must consume other organisms to meet their energy needs. Animals have different methods that help them get food (4.2 b). • For many green plants, there are anatomical structures that perform basic functions. Roots anchor the plants and take water and nutrients from the soil. Stems provide support and allow movement of water and nutrients. Leaves are the primary sites for photosynthesis. Flowers are the reproductive structures (4.2 b). • For a population to thrive, its members must be able to reproduce (4.2 c). 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> • explain the critical role of photosynthesis in the survival of plants and animals within an ecosystem (4.2 a) • create a model or diagram illustrating the parts of a plant in terms of obtaining energy; explain the role of roots, stems, and leaves (4.2 a, b) • plan and conduct an investigation to determine how the amount of sunlight a plant receives affects plant growth (4.2 b) • compare methods by which plants and animals obtain energy and describe how these processes are related (4.2 b) • compare plant characteristics used for attracting pollinators (4.2 c) • create and explain a model of a flower, illustrating the parts of the flower and its reproductive processes (4.2 c) • understand that for animal populations to survive, the animals must be able to successfully reproduce (4.2 c).

Enduring Understandings	Essential Knowledge and Processes
<ul style="list-style-type: none"> • Most plants reproduce with seeds which are formed in the reproductive process of flowering plants. Pollination is the process by which pollen is transferred from the stamen (male reproductive structure) to the pistil (female reproductive structure). This transfer can occur as a result of wind, water, or animals. Scents and colors of flowers are attractive to certain pollinators (4.2 c). <i>Students are not responsible for naming the male or female reproductive structures of the flower.</i> • Animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction (4.2 c). <i>Students are not responsible for knowing specific reproductive structures or the process of animal reproduction.</i> 	

- 4.3 The student will investigate and understand that organisms, including humans, interact with one another and with the nonliving components in the ecosystem. Key ideas include**
- a) interrelationships exist in populations, communities, and ecosystems;
 - b) food webs show the flow of energy within an ecosystem;
 - c) changes in an organism’s niche and habitat may occur at various stages in its life cycle; and
 - d) classification can be used to identify organisms.

Central Idea: An ecosystem is made up of interacting components that allow for the transfer of matter and energy. Each organism has a specific niche that supports life processes.

Vertical Alignment: Students learn about food chains and the roles that organisms occupy within their community in third grade, which is an introduction to the concept that organisms are part of a system and depend on each other and the nonliving parts of the system (3.5). The concept is expanded in Life Science to include the flow of matter and energy in food webs, the food pyramid, and the interactions that exist among organisms within a population (LS.5, LS.6).



Enduring Understandings	Essential Knowledge and Practices
<p>Ecosystems and their characteristics are the result of complex interactions among Earth’s systems. An ecosystem is an area where living and nonliving things interact. Nonliving factors of an ecosystem include things such as sunlight, water, nutrients, soil, and air (a).</p> <ul style="list-style-type: none"> • All the organisms of the same species that live in the same place at the same time are a population (4.3 a). • The populations of species that live in the same place at the same time together make up a community (4.3 a). <p>The life processes of plants and animals are interdependent and contribute to the flow of energy and cycles of matter within an ecosystem.</p> <ul style="list-style-type: none"> • The interactions and organization within an ecosystem is based on the utilization of the energy from the sun. The greatest amount of energy in an ecosystem is in the producers (4.3 a, b). • The sun’s energy cycles through ecosystems from producers through consumers and back into the nutrient pool through decomposers (4.3 b). • Within a community, organisms are dependent on the survival of other organisms. Energy is passed from one organism to another as modeled in a food chain or food web (4.3 a, b). • A food web illustrates the interconnected and overlapping food chains in an ecosystem. The arrow in a food chain always points to the organism doing the eating. These 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> • analyze and model how populations, communities, and ecosystems interrelate (4.3 a) • research animals and plants in a local environment and describe interrelationships among these organisms (4.3 b) • construct a food web demonstrating the flow of energy through an ecosystem (4.3 b) • illustrate the food webs in a local area (4.3 b) • explain how an organism’s niche may change at different stages in its life cycle (4.3 c) • analyze a food web and explain how changes in one part of the food web would affect other organisms (4.3 c) • compare the niches of several different organisms within the community (4.3 c) • use a simple dichotomous key to classify organisms (4.3 d).

Enduring Understandings	Essential Knowledge and Practices
<p>arrows show the flow of energy within the food chain (4.3 b). <i>Students are not responsible for food pyramids.</i></p> <ul style="list-style-type: none"> • Members of a population interact with other populations in a community. They compete to obtain resources, mates, and territory, and they cooperate to meet basic needs (4.3 c). • A habitat is the place where 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 (4.3 c). • A niche is the function or role that an organism performs in the food web of that community. A niche also includes everything else the organism does and needs in its environment, including what it eats and how it interacts with other organisms and the nonliving factors in its environment. Organisms that share the same need for resources must compete to meet their needs. No two types of organisms occupy the same niche in a community (4.3 c). • During its life cycle, an organism’s role in the community (niche) may change. What an animal eats, what eats it, and other relationships may change. For example, tadpoles live in water, breathe through gills, and generally are herbivores. However, adult frogs live primarily on land, breathe with lungs, and are carnivores (4.3 c). <p>Noticing patterns is a key step to formulating scientific questions. Classification relies on careful observation of patterns, similarities, and differences. Classification is useful in</p>	



Enduring Understandings	Essential Knowledge and Practices
<p>explaining relationships by organizing objects or processes into groups.</p> <ul style="list-style-type: none"> Organisms can be organized into groups to help understand similarities and differences (4.3 d). A dichotomous key is a tool used to classify organisms based on physical characteristics (4.3 d). 	

Earth and Space Systems

4.4 The student will investigate and understand that weather conditions and phenomena affect ecosystems and can be predicted. Key ideas include

- weather measurements create a record that can be used to make weather predictions;**
- common and extreme weather events affect ecosystems; and**
- long-term seasonal weather trends determine the climate of a region.**

Central Idea: Weather conditions and phenomena may have significant impact on ecosystems. The prediction of weather events is possible by tracking weather conditions.

Vertical Alignment: In second grade, students are introduced to weather events and the collection of weather data for identification of weather patterns (2.6, 2.7). The concept is expanded in sixth grade as students investigate the effects of uneven distribution of thermal energy on Earth as it relates to weather and climate (6.7).

Enduring Understandings	Essential Knowledge and Practices
<p>Thermal energy transfer from the sun impacts air movement and weather conditions. Models constructed based on patterns in atmospheric conditions are used to predict weather.</p> <ul style="list-style-type: none"> The analysis of weather data is used to predict weather events which can affect ecosystems. Such impacts include 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> analyze and report data on temperature and precipitation (4.4 a) differentiate among the types of weather associated with high-pressure and low-pressure air masses (4.4 a)

Enduring Understandings	Essential Knowledge and Practices
<p>flooding, droughts, and destruction of habitats. Average weather data over at least 30 years determines a region’s climate. Some weather components that make up climate include average temperature, humidity, wind, and amount of precipitation (4.4 a, b, c).</p> <ul style="list-style-type: none"> • Some components used to describe weather are temperature, atmospheric pressure, wind speed, precipitation, and cloudiness. Data describing these components, along with the knowledge of atmospheric processes, help meteorologists forecast the weather (4.4 a). • Clouds are associated with certain weather conditions (4.4 a). <ul style="list-style-type: none"> ○ Cumulus clouds are fluffy and white with flat bottoms. They usually indicate fair weather. However, when the clouds get larger and darker on the bottom, they become cumulonimbus clouds. Cumulonimbus clouds may produce thunderstorms. ○ Stratus clouds are smooth, gray clouds that cover the whole sky (and 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. High pressure air masses are associated with clear skies and light winds. Low pressure air masses are associated with stormy weather and strong winds. <i>Students are not expected to identify or interpret fronts or pressure systems on a weather map.</i> 	<ul style="list-style-type: none"> • differentiate among cloud types (i.e., cirrus, stratus, cumulus, and cumulonimbus clouds) and the weather associated with each (4.4 a) • use weather instruments (thermometer, barometer, rain gauge, anemometer) and observations of sky conditions to collect, record, and graph weather data over time; analyze results and determine patterns that may be used to make weather predictions (4.4 a) • discuss the importance of monitoring weather data to make weather predictions (4.4 a) • recognize a variety of storm types and the conditions and types of precipitation associated with each; explain when these storms occur (4.4 b) • research and analyze the effects of extreme weather events on the environment (4.4 b) • explain the difference between weather and climate and the effect climate has on an ecosystem (4.4 c).

Enduring Understandings	Essential Knowledge and Practices
<p>The atmosphere is a dynamic system and changes in conditions cause weather phenomena that may affect an ecosystem.</p> <ul style="list-style-type: none"> • On Earth, atmospheric conditions create weather phenomena. Common events include rain, snow, and fog. Extreme events include tornadoes, hurricanes, typhoons, and ice storms (4.4 b). <ul style="list-style-type: none"> ○ Thunderstorms—Warm, humid conditions are very favorable for thunderstorm development. A typical thunderstorm produces a brief period of heavy rain and lasts anywhere from 30 minutes to an hour. Lightning always precedes thunder. ○ Hurricanes—Hurricanes occur over warm, tropical water and have winds equal to or greater than 74 miles per hour. ○ Tornadoes—Most tornadoes form from thunderstorms as the wind changes direction and the air begins to rotate. • Weather is the day-to-day state of the atmosphere for a given area. Climate is the weather of a given area averaged over an extended period of time (years) (4.4 c). 	

4.5 The student will investigate and understand that the planets have characteristics and a specific place in the solar system. Key ideas include

- a) planets rotate on their axes and revolve around the sun;**
- b) planets have characteristics and a specific order in the solar system; and**
- c) the sizes of the sun and planets can be compared to one another.**

Central Idea: Our solar system is composed of planets with unique characteristics, primarily due to their locations within the system. Earth is unique in that its characteristics and location allow for life to exist.

Vertical Alignment: Although students learn characteristics of Earth in lower grades, fourth grade is the first time students are introduced to the planets that make up the solar system. The components and interactions of celestial bodies within the solar system is the focus in sixth grade science (6.2).

Enduring Understandings	Essential Knowledge and Practices
<p>The solar system is a set of interrelated and interdependent elements that are connected through the flow of matter and energy. Characteristics of these elements within the solar system are determined by their composition.</p> <ul style="list-style-type: none"> • 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 the planets revolve around the sun (4.5 a). • 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 (4.5 b, c). <i>Student are not responsible for describing sizes of planets in relation to Earth’s size.</i> <ul style="list-style-type: none"> ○ Mercury is closest to the sun and is a small, heavily cratered planet. Mercury looks like our moon. Mercury is the smallest planet in our solar system and its atmosphere is very thin. ○ Venus is the second planet from the sun. Similar to Earth in size and mass, Venus has a permanent blanket of clouds that traps thermal energy which causes high surface temperatures. ○ Earth is the third planet from the sun. Earth’s atmosphere, its liquid water, and its distance from the sun (among other factors) make Earth ideal for life. 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> ● create a model that demonstrates the differences between rotation and revolution (4.5 a) ● research the planets and communicate basic characteristics of each, including whether each is terrestrial or a gas giant, and its relative location in the solar system (4.5 b) ● construct and interpret a simple model to show the location and order of planets in relation to the sun in our solar system (4.5 b) • compare the relative sizes of the planets to each other as well as to the sun (4.5 c).

Enduring Understandings	Essential Knowledge and Practices
<ul style="list-style-type: none"> ○ Mars is the fourth planet from the sun and is sometimes called <i>the red planet</i>. The atmosphere on Mars is thin. Mars has a vast network of canyons and riverbeds. Mars is roughly half the size of Earth. ○ Jupiter is the fifth planet from the sun, the largest planet in the solar system (eleven times larger than Earth), and it is considered a gas giant. Jupiter has no solid surface. Its colored cloud patterns are caused by enormous storms in its atmosphere. ○ Saturn is the sixth planet from the sun. Early scientists thought Saturn was the only planet with rings, but we now know that all four gas giants (Jupiter, Saturn, Uranus, and Neptune) have rings. Saturn’s atmosphere is similar to that of Jupiter. Saturn is almost ten times the size of Earth. ○ Uranus is the seventh planet from the sun. Uranus is a gas giant and is unique in that it spins on its side. It has a large atmosphere and is a cold planet that is four times the size of Earth. ○ Neptune, a very cold planet, is eighth from the sun. Neptune appears blue because of its atmosphere. It is roughly four times the size of Earth. ● Pluto is no longer included in the list of planets in our solar system due to its small size and irregular orbit (4.5 b). 	

4.6 The student will investigate and understand that there are relationships among Earth, the moon, and the sun. Key relationships include

- a) the motions of Earth, the moon, and the sun;
- b) the causes for Earth’s seasons;
- c) the causes for the four major phases of the moon and the relationship to the tide cycles; and
- d) the relative size, position, age and makeup of Earth, the moon, and the sun.

Central Idea: The relationship of the Earth, moon, and sun in the solar system and to each other lead to seasons, tides, and the phases of the moon.

Vertical Alignment: Students are introduced to the effect of the sun on the temperatures of land, water, and air in first grade (1.6). In sixth grade, students further explore Earth’s unique properties and movements as well as the causes of seasons and the tides (6.3).

Enduring Understandings	Essential Knowledge and Practices
<p>The proximity of the Earth to the sun and moon in our solar system influences Earth systems and enable life to exist on Earth.</p> <ul style="list-style-type: none"> • The interactions and orientations of the sun, Earth, and moon lead to patterns that are evidenced in seasons, eclipses, and the phases of the moon (4.6). • Earth’s axial tilt causes the sun’s rays to hit the Earth’s surface at different angles. More direct rays are more intense, resulting in higher temperatures at those locations (4.6 b). • The phases of the moon are caused by its position relative to the Earth and the sun. The phases of the moon are caused by the reflection of sunlight off the moon’s surface and include the following phases: new, first quarter, full, and last (third) quarter (4.6 c). <i>Students are not responsible for the terms waxing crescent, waxing gibbous, waning gibbous, and waning crescent.</i> • The phases of the moon are responsible for the changes in tidal range. Highest tidal ranges are associated with full and new moons, which are when the Earth, moon and sun are aligned. The smallest tidal ranges are associated with the first and last quarter, when the earth, sun, and moon are at right angles (4.6 c) <i>Students are not responsible for the terms spring and neap tides.</i> 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> • create a model that demonstrates the motions of the moon, sun, and Earth and use it to describe how the main phases of the moon occur (i.e., new moon, first quarter, full moon, and last quarter) (4.6 a, c) • model and describe how the Earth’s rotation results in day and night (a) • model and describe how Earth’s axial tilt and its revolution around the sun causes seasons (4.6 b) • analyze data from simple tide tables to determine a pattern of high and low tides (4.6 c) • analyze simple tide tables and the phases of the moon over time to explain the relationship between the tides and the phases of the moon (4.6 c) • compare the relative size, position, age, and composition of the sun, moon, and Earth (4.6 d).

Enduring Understandings	Essential Knowledge and Practices
<ul style="list-style-type: none"> • The sun is an average-sized yellow star, about 110 times the diameter of Earth. The sun is approximately 4.6 billion years old (4.6 d). • 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, and no atmosphere or water to support life (4.6 d). • Earth’s surface is constantly changing. Unlike the other three inner planets, 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 (4.6 d). 	

- 4.7 The student will investigate and understand that the ocean environment has characteristics. Key characteristics include**
- a) geology of the ocean floor;**
 - b) physical properties and movement of ocean water; and**
 - c) interaction of organisms in the ocean.**

Central Idea: The ocean is a dynamic system that covers most of Earth’s surface; its characteristics are unique and allow it to support a diverse number of organisms.

Vertical Alignment: Students are introduced to the characteristics of aquatic and terrestrial ecosystems, including living and nonliving components, in third grade (3.5). Further exploration of the geological, physical, and biological aspects of the ocean environment is conducted in Earth Science (ES.10).



Enduring Understandings	Essential Knowledge and Practices
<p>Ocean systems are comprised of interacting and interdependent elements that are subject to change in response to inputs and outputs of energy and matter.</p> <ul style="list-style-type: none"> • The ocean’s geological and physical properties affect the interactions among organisms (4.7 a, b, c). • Important features of the ocean floor are the continental shelf, continental slope, continental rise, abyssal plain, and ocean trenches. Most areas are covered with thick layers of sediments (e.g., sand, mud, rocks) (4.7 a). <i>Students are not expected to memorize these features.</i> • The depth of the ocean varies. Ocean trenches are very deep and the continental shelf is relatively shallow (4.7 a). <i>Students do not need to know the zones of the ocean.</i> • Ocean water is a complex mixture of gases, water, and dissolved solids. Marine organisms are dependent on dissolved gases for survival (4.7 b). • Salinity is the measure of all salts dissolved in water. The salinity of ocean water varies in some places, depending on rates of evaporation, the depth of the water, melting icebergs, and amount of runoff from nearby land (4.7 b). • Ocean currents, including the Gulf Stream, are caused by wind patterns and the differences in water due primarily to temperature differences. Ocean currents affect the mixing of ocean waters. This can affect plant and animal populations. Currents also affect navigation routes (4.7 b). <i>Students are not responsible for the term density. Students do not need to classify currents as surface and deep currents.</i> 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> • construct a model of the ocean floor and label and describe each of the major features, including the relative depths of each (4.7 a) • demonstrate and explain how wind causes the formation of currents (4.7 b) • compare the motions of water as related to currents and tides (4.7 b) • construct a model of a basic marine food web, including floating organisms (plankton), swimming organisms, and organisms living on the ocean floor (4.7 c) • interpret diagrams related to the ecological characteristics of the ocean, such as the types of organisms vs. the depth of the water (4.7 c) • research and communicate where organisms live in the ocean and infer reasons they live within those areas (4.7 c).

Enduring Understandings	Essential Knowledge and Practices
<ul style="list-style-type: none"> • In oceans, both plants and floating organisms such as algae serve as producers within a food chain (4.7 c). • Organisms in the ocean environment are grouped according to their movement: floating organisms (e.g., plankton), swimming organisms, and organisms that are non-moving and adhere to surfaces on the ocean floor. These organisms play a role in ocean food chains (4.7 c). 	

Earth Resources

- 4.8 The student will investigate and understand that Virginia has important natural resources. Key resources include**
- a) watersheds and water;
 - b) plants and animals;
 - c) minerals, rocks, and ores; and
 - d) forests, soil, and land.

Central Idea: Virginia has many natural resources, including watersheds, minerals, rocks, ores, soil, land, and forests.

Vertical Alignment: The importance of resources is a consistent theme in all elementary years, with third grade focusing on the importance of water and soil as resources (3.8). In sixth grade, students deepen their understanding of human impact on the environment and learn how individuals can influence public policy decisions related to energy and the environment (6.9).

Enduring Understandings	Essential Knowledge and Practices
<p>Natural resources are necessary or useful to humans. Many natural resources are distributed unevenly around the planet.</p> <ul style="list-style-type: none"> • Virginia has many natural resources. Some examples of Virginia’s natural resources include minerals, plants, animals, water, soil, and land (4.8 a, b, c, d). 	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> • describe characteristics of Virginia’s waterways (including rivers, bays, lakes, and the Atlantic Ocean), name an example of each, and discuss the importance of the waterways to Virginia (4.8 a)

Enduring Understandings	Essential Knowledge and Practices
<ul style="list-style-type: none"> • A watershed is an area of land over which surface water flows to a single collection place. The materials from the watershed, including pollutants, add to the water flow and impact organisms that may serve as a natural resource for humans. The Chesapeake Bay watershed covers approximately half of Virginia’s land area. The other two major watershed systems in Virginia are the Gulf of Mexico and the North Carolina sounds (4.8 a). <i>Students do not need to identify all the major watersheds in Virginia; however, they should be able to identify the watershed in which they live.</i> • Virginia’s water resources include lakes, rivers, bays, and the Atlantic Ocean (4.8 a). • Virginia has a great variety of plant and animal resources. Plants hold soil in place to reduce erosion, which aids in improving water quality. Plants provide food, materials for shelter, habitats, and add oxygen to the air. Animals provide materials such as food, fiber, and leather (4.8 b). • Healthy populations of plants and animals are critical for life (4.8 b). • Minerals, ores, and rocks are considered natural resources and have specific purposes in everyday life (e.g., building materials and fuel sources) (4.8 c). <i>Students do not need to know specific minerals and do not need to differentiate among minerals, ores, and rocks.</i> • Natural and cultivated forests are widespread resources in Virginia. Uses of forests include providing building materials, fuel, and habitats (4.8 d). 	<ul style="list-style-type: none"> • create and interpret a model of a watershed (4.8 a) • use evidence to explain the statement, “We all live downstream.” (4.8 a) • explain the importance of Virginia’s animals and plants to humans (4.8 b) • research a Virginia mineral, ore, and/or rock and communicate its use in everyday applications (4.8 c) • describe a variety of important land uses in Virginia, including natural and cultivated forests (4.8 d) • investigate the school yard or local ecosystem to identify questions, problems, or issues that affect a natural resource in that area and determine a possible solution to an identified problem (4.8 a, b, c, d).

Enduring Understandings	Essential Knowledge and Practices
<ul style="list-style-type: none">• Virginia’s soil and land support a great variety of life and provide space for us to live, work, and play (4.8 d).	