5th Grade

Science Pacing Guide

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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

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 a 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.

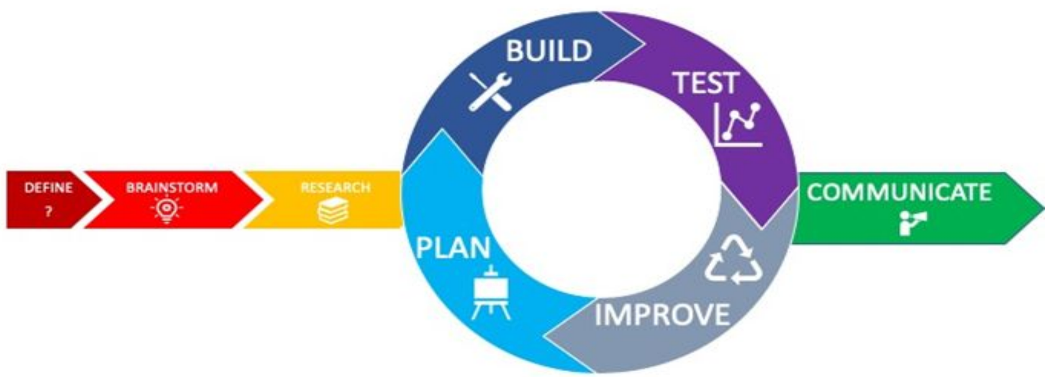

Figure 1: Engineering Design Process image based on the National Aeronautics and Space Administration (NASA) engineering design model.

The Engineering Design Process:

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

Transforming matter and energy

Grade five science delves more deeply into foundational concepts in physical science, and students begin to make connections between energy and matter. Students explore how energy is transformed and learn about electricity, sound, and light. They also learn about the composition of matter and explore how energy can change phases of matter. Students apply an understanding of force, matter, and energy when they explore how the Earth's surface changes. Students continue to develop scientific skills and processes as they pose questions and predict outcomes, plan and conduct investigations, collect and analyze data, construct explanations, and communicate information about the natural world. Mathematics and computational thinking gain importance as students advance in their scientific thinking. 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.

Scientific and Engineering Practices — ALL YEAR
SOL 5.1

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

a) asking questions and defining problems
- ask testable questions based on observations and predict reasonable outcomes based on patterns
- develop hypotheses as cause-and-effect relationship
- define design problems that can be solved through the development of an object, tool, process, or system

b) planning and carrying out investigations
- collaboratively plan and conduct investigations to produce data
- identify independent variable, dependent variables, and constants
- determine data that should be collected to answer a testable question
- take metric measurements using appropriate tools
- use tools and/or materials to design and/or build a device that solves a specific problem

c) interpreting, analyzing, and evaluating data
- represent and analyze data using tables and graphs
- organize simple data sets to reveal patterns that suggest relationships
- compare and contrast data collected by different groups and discuss similarities and differences in their findings
- use data to evaluate and refine design solutions

d) constructing and critiquing conclusions and explanations
- construct and/or support arguments with evidence, data, and/or a model
- describe how scientific ideas apply to design solutions
- generate and compare multiple solutions to problems based on how well they meet the criteria and constraints

e) developing and using models
- develop models using an analogy, example, or abstract representation to describe a scientific principle or design solution
- 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

Review Planets, Sun, and Moon & Oceans — Departmentalized: Weeks 2-5
SOL 4.5, 4.6, & 4.7 — Non-Departmentalized: Weeks 1-2

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
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. • 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). *Student are not responsible for describing sizes of planets in relation to Earth's size.*	In order to meet this standard, it is expected that students will • 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).

SOL 4.5 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
o 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. o 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. o 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. o Mars is the fourth planet from the sun and is sometimes called *the red planet*. The atmosphere on Mars is thin. Mars has a vast network of canyons and riverbeds. Mars is roughly half the size of Earth. o 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. o 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. o 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. o 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
The proximity of the Earth to the sun and moon in our solar system influences Earth systems and enable life to exist on Earth. • 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). *Students are not responsible for the terms* waxing crescent, waxing gibbous, waning gibbous, and waning crescent. • 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) *Students are not responsible for the terms spring and neap tides.*	In order to meet this standard, it is expected that students will 🍃 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).

SOL 4.6 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• 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

Ocean systems are comprised of interacting and interdependent elements that are subject to change in response to inputs and outputs of energy and matter.

- 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). *Students are not expected to memorize these features.*
- The depth of the ocean varies. Ocean trenches are very deep and the continental shelf is relatively shallow (4.7 a). *Students do not need to know the zones of the ocean.*
- Ocean water is a complex mixture of gases, water, and dissolved solids. Marine organisms are dependent on dissolved gases for survival (4.7 b).

Essential Knowledge and Practices

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

- 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).

SOL 4.7 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• 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). *Students are not responsible for the term density. Students do not need to classify currents as surface and deep currents.* • 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).	

5.8 The student will investigate and understand that Earth constantly changes. Key ideas include

a) Earth's internal energy causes movement of material within the Earth;
b) plate tectonics describe movement of the crust;
c) the rock cycle models the transformation of rocks;
d) processes such as weathering, erosion, and deposition change the surface of the Earth; and
e) fossils and geologic patterns provide evidence of Earth's change.

Central Idea: Earth's geosystem is constantly changing; these changes are modeled in the rock cycle and through plate tectonics.

Vertical Alignment: Students describe the importance of Virginia's minerals and ores, including quartz, coal, granite, and limestone in fourth grade (4.8). In sixth grade, students investigate water's role in weathering (6.6).

Enduring Understandings	Essential Knowledge and Practices
A system is a set of interrelated parts that make up a unified whole. The Earth system is composed of interrelated parts to include the atmosphere (air), geosphere (solid Earth), biosphere (organisms), and hydrosphere (water). Systems are seamlessly connected through the flow of matter and energy. • Earth is constantly changing; these changes occur both on and beneath Earth's surface (5.8). • Earth is composed of four concentric layers—the crust, mantle, outer core, and inner 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 (5.8 a). • Earth's thermal energy causes movement of material within Earth. Large continent-size plates move slowly about Earth's surface, driven by that thermal energy (5.8 a).	In order to meet this standard, it is expected that students will • describe the structure of Earth in terms of its major layers: crust, mantle, inner core, and outer core (5.8 a) 🍃 model the movements of plates at tectonic boundaries (divergent, convergent, and transform), explain how the movement of tectonic plates relates to the changing surface of Earth, and describe the benefits and limitations of the models created (5.8 b) • compare the origins of igneous, sedimentary, and metamorphic rocks (5.8 c) • draw and label a simple diagram of the rock cycle and describe the major processes and rock types involved (5.8 c) • compare the formation of igneous, sedimentary, and metamorphic rocks (5.8 c) 🍃 use a dichotomous classification key to identify rocks (5.8 c)

SOL 5.8 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• Most earthquakes and volcanoes are located at the boundaries of the plates *(faults*). Plates can move toward each other *(convergent boundaries*), apart from each other *(divergent boundaries)*, or slip past each other horizontally *(transform boundaries)* (5.8 b). *Students are not expected to use the terminology when demonstrating Earth's movement.* • 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 (5.8 b). • Rocks move and change due to heat and pressure within Earth and due to weathering, erosion, and deposition at the surface. These and other processes constantly change rock from one type to another (5.8 c). • Depending on how rocks are formed, they are classified as *sedimentary* (layers of sediment cemented together), *igneous* (melted and cooled), and *metamorphic* (changed by heat and pressure) (5.8 c). *Students are not responsible for identifying specific examples of sedimentary, metamorphic, or igneous rocks.* • Rocks and other materials on Earth's surface are constantly being broken down by both chemical and physical weathering. The products of weathering include clay, sand, rock fragments, and soluble substances (5.8 d). • Materials can be moved by water and wind *(erosion)* and deposited in new locations as sediment *(deposition)* (5.8 d). • Fossils provide information about life and conditions in the past. Fossils may be found in different rock layers, which allows scientists to infer changes in landscapes (5.8 e).	• make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, or wind (5.8 d) • model weathering, erosion, and deposition and explain the benefits and limitations of the model(s) created (5.8 d) • locate, chart, and report weathering, erosion, and deposition at home or on the school grounds; create and implement a plan to reduce weathering, erosion, and/or deposition problems that may be found and discuss the results of the experiment (5.8 d) • identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time (5.8 e

Force, Motion, & Energy: Forms of Energy
SOL 5.2

Departmentalized: Weeks 11-14
Non-Departmentalized: Weeks 9-12

5.2 The student will investigate and understand that energy can take many forms. Key ideas include

a) energy is the ability to do work or to cause change;
b) there are many different forms of energy;
c) energy can be transformed; and
d) energy is conserved.

Central Idea: Energy can occur in different forms, can be transformed from one form to another, but it cannot be created or destroyed.

Vertical Alignment: Students are introduced to the sun as the source of energy for the water cycle in third grade (3.7). The importance of the sun in the formation of most energy sources, energy transformations, and the conservation of energy is emphasized in sixth grade (6.4, 6.6, 6.9).

Enduring Understandings

Energy is the ability to cause change or do work. Energy can be transferred in various ways and between objects.

- Energy is the ability to cause change and that change can take multiple forms (5.2 a). *Students are not expected to give a precise or complete definition of energy.*
- At the macroscopic level, energy manifests itself in multiple phenomena, such as motion, light, sound, electrical and magnetic fields, and thermal energy (5.2 a).
- Energy cannot be created or destroyed; however, it can transform from one form into another. Energy can take many forms such as thermal, radiant, mechanical, and electrical (5.2 a, b, c, d).
- Energy can be transformed from one form to another to do work. Work, in a scientific sense, is defined as a force acting upon an object, causing that object to move in the direction of the force (5.2 a). *Students are not responsible for calculating work.*
- Energy can be moved from place to place by moving objects, or through sound, light, or electric currents (5.2 b).
- Energy can change forms but cannot be created or destroyed. For example, electrical energy is transformed into thermal energy when a stove is turned on. The electrical energy does not just disappear and thermal energy does not just appear out of nowhere (5.2 c, d).

Essential Knowledge and Practices

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

- recognize examples of energy causing change or doing work (5.2 a)
- compare forms of energy (5.2 b)
- make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents, and through contact between objects (5.2 b)
- describe everyday examples of energy changing forms (5.2 c)
- identify the energy transformations that occur when energy is used to run a device in the home or school (5.2 c)
- apply scientific ideas to design, test, and refine a device that converts energy from one form to another (5.2 c)
- explain that energy is conserved and cannot be created or destroyed; energy can change forms (5.2 d).

5.3 The student will investigate and understand that there is a relationship between force and energy of moving objects. Key ideas include

a) moving objects have kinetic energy;
b) motion is described by an object's direction and speed;
c) changes in motion are related to net force and mass;
d) when objects collide, the contact forces transfer energy and can change objects' motion; and
e) friction is a force that opposes motion.

Central Idea: An object's motion is described by its direction and the speed.

Vertical Alignment: Students learn about net forces and apply forces to demonstrate work done by simple machines in third grade (3.2). In Physical Science, students further explore motion as they learn Newton's laws and deepen their understanding of the relationship between machines and the force required to do work (PS.8).

Enduring Understandings	Essential Knowledge and Practices
Forces between objects can cause a change in motion. When two objects interact, each exerts a force on the other. These forces can transfer energy between objects which can cause changes in their motion. • Moving objects have kinetic energy, which is the energy of motion. The motion of an object is described by its direction and speed (5.3 a). • A change in motion is related to net force and mass (5.3 c). • The net force is the combination of all the forces acting on an object (5.3 b). *Students are not expected to calculate net force.* • Whether an object stays still or moves often depends on the effects of multiple pushes or pulls. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero net force can cause changes in the object's speed or direction of motion (5.3 b). *Students are not expected to calculate net force.*	In order to meet this standard, it is expected that students will • define *kinetic energy* (5.3 a) • describe the motion of an object using both direction and speed (5.3 b) • plan an experiment to collect time and position data for a moving object in a table and line graph and interpret the data to determine if the speed of the object was increasing, decreasing, or remaining the same (5.3 b) • plan and conduct an investigation related to net force and the movement of an object (5.3 c, e)

SOL 5.3 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• When objects collide, the energy from one object transfers to another object. That transfer in energy can change an object's speed and or direction (5.3 a, b, c, d, e). • Motion is described as an object's direction and speed (5.3 b). *Students do not calculate speed until Physical Science.* • Speed describes how fast an object is moving (5.3 b). • Unless acted on by a force, objects in motion tend to stay in motion and objects at rest remain at rest (5.3 c). • A *force* is any push or pull that causes an object to move, stop, or change speed or direction (5.3 c). • With objects of the same mass, the greater the force, the greater the change in motion. The more massive an object, the less effect a given force will have on that object (5.3 c). • Friction is a force that opposes the motion of an object (5.3 e).	• plan and conduct an investigation to test the question, "What is the relationship between motion and mass?" (5.3 c, e) • ask questions and predict outcomes about the changes in motion that occur when objects collide (5.3 d) • interpret data in graphs, charts, and/or diagrams related to force and the motion of objects (5.3 c, d) • plan and conduct an investigation to determine the effect of friction on moving objects (5.3 e).

5.4 The student will investigate and understand that electricity is transmitted and used in daily life. Key ideas include

a) electricity flows easily through conductors but not insulators;
b) electricity flows through closed circuits;
c) static electricity can be generated by rubbing certain materials together;
d) electrical energy can be transformed into radiant, mechanical, and thermal energy; and
e) a current flowing through a wire creates a magnetic field.

Central Idea: Energy can move from one location to another through electrical circuits; this energy can then be transformed into different forms for multiple uses.

Vertical Alignment: Although students have been introduced to the concept of energy in early years, the study of electricity is new in fifth grade. In Physical Science, static and current electricity as well as electromagnets, motors, and generators will be introduced (PS.9).

Enduring Understandings	Essential Knowledge and Practices
The flow of energy as a current through the circuit can be used to do work. The circuit is a system composed of various functioning components. • Electricity is used every day. Humans transform electrical energy into different forms of energy to meet needs (5.4). • Conductors are materials which allow electricity to easily flow through them. Examples of conductors include metals. Insulators are materials that do not allow electricity to flow easily through them. Examples of insulators include rubber, wood, and plastics (5.4 a). • A closed circuit allows electricity to flow within the circuit. If there is an opening in the circuit, electricity will not flow (5.4 b). • A simple circuit consists of a bulb, battery, and wire (5.4 b). *Students are not expected to recognize or build series and parallel circuits.*	In order to meet this standard, it is expected that students will • provide examples of materials that are good electrical conductors and insulators (5.4 a) • differentiate between open and closed electric circuits (5.4 b) 🍃 create a model of a simple circuit and explain how it works (5.4 b) 🍃 create a functioning simple circuit and explain how the circuit works, using appropriate scientific terms (5.4 b) • provide examples of static electricity (5.4 c) 🍃 identify ways to generate static electricity (5.4 c)

SOL 5.4 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• Static electricity is the transfer of negatively charged particles between materials. Common examples of static electricity include lightning, clothes sticking together when coming out of a dryer, and getting a shock when touching a door knob (5.4 c). *Students are not responsible for knowing how static electricity occurs.* • In a lamp, electrical energy is transformed into radiant energy. In a fan, electrical energy is transformed into mechanical energy. In a toaster, electrical energy is transformed into thermal energy (5.4 d). *Students do not need to account for all energy transformations within a system.* • A current flowing through a wire creates a magnetic field. Wrapping a wire around certain iron-bearing metals (e.g., an iron nail) and creating a closed circuit is an example of a simple electromagnet. The strength of an electromagnet is mainly affected by the number of coils, the amount of current, the gauge of the wire, and the iron core (5.4 e).	• illustrate simple energy transformations (electrical to thermal, electrical to radiant, and electrical to mechanical) (5.4 d) • construct a simple electromagnet using a dry cell, wire, nail, or other object containing iron (5.4 e) • plan and conduct an investigation to determine the strength of an electromagnet (5.4 e) • define a problem and design a solution that uses an electromagnet; demonstrate and explain how the electromagnet works (5.4 e).

5.5 The student will investigate and understand that sound can be produced and transmitted. Key ideas include

a) sound is produced when an object or substance vibrates;
b) sound is the transfer of energy;
c) different media transmit sound differently; and
d) sound waves have many uses and applications.

Central Idea: Energy can be transmitted through different media (solids, liquids, gases) in waves. The transfer of energy in waves causes vibrations that can produce sound.

Vertical Alignment: Students are introduced to sound as a vibrating movement of an object in first grade (1.2). In Physical Science, the understanding of sound waves is expanded to include sound wave characteristics and interactions (PS.6).

Enduring Understandings	Essential Knowledge and Practices
Waves transmit energy from one place to another. Sound is produced as these waves cause vibrations as they travel through matter. • Sound is a form of mechanical energy produced and transmitted by vibrating matter. Mechanical energy is the energy an object has due to its motion or position (5.5 a, b). • In sound waves, energy is transferred through the vibration of particles of the medium through which the sound travels (5.5 a). • Sound travels in compression waves and must have a medium through which to travel. Sound also travels in liquids and solids (5.5 a). • Sound travels more quickly through solids than through liquids and gases because the particles of a solid are closer together. Sound travels the slowest through gases because the particles of a gas are farthest apart (5.5 c). • Objects vibrating rapidly have a higher pitch than objects vibrating more slowly (5.5 c). • Musical instruments vibrate to produce sound. There are many different types of musical instruments and each instrument causes vibrations in different ways (5.5 d).	In order to meet this standard, it is expected that students will • explain how sounds are formed (5.5 a, b) • collaboratively plan and conduct an investigation to demonstrate that vibrating materials can produce sound and transmit energy, determine data that should be collected and organized to identify patterns, and communicate findings (5.5 a) • compare sound traveling through a solid and sound traveling through the air (5.5 c) • analyze and explain how different musical instruments produce sound (5.5 d) • design and construct an instrument that produces at least two different pitches; record design changes made based on testing outcomes, and communicate results and challenges (5.5 d) • identify applications of sound in the home and community (5.5 d).

5.6 The student will investigate and understand that visible light has certain characteristics and behaves in predictable ways. Key ideas include

a) visible light is radiant energy that moves in transverse waves;
b) the visible spectrum includes light with different wavelengths;
c) matter influences the path of light; and
d) radiant energy can be transformed into thermal, mechanical, and electrical energy.

Central Idea: Visible light is a form of radiant energy that can be seen and can interact in different ways when it contacts an object.

Vertical Alignment: Students are introduced to the sun as a source of light and warmth in first grade (1.6). In Physical Science, the concept of light is expanded to include the electromagnetic spectrum. Characteristics of light and its interactions are discussed as students build a more sophisticated understanding of technological applications of electromagnetic radiation (PS.7).

Enduring Understandings	Essential Knowledge and Practices
Energy may take different forms, including radiant energy. Radiant energy that can be seen by the human eye is called *visible light*. • The sun produces radiant energy. Many types of radiant energy cannot be seen (5.6 a). *Students do not need to identify the electromagnetic spectrum.* • Light travels in transverse waves and does not need a medium through which to move (5.6 a). • Light waves are characterized by their wavelengths. A *wavelength* is the distance between any two corresponding points on successive waves (usually crest-to-crest or trough-to-trough). The wavelength can be measured from any point on a wave provided it is measured to the same point on the next wave (5.6 b). • *Frequency* is the number of waves passing a given point in a designated time. The greater the frequency, the greater the amount of energy (5.6 b).	In order to meet this standard, it is expected that students will • explain the relationship between energy and visible light (5.6 a) • construct a model of a transverse wave and label a wavelength, crest, and trough (5.6 a) • describe the relationship between wavelength and color of light (5.6 b) • create models illustrating high- and low-energy light waves (5.6 b) • plan and conduct an investigation using water, mirrors, and prisms to explore the reflection and refraction of light (5.6 b, c) • plan and conduct an investigation to determine how different materials interact with light (5.6 c) • compare the reflection and refraction of light (5.6 c) • describe examples of radiant energy transfer in both nature and the manmade world (5.6 d).

SOL 5.6 Continued	
Enduring Understandings	**Essential Knowledge and Practices**
• The visible spectrum has a range of colors that are determined by wavelength. The colors of the spectrum from the longest wavelength to the shortest wavelength are red, orange, yellow, green, blue, and violet (ROYGBV). The sum of these colors is white light (5.6 b). *Students are not responsible for indicating wavelengths associated with color.* • Light travels in straight paths until it hits an object, where it is reflected, refracted, transmitted, and/or absorbed (5.6 c). Examples of refraction, or bending of waves, include o refraction causing a setting sun to look flat o a spoon appearing to bend when immersed in a cup of water o a glass prism dispersing white light into its individual colors as the colors refract at different angles (as visible light exits the prism, it is refracted and separated into the visible spectrum). • Light can be reflected when light bounces off an object. An example of this is light hitting a mirror (5.6 c). • Light passes through some materials easily (transparent materials), through some materials partially (translucent materials), and through some not at all (opaque materials). The relative terms *transparent, translucent*, and *opaque* indicate the amount of light that passes through objects (5.6 c). o Examples of transparent materials include clear glass, clear plastic wrap, water, and air. o Examples of translucent materials include wax paper, frosted glass, thin fabrics, and thin paper. o Examples of opaque materials include metal, wood, and bricks. • Light transfers radiant energy. For example, energy radiated from the sun is transferred to Earth by light. When this light is absorbed, it warms Earth's land, air, and water and facilitates plant growth through the process of photosynthesis. Current technology also transforms light energy into mechanical and electrical energy; an example of this is the use of solar panels to produce electrical power (5.6 d).	

5.7 The student will investigate and understand that matter has properties and interactions. Key ideas include
a) matter is composed of atoms;
b) substances can be mixed together without changes in their physical properties; and
c) energy has an effect on the phases of matter.

Central Idea: *Matter* is defined as anything that has mass and takes up space. Properties of various types of matter determine their uses.

Vertical Alignment: Students are introduced to solutions in third grade as materials interact with water (3.3). In sixth grade, students further develop their understanding of atoms, as they learn about subatomic particles, compounds, and chemical change (6.5).

Enduring Understandings	Essential Knowledge and Practices
Matter consists of atoms that have different properties. These properties determine interactions that can occur among different atoms. Different substances with different properties are suited to different uses. • *Matter* is anything that has mass and takes up space (has volume) (5.7 a). • *Mass* is the amount of matter in an object (5.7 a). *Students are not responsible for explaining the weight or proportion of weight on various planets and moons.* • Matter of any type can be subdivided into particles called *atoms* that are too small to see but can be detected by other means. Examples include blowing up a balloon, compressing air in a syringe, and dissolving sugar in water (5.7 a). *Students are not expected to identify the structure of the atom or subatomic particles.* • Sometimes when two or more substances are combined, they do not lose their identifying characteristics. These substances are called mixtures. Examples of mixtures include soil, concrete, and a mud puddle (5.7 b). • Solutions are a special type of mixture in which one substance is uniformly dissolved in a liquid. Examples include sugar water, salt water, and soda (5.7 b). *Students are not responsible for the terms solubility, solute, and solvent.* • Many kinds of matter change from a solid to a liquid to a gas when undergoing a temperature increase. As temperature decreases, that matter changes from a gas to a liquid to a solid (5.7 c). • Matter does not gain or lose mass during phase changes (5.7 c).	In order to meet this standard, it is expected that students will • make observations and measurements to identify materials based on their properties (5.7) • define *matter* (5.7 a) • construct a simple model to show that matter is composed of atoms and identify the advantages and the limitations of the model (5.7 a) • plan and conduct an experiment to separate two or more types of matter within a mixture (5.7 b) • explain the role of energy in changing the phase of matter of a substance (5.7 c) • measure and graph quantities to demonstrate that, regardless of the type of change that occurs when heating, cooling, or mixing substances, the total mass of matter is unchanged (5.7 c).

Earth Resources
SOL 5.9

Departmentalized: Weeks 28-31
Non-Departmentalized: Weeks 28-29

5.9 The student will investigate and understand that the conservation of energy resources is important. Key ideas include
a) some sources of energy are considered renewable and others are not;
b) individuals and communities have means of conserving both energy and matter; and
c) advances in technology improve the ability to transfer and transform energy.

Central Idea: Some resources are considered renewable and others are not. It is possible to conserve energy.

Vertical Alignment: Students learn about the importance of Virginia's natural resources in fourth grade (4.8). In sixth grade, students will learn how to manage the resources and the cost and benefits of that maintenance (6.9).

Enduring Understandings	Essential Knowledge and Practices
Energy cannot be created or destroyed; however, the availability of certain energy sources differs. Most of the energy used in the United States comes from non-renewable sources. • Energy and fuels that humans use derive from natural sources (5.9 a). • Nonrenewable energy sources are natural resources that cannot be replaced after they are used because they take millions of years to form. Fossil fuels such as petroleum, coal, and natural gas are all nonrenewable energy sources (5.9 a). • Renewable energy sources come from resources that are replaced naturally and can be used again. Wind energy, water behind dams, and sunlight are examples of renewable energy sources (5.9 a). • Energy use affects the environment in many ways. In general, fossil fuels do more harm to the environment than the use of renewable energy sources. Some harmful consequences of energy use include air and water pollution and wildlife and habitat loss (5.9 a). • There are many ways to conserve energy. In the home, actions such as turning off the lights and electronic devices when not in use, taking shorter hot showers, and adjusting the thermostat by a few degrees (higher in summer, lower in winter) will conserve energy. Walking or biking instead of taking the car for short trips also conserves energy (5.9 b). • Advances in technology continually improve our ability to harness and use energy more efficiently (5.9 c).	In order to meet this standard, it is expected that students will • compare energy sources, including their benefits and limitations (5.9 a) • identify the type(s) of energy used in the home or school to power devices and research the origin of the identified energy, including how long it takes to form, and classify it as either a renewable or nonrenewable source (5.9 a) • analyze and interpret data showing human consumption of energy over the last century and infer what might happen if the trend in energy consumption continues (5.9 b) • create and implement a plan to conserve energy in the home or school (5.9 b) • provide examples of current technology that use energy efficiently (5.9 c).