Science

Grade 5

Curriculum Guide

SY 2012-13 through SY 2018-19

Prince William County
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Introduction

The Prince William County Public Schools Science Curriculum is based on the *Science Standards of Learning for Virginia Public Schools* and is further defined by the *Science Standards of Learning* Curriculum Framework. The Science Curriculum provides guidance to teachers as they develop instruction appropriate for their students. It assists teachers as they plan their lessons by identifying essential understandings, skills, and processes students need to master. The curriculum specifically outlines the minimum content that all teachers should teach and all students should learn.

Teachers should use the science curriculum as a resource for developing instruction without limiting the scope of instruction. Additional knowledge and skills that can enrich and enhance students' understanding of the content identified in the curriculum should be included as a part of quality learning experiences.

The Prince William County Science Curriculum reflects the knowledge and skills that students are accountable for on the Science Standards of Learning assessments that are administered in the spring of each school year. Assessment items are not a verbatim reflection of the information presented in the Science Curriculum. Students are expected to continue to apply knowledge and skills from curriculum presented in previous grades as they build scientific expertise.

The design of the Science Curriculum requires that teachers 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 assessments are administered at the end of the year in which instruction takes place. (Students may earn verified units of credit upon successfully meeting expectations on the Standards of Learning assessment and course material.)

Each topic in the Science Curriculum is derived from the Science Standards of Learning. The format of the Science Curriculum facilitates teacher planning by identifying the key questions, concepts, knowledge and skills that should be the focus of instruction for each standard. The curriculum document is divided into three columns: *Curriculum Information, Essential Knowledge, Skills, and Processes/Key Vocabulary,* and *Essential Questions and Understandings*. The purpose of each column is explained below.

Curriculum Information
Each standard reflects what students know and should be able to do. In this column, the unit, SOL Reporting Category and standard are listed. Additionally, because the *Science Standard of Learning for Virginia Public Schools* is scaffolded, Foundational Standards that support the SOL from previous grades are listed.

Essential Knowledge, Skills and Processes; Key Vocabulary
This section delineates the key concepts, ideas and scientific relationships that all students should grasp to demonstrate an understanding of the Standards. This is not meant to be an exhaustive list nor a list that limits what is taught in the classroom. This section is helpful to teachers when planning classroom assessments as it is a guide to the knowledge and skills that define the objective. This section also identifies vocabulary that is critical to mastering the objective of that standard and many times is the first introduction for the student to new concepts and skills. The vocabulary identified is not an exhaustive list of terms that a student will encounter in addressing each standard.

Essential Questions and Understandings
This section includes background information for the teacher. It contains content that may extend the teachers' knowledge of the standard beyond the current grade level. It may also contain definitions of key vocabulary to help facilitate student learning.

Investigate and Understand

Many of the standards in the *Science Standards of Learning* begin with the phrase "Students will investigate and understand." This phrase was chosen to communicate the range of rigorous science skills and knowledge levels embedded in each standard. Limiting a standard to one observable behavior, such as "describe" or "explain," would have narrowed the interpretation of what was intended to be a rich, highly rigorous, and inclusive content standard.

"Investigate" refers to scientific methodology and implies systematic use of the following inquiry skills:

- observing;
- classifying and sequencing;
- communicating;
- measuring;
- predicting;
- hypothesizing;
- inferring;
- defining, controlling, and manipulating variables in experimentation;
- designing, constructing, and interpreting models; and
- interpreting, analyzing, and evaluating data.

"Understand" refers to various levels of knowledge application. In the *Science Standards of Learning*, these knowledge levels include the ability to:

- recall or recognize important information, key definitions, terminology, and facts;
- explain the information in one's own words, comprehend how the information is related to other key facts, and suggest additional interpretations of its meaning or importance;
- apply the facts and principles to new problems or situations, recognizing what information is required for a particular situation, using the information to explain new phenomena, and determining when there are exceptions;
- analyze the underlying details of important facts and principles, recognizing the key relations and patterns that are not always readily visible;
- arrange and combine important facts, principles, and other information to produce a new idea, plan, procedure, or product; and
- make judgments about information in terms of its accuracy, precision, consistency, or effectiveness.

Therefore, the use of "investigate and understand" allows each content standard to become the basis for a broad range of teaching objectives, which the school division will develop and refine to meet the intent of the *Science Standards of Learning*.

Reporting Category	Unit	Objective	Suggested Time Allocation
Scientific Investigation, Reasoning, and Logic	Science Process Skills	**5.1 / Infused** Planning and conducting investigations (using classification keys; estimating and obtaining measurements using correct instrumentation; variables and constants; constructing models; using current applications to reinforce concepts)	Infused throughout the year with content-specific objectives. Skills are reinforced with hands-on activities.
Life Processes and Living Systems	Cells	**5.5** Cell distinguishing characteristics (cell structure/function; classification using physical characteristics, body structures, and behavior; traits for survival)	6 weeks
Force, Motion, Energy, and Matter	Matter	**5.4** Organization of matter (atoms, elements, molecules, compounds); mixtures and solutions; effect of temperature on states; distinguishing properties	4 weeks
	Sound	**5.2** Concepts related to sound (compression waves; transmission; different media; use and application of sound waves)	4 weeks
	Light	**5.3** Visible spectrum; transverse waves; refraction; reflection; transmission through materials	4 weeks
Earth/Space Systems and Cycles	Oceanography	**5.6** Characteristics of the ocean environment (geological, physical, ecological)	6 weeks
	Geology	**5.7** Changes and motions of Earth's surface (rock types and cycle; history and fossil evidence; Earth's interior; plate tectonics; weathering, erosion; human impact)	5 weeks

K – 5 SCOPE AND SEQUENCE: SCIENTIFIC REASONING AND LOGIC STRAND OBJECTIVES

Skill	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Observing	SOL K.1a—basic characteristics or properties of objects are identified by direct observation SOL K.1b—observations are made from multiple positions to achieve different perspectives SOL K.2a-c—five senses, sensory organs, sensory descriptors SOL K.1f, h—observations and predictions are made for an unseen member in a sequence of objects; observations recorded	SOL 1.1a—observe differences in physical properties using senses SOL 1.1b—observations are made from multiple positions to achieve different perspectives SOL 1.1g—questions developed from observations	SOL 2.1a—observations are made and questions formed SOL 2.1c—repeat observations for accuracy SOL 2.1j—conclusions are drawn SOL 2.1k—observations and data communicated with simple bar graphs, pictures, written statements and numbers	SOL 3.1a—make observations and repeat for accuracy	SOL 4.1a—make distinctions among observations, conclusions, inferences, predictions	
Communicating	SOL K.1i—picture graphs are constructed SOL K.1k—objects are described pictorially and verbally	SOL 1.1i—communicate, record, and analyze data and observations with graphs, pictures, statements, numbers	SOL 2.1j—observations and data communicated with simple bar graphs, pictures, written statements and numbers	SOL 3.1h—gather, chart, graph, and analyze data SOL 3.1k—communicate data		SOL 5.1g—collect, record, analyze, and communicate data using appropriate graphical representations and metric measurements
Classifying and Sequencing	SOL K.1c—sequence a set of objects according to size SOL K.1d—separate a set of objects into two groups based on a single physical characteristic	SOL 1.1c—classify objects or events according to characteristics	SOL 2.1d—use two or more characteristics or properties to classify items	SOL 3.1c—classify objects with similar characteristic or properties into two sets and two subsets SOL 3.1d—sequence natural events chronologically	SOL 4.1b—objects or events are classified and arranged according to characteristics or properties	SOL 5.1a—classify rocks, minerals, organisms using various classification keys

Skill	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Measuring	SOL K.1e—nonstandard units to measure the length, mass, and volume of common objects	SOL 1.1e—measure length, mass, volume, and temperature using standard units SOL 1.1d—simple tools to enhance observations	SOL 2.1e, f—take measurements in metric and English units (length, volume, mass, temp.) using the proper tools; time is measured	SOL 3.1e, f—measure volume, length, mass, temperature, time using proper tools and techniques	SOL 4.1c, d—select appropriate instruments to measure length, mass, volume and temperature in metric units; measure time	SOL 5.1c—select appropriate instruments to measure
Inferring		SOL 1.1f—make inferences and conclusions about objects	SOL 2.1b – differentiate observation from personal interpretation	SOL 3.1j—make inferences and conclusions	SOL 4.1a, e—distinctions among observations, conclusions, inferences, predictions	SOL 5.1i—inferences made and conclusions drawn
Predicting	SOL K.1.f—observations and predictions are made for an unseen member in a sequence of objects SOL K.1g—a question is developed and predictions are made from one or more observations	SOL 1.1g—questions developed from observations SOL 1.1h—make predictions based on patterns of observations	SOL 2.1g—conditions that influence a change identified and inferences made	SOL 3.1b—formulate predictions using variety of sources	SOL 4.1e—make predictions and inferences from variety of sources; draw conclusions	SOL 5.1b, c—make estimates and accurate measurements of length, mass, volume in metric units with proper tools; measure time SOL 5.1h—use patterns and extrapolate data to predict, generate simple graphs
Hypothesizing	SOL K.1g— a question is developed and predictions are made from one or more observations			SOL 3.1g—formulate hypotheses	SOL 4.1h—develop hypotheses based on cause/effect relationships	SOL 5.1d—hypotheses formed from testable questions
Using Variables in Experimentation		SOL 1.1j—conduct simple experiments to answer questions			SOL 4.1f,g—identify constants, independent, and dependent variables	SOL 5.1e, f—identify independent and dependent variables and constants

Skill	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Interpreting, Analyzing, and Evaluating Data	SOL K.1j— unusual or unexpected results in an activity are recognized		SOL 2.1h—data collected and recorded and bar graphs constructed using numbered axes SOL 2.1i—recognize unexpected or unusual quantitative data	SOL 3.1i—recognize unexpected or unusual quantitative data	SOL 4.1i-k—collect, record, analyze, and display data on bar and line graphs using metric measurements make predictions from data; recognize contradictory data	SOL 5.1h—use patterns and extrapolate data to predict; construct simple graphs
Designing, Constructing, & Using Models			SOL 2.1l—construct simple physical models to clarify explanations and show relationships	SOL 3.1l—models designed and built	SOL 4.1l—models constructed to clarify explanations or demonstrate relationships	SOL 5.1j—models constructed to clarify explanations, demonstrate relationships and solve needs
Context			SOL 2.1m—current applications used to reinforce science concept	SOL 3.1m—current applications used to reinforce science concept	SOL 4.1m—current applications used to reinforce science concept	SOL 5.1k—current applications used to reinforce science concept

In the PWCS Curriculum, all .1 standards are intended to develop investigative and inquiry skills and an understanding of the nature of science. These standards describe the range of inquiry skills and the level of proficiency in using those skills students should achieve, and the components of the nature of science that should be developed and reinforced in the context of science concepts developed in grades K - 12. **.1 standards do not require a discrete unit be taught on scientific investigation and the nature of science because the skills that make up the standard should be incorporated in all the other grade level science standards.** It is also intended that by participating in activities and experiences that develop these skills, students will achieve a preliminary understanding of scientific inquiry and the nature of science and more fully grasp the content-related concepts.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Science Process Skills (Suggested Time: Infused throughout the year) **SOL Reporting Category** Scientific Investigation, Reasoning, and Logic **Virginia SOL 5.1** The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) items such as rocks, minerals, and organisms are identified using various classification keys; b) estimates are made and accurate measurements of length, mass, volume, and temperature are made in metric units using proper tools; c) estimates are made and accurate measurements of elapsed time are made using proper tools; d) hypotheses are formed from testable questions; e) independent and dependent variables are identified; f) constants in an experimental situation are identified; g) data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements; h) predictions are made using	**The student will** • use classification keys to identify rocks, minerals, and organisms. • select and use the appropriate instruments, including centimeter rulers, meter sticks, graduated cylinders, balances, stopwatches, and thermometers for making basic measurements. • make reasonable estimations of length, mass, volume, and elapsed time. • measure length, mass, volume, and temperature using metric measures. This includes millimeters, centimeters, meters, kilometers, grams, kilograms, milliliters, liters, and degrees Celsius. • use a testable question to form a hypothesis as cause and effect (e.g., "if…, then…") statement. • analyze the variables in a simple experiment and identify the independent and dependent variables, and the constants. • collect, record, analyze, and report data, using charts and tables, and translate numerical data into bar or line graphs. • make predictions based on trends in data. This requires the recognition of patterns and trends and determination of what those trends may represent.	**Essential Questions** • What does a scientific process, or research method, allow us to do? • Can you identify the independent and dependent variables in an experiment? • What tools and units of measure should be used to measure the variables in an experiment? • What are some methods of collecting, recording, and reporting data from an experiment? **Essential Understandings** • The nature of science refers to the foundational concepts that govern the way scientists formulate explanations about the natural world. The nature of science includes the following concepts: a) the natural world is understandable; b) science is based on evidence, both observational and experimental; c) science is a blend of logic and innovation; d) scientific ideas are durable yet subject to change as new data are collected; e) science is a complex social endeavor; and f) scientists try to remain objective and engage in peer review to help avoid bias. In grade five, an emphasis should be placed on concepts a, b, c, d, and e. • Science assumes that the natural world is understandable. Scientific inquiry can provide explanations about nature. This expands students' thinking from just a knowledge of facts to understanding how facts are relevant to everyday life. • Science demands evidence. Scientists develop their ideas based on evidence and they change their ideas when new evidence becomes available or the old evidence is viewed in a different way. • Science uses both logic and innovation. Innovation has always been an important part of science. Scientists draw upon their creativity to visualize how nature works, using analogies, metaphors, and mathematics. • Scientific ideas are durable yet subject to change as new data are collected. The main body of scientific knowledge is very stable and grows by being corrected slowly and having its boundaries extended gradually. Scientists themselves accept the notion that scientific knowledge is always open to improvement and can never be declared absolutely certain. New questions arise, new theories are

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
patterns from data collected, and simple graphical data are generated; i) inferences are made and conclusions are drawn; j) models are constructed to clarify explanations, demonstrate relationships, and solve needs; and k) current applications are used to reinforce science concepts. **Foundational Standards** K.1; K.2; 1.1; 2.1; 3.1; 4.1	• make inferences and draw conclusions. • distinguish between inferences and conclusions. • construct a physical model to clarify an explanation, demonstrate a relationship, or solve a need. **Key Vocabulary** qualitative data quantitative data classification independent variable dependent variable constants control	proposed, new instruments are invented, and new techniques are developed. • Science is a complex social endeavor. It is a complex social process for producing knowledge about the natural world. Scientific knowledge represents the current consensus among scientists as to what is the best explanation for phenomena in the natural world. This consensus does not arise automatically, since scientists with different backgrounds from all over the world may interpret the same data differently. To build a consensus, scientists communicate their findings to other scientists and attempt to replicate one another's findings. In order to model the work of professional scientists, it is essential for fifth-grade students to engage in frequent discussions with peers about their understanding of their investigations. • Systematic investigations require standard measures and consistent and reliable tools. Metric measures are a standard way to make measurements and are recognized around the world. • A classification key is an important tool used to help identify objects and organisms. It consists of a branching set of choices organized in levels, with most levels of the key having two choices. Each level provides more specific descriptors, eventually leading to identification. • A hypothesis is an educated guess/prediction about what will happen based on what you already know and what you have already learned from your research. It must be worded so that it is "testable." The hypothesis can be written as an "If…, then…." statement, such as "If all light is blocked from a plant for two weeks, then the plant will die." • An independent variable is the factor in an experiment that is altered by the experimenter. The independent variable is purposely changed or manipulated. • A dependent variable is the factor in an experiment that changes as a result of the manipulation of the independent variable. • The constants in an experiment are those things that are purposefully kept the same throughout the experiment. • When conducting experiments, data are collected, recorded, analyzed, and communicated using proper graphical representations and metric measurements. • Systematic investigations require organized reporting of data. The way the data are displayed can make it easier to see important patterns, trends, and relationships. Bar graphs and line graphs are useful tools for reporting discrete

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		data and continuous data, respectively. • A scientific prediction is a forecast about what may happen in some future situation. It is based on the application of factual information and principles and recognition of trends and patterns. • Estimation is a useful tool for making approximate measures and giving general descriptions. In order to make reliable estimates, one must have experience using the particular unit. • An inference is a tentative explanation based on background knowledge and available data. • A conclusion is a summary statement based on the results of an investigation. Scientific conclusions are based on verifiable observations (science is empirical). • Scientific modeling is the process of generating abstract, conceptual, graphical and/or mathematical models. It is an approximation or simulation of a real system that omits all but the most essential variables of the system. In order to create a model, a scientist must first make some assumptions about the essential structure and relationships of objects and/or events in the real world. These assumptions are about what is necessary or important to explain the phenomena. • It is important for students to apply the science content that they have learned to current issues and applications.

K-5 SCOPE AND SEQUENCE: LIFE SCIENCE OBJECTIVES

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Cycles/Patterns	SOL K.9a-d—observable patterns in daily life: shapes, growth, routines SOL K.10a, b—natural changes occur over time and can be observed and measured	SOL 1.7a, b—tracking of changes over time (plants, animals, humans)	SOL 2.4a, b—life cycles of plants and animals SOL 2.7a—effects of weather and seasonal changes on the growth of living things	SOL 3.8b, c—plant and animal life cycles in specific environments	SOL 4.5e—plant and animal niches changes during life cycle	
Life Needs	SOL K.6a, b—living and nonliving differences SOL K.7a-d—basic needs and concept of life cycles	SOL 1.4a—plant needs SOL 1.5a—animal needs				
Physical Characteristics / Adaptations of Living Things		SOL 1.4b, c—plant parts and classification by characteristics SOL 1.5b, c—physical characteristics and classification by characteristics		SOL 3.4a, b—animal behavioral, physical adaptations	SOL 4.4a-d—general plant anatomy; plant structures, function; reproduction processes; photosynthesis, adaptations SOL 4.5a-c—plant and animal adaptations	SOL 5.5a-c—cell distinguishing characteristics (cell structure/function; classification using physical characteristics, body structures, and behavior; traits for survival)

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Interrelationships		SOL 1.7b—relationships between daily and seasonal changes	SOL 2.5a-c—living things are a part of a system (interdependence with living and nonliving; habits and how they can change); fossils provide information	SOL 3.5a-c—aquatic and terrestrial food chains; producer/consumer; predator/prey; herbivore/carnivore 3.10a—interdependency of plants and animals	SOL 4.5b-d—organization of populations, communities, ecosystems and interrelationship; food webs, habitats, niches	
Ecosystems			SOL 2.5b—animals home is its habitat and includes adequate food, water, shelter or cover, and space.	SOL 3.6a-d—types of ecosystems (terrestrial, aquatic); concept of population and community; diversity of life, human role in conserving limited resources	SOL 4.5f—human influences on ecosystems	

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Plants (Suggested Time: 6 weeks) **SOL Reporting Category** Life Processes and Living Systems **Virginia SOL 5.5** The student will investigate and understand that organisms are made of one or more cells and have distinguishing characteristics that play a vital role in the organism's ability to survive and thrive in its environment. Key concepts include a) basic cell structures and functions; b) classification of organisms using physical characteristics, body structures, and behavior of the organism; and c) traits of organisms that allow them to survive in their environment. **Foundational Standards** 2.4; 4.4	**The student will** • draw, label, and describe the essential structures and functions of plant and animal cells. For plants, include the nucleus, cell wall, cell membrane, vacuole, chloroplasts, and cytoplasm. For animals, include the nucleus, cell membrane, vacuole, and cytoplasm. • design an investigation to make observations of cells. • compare and contrast plant and animal cells and identify their major parts and functions. • group organisms into categories, using their characteristics: plants (vascular and nonvascular) and animals (vertebrates or invertebrates). Name and describe two common examples of each group. • compare and contrast the distinguishing characteristics of groups of organisms. • identify and explain traits of organisms that allow them to survive in their environment. **Key Vocabulary** cells nucleus cell wall cell membrane vacuole chloroplast	**Essential Questions** • Can you compare and contrast the parts and functions of plant and animal cells? • Can you identify and explain traits of organisms that allow them to survive in their environment? **Essential Understandings** • Living things are made of cells. Cells carry out all life processes. New cells come from existing cells. Cells are too small to be seen with the eye alone. By using a microscope, many parts of a cell can be seen. • Though plant and animal cells are similar, they are also different in shape and in some of their parts. Plant cells tend to be rectangular, while animal cells tend to be spherical or at times irregular. • Organisms that share similar characteristics can be organized into groups in order to help understand similarities and differences. • Plants can be categorized as vascular (having special tissues to transport food and water — for example, trees and flowering plants) and nonvascular (not having tissues to transport food and water — for example, moss, liverworts, and hornworts). Most plants are vascular. • Animals can be categorized as vertebrates (having backbones) or invertebrates (not having backbones).

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	cytoplasm vascular nonvascular vertebrate invertebrate structure function	

K – 5 SCOPE AND SEQUENCE: ENVIRONMENTAL SCIENCE OBJECTIVES

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Conservation	SOL K.11a, b—reuse, recycle, conserve	SOL 1.8c—recycle, reuse, reduce consumption of natural resources		SOL 3.10d—conservation and resource renewal methods		*Environmental concepts for Grade 5 are tested in Oceanography unit in Earth and Space Science Strand (SOL 5.7g)
Energy Sources / Types	SOL K.11c—water, energy conservation			SOL 3.11a-c—energy sources (sun, renewable, nonrenewable	SOL 4.9c—Virginia rocks, minerals, ores, energy sources	
Plant and Animal Resources, VA Watersheds		SOL 1.8a, b—identification of natural resources and factors that affect air and water quality	SOL 2.8a-d—plants as resources: purposes, products, availability, soil erosion	3.10a—interdependency of plants and animals	SOL 4.9a, b, d—Virginia watersheds and water resources, Virginia plants and animals, Virginia forests, soil and land	
Natural and Human Impact; Policy				SOL 3.10b, c—natural events; human influences		

K – 5 SCOPE AND SEQUENCE: PHYSICAL SCIENCE OBJECTIVES

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Matter	SOL K.4a-d—objects can be described (colors, shapes, textures, relative size, weight, position, speed) SOL K.5a-c—water occurs in states; flow is downhill; float/sink	SOL 1.3a-c—materials interact with water (liquids, solids, effect of temperature)	SOL 2.3a-c—distinguishing characteristics of solids, liquids, and gases (measurement of mass/volume of solids and liquids; phase changes with addition or removal of energy)	SOL 3.3a-c—objects are made of one or more materials; physical properties remain the same when reduced in size; visible physical changes are identified		SOL 5.4a-e—organization of matter (atoms, elements, molecules, compounds); mixtures and solutions; effect of temperature on states; distinguishing properties
Force, Motion, and Energy	SOL K.4e—words used to describe relative position	SOL 1.2a, c—motions of objects; pushes/pulls;			SOL 4.2a-d—characteristics and interactions of moving objects (cause of motion; change in motion; friction; kinetic energy)	
Machines				SOL 3.2a-d—purpose, function, and types of simple machines; compound machines; examples of simple and compound machines		
Electricity					SOL 4.3a-f—conductors and insulators; circuits; static electricity; ability to transform electrical energy to other forms and produce heat; historical contributions	

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Magnets	SOL K.3a-b—effects and applications		SOL 2.2a-b—magnets (vocabulary; properties, applications)			
Light and Sound	SOL K.8a-b—basic concepts related to light and shadows (occur naturally; can be produced)	SOL 1.2b—vibrations can cause sound				SOL 5.2a-d—concepts related to sound (compression waves; transmission; different media; use and application of sound waves) SOL 5.3a-e—visible spectrum; transverse waves; refraction; reflection; transmission through materials

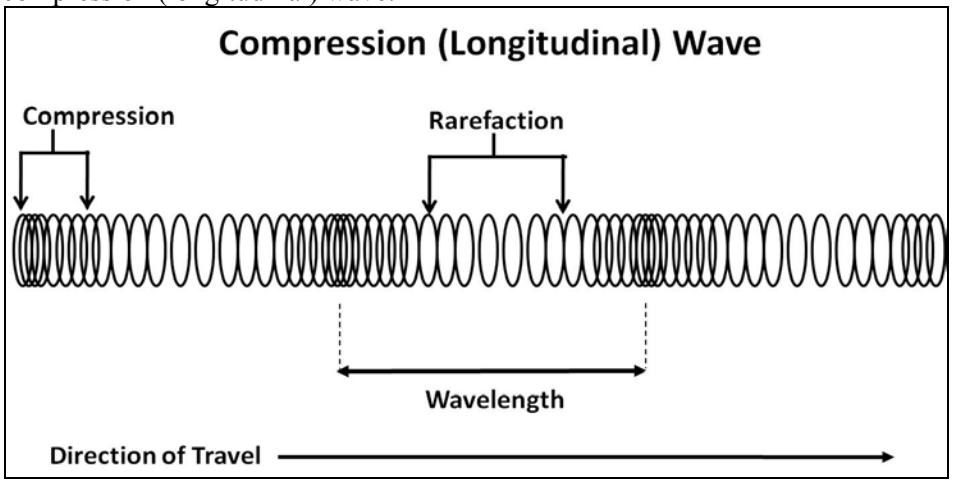
Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Matter (Suggested Time: 4 weeks) **SOL Reporting Category** Force, Motion, Energy, and Matter **Virginia SOL 5.4** The student will investigate and understand that matter is anything that has mass and takes up space; and occurs as a solid, liquid, or gas. Key concepts include a) distinguishing properties of each phase of matter; b) the effect of temperature on the phases of matter; c) atoms and elements; d) molecules and compounds; and e) mixtures including solutions. **Foundational Standards** 3.3	**The student will** • construct and interpret a sequence of models (diagrams) showing the activity of molecules in all three basic phases of matter. • construct and interpret models of atoms and molecules. • identify substances as being an element or a compound. • design an investigation to determine how a change in temperature affects the phases of matter (e.g., water). Include in the design ways information will be recorded, what measures will be made, what instruments will be used, and ways the data will be graphed. • compare and contrast mixtures and solutions. **Key Vocabulary** atom element molecule compound phase mixture solution	**Essential Questions** • What is matter and how is it organized? • Can you compare and contrast mixtures and solutions? • Can you give an example of and explain what is a physical change and a chemical change? • What is the influence of heat on matter? **Essential Understandings** • Matter is anything that has mass and volume. • Mass is the amount of matter in an object. The mass of an object does not change. (Weight of an object changes based on the gravitational pull on it. A person will have the same mass on Earth, Mars, and our moon. However, his or her weight on our moon will be 1/6 of what it is on Earth and will be 1/3 as much on Mars.) • Matter can exist in several distinct forms which are called phases. The three basic phases of matter generally found on Earth are gas, liquid, and solid. (Though other phases of matter have been identified, these are the phases of matter that fifth-grade students are expected to know.)

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings

Characteristics of Gases, Liquids, and Solids		
gas	**liquid**	**solid**
Assumes the shape of its container	Assumes the shape of its container	Retains a fixed shape
Assumes the volume of its container – no definite volume	Has a definite volume	Has a definite volume
Compressible (lots of free space between particles)	Not easily compressible (little free space between particles)	Not easily compressible (little free space between particles)
Flows easily (particles can move past one another)	Flows easily (particles can move/slide past one another)	Does not flow easily (rigid-particles cannot move/slide past one another)

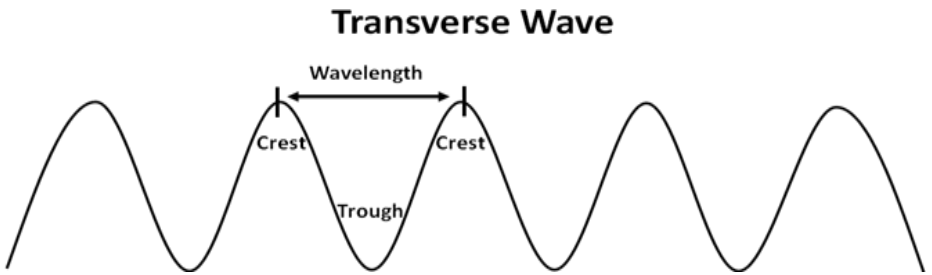
- As its temperature increases, many kinds of matter change from a solid to a liquid to a gas. As its temperature decreases, that matter changes from a gas to a liquid to a solid.
- All matter, regardless of its size, shape, or color, is made of particles (atoms and molecules) that are too small to be seen by the unaided eye.
- There are more than 100 known elements that make up all matter. A few of the more familiar elements include: hydrogen (H), oxygen (O), helium (He), carbon (C), sodium (Na), and potassium (K). The smallest part of an element is an atom.
- A mixture is a combination of two or more substances that do not lose their identifying characteristics when combined. A solution is a mixture in which one substance dissolves in another.
- When two or more elements combine to form a new substance, it is called a compound. There are many different types of compounds because atoms of elements combine in many different ways (and in different whole number ratios) to form different compounds. Examples include water (H_2O) and table

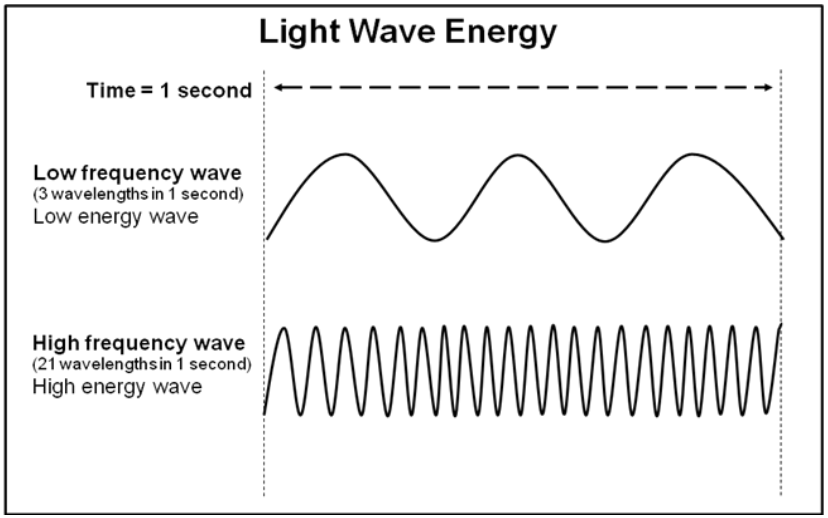
Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		salt (NaCl). The smallest part of a compound is a molecule. • Nanotechnology is the study of materials at the molecular (atomic) scale. Items at this scale are so small they are no longer visible with the naked eye. Nanotechnology has shown that the behavior and properties of some substances at the nanoscale (a nanometer is one-billionth of a meter) contradict how they behave and what their properties are at the visible scale. Many products on the market today are already benefiting from nanotechnology such as sunscreens, scratch-resistant coatings, and medical procedures.

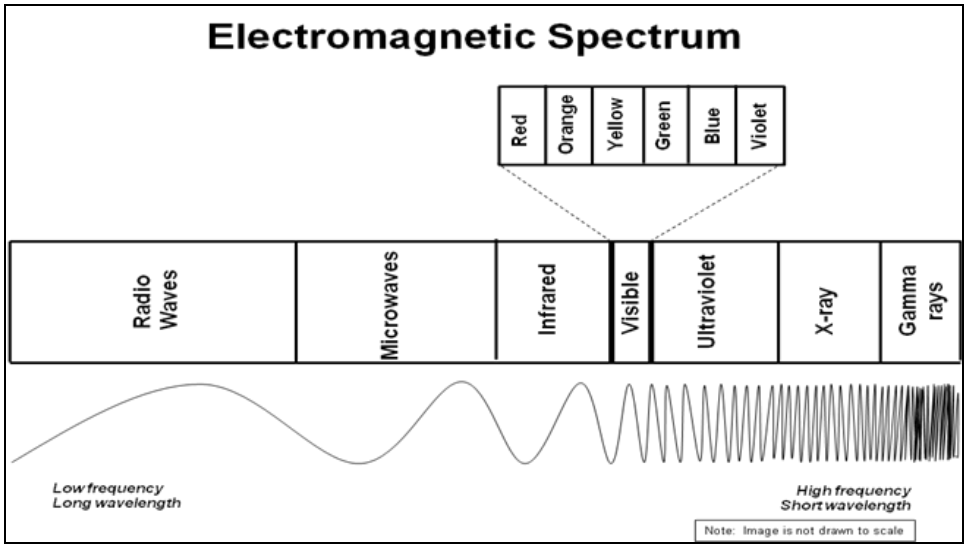
Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Sound (Suggested Time: 4 weeks) **SOL Reporting Category** Force, Motion, Energy, and Matter **Virginia SOL 5.2** The student will investigate and understand how sound is created and transmitted, and how it is used. Key concepts include a) compression waves; b) vibration, compression, wavelength, frequency, amplitude; c) the ability of different media (solids, liquids, and gases) to transmit sound; and d) uses and applications of sound waves. **Foundational Standards**	**The student will** • use the basic terminology of sound to describe what sound is, how it is formed, how it affects matter, and how it travels. • create and interpret a model or diagram of a compression wave. • explain why sound waves travel only where there is matter to transmit them. • explain the relationship between frequency and pitch. • design an investigation to determine what factors affect the pitch of a vibrating object. This includes vibrating strings, rubber bands, beakers/bottles of air and water, tubes (as in wind chimes), and other common materials. • compare and contrast sound traveling through a solid with sound traveling through the air. Explain how different media (solid, liquid, and gas) will affect the transmission of sound. • compare and contrast the sound (voice) that humans make and hear to those of other animals. This includes bats, dogs, and whales. • compare and contrast how different kinds of musical instruments make sound. This includes string instruments, woodwinds, percussion instruments, and brass instruments.	**Essential Questions** • How are sounds produced? • Can you create and interpret a model or diagram of a compression wave? • How do different media affect the transmission of sound? • What is the relationship between frequency and pitch? What is the relationship between amplitude and volume? • How would you modify a musical instrument to change the pitch? **Essential Understandings** • Sound is a form of energy produced and transmitted by vibrating matter. • Sound waves are compression (longitudinal) waves. • When compression (longitudinal) waves move through matter (solid, liquid, or a gas), the molecules of the matter move backward and forward in the direction in which the wave is traveling. As sound waves travel, molecules are pressed together in some parts (compression) and in some parts are spread out (rarefaction). A child's toy in the form of a coil is a good tool to demonstrate a compression (longitudinal) wave.  • The frequency of sound is the number of wavelengths in a given unit of time. • The wavelength of sound is the distance between two compressions or between two rarefactions. The wavelength can be measured from any point on a wave as

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	Key Vocabulary wave frequency pitch wavelength compression amplitude	long as it is measured to the same point on the next wave. • When we talk, sound waves travel in air. Sound also travels in liquids and solids. Sound waves must have a medium through which to travel. In a vacuum sound cannot travel because there is no matter for it to move through. • Pitch is determined by the frequency of a vibrating object. Objects vibrating faster have a higher pitch than objects vibrating slower. A change in frequency of sound waves causes an audible sensation—a difference in pitch. • Amplitude is the amount of energy in a compression (longitudinal) wave and is related to intensity and volume. For example, when a loud sound is heard, it is because many molecules have been vibrated with much force. A soft sound is made with fewer molecules being vibrated with less force. • Sound travels more quickly through solids than through liquids and gases because the molecules of a solid are closer together. Sound travels the slowest through gases because the molecules of a gas are farthest apart. • Some animals make and hear ranges of sound vibrations different from those that humans can make and hear. • Musical instruments vibrate to produce sound. There are many different types of musical instruments and each instrument causes the vibrations in different ways. The most widely accepted way to classify musical instruments is to classify them by the way in which the sound is produced by the instrument. The four basic classifications are percussion instruments (e.g., drums, cymbals), stringed instruments (e.g., violin, piano, guitar), wind instruments (e.g., flute, clarinet, trumpet, trombone), and electronic instruments (e.g., electronic organ, electric guitar).

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Light (Suggested Time: 4 weeks) **SOL Reporting Category** Force, Motion, Energy, and Matter **Virginia SOL 5.3** The student will investigate and understand basic characteristics of visible light and how it behaves. Key concepts include a) transverse waves; b) the visible spectrum; c) opaque, transparent, and translucent; d) reflection of light from reflective surfaces; and e) refraction of light through water and prisms. **Foundational Standards** 4.2	**The student will** • diagram and label a representation of a light wave, including wavelength, crest, and trough. • explain the relationships between wavelength and the color of light. Name the colors of the visible spectrum. • explain the terms transparent, translucent, and opaque, and give an example of each. • compare and contrast reflection and refraction, using water, prisms, and mirrors. • analyze the effects of a prism on white light and describe why this occurs. • explain the relationship between the refraction of light and the formation of a rainbow. **Key Vocabulary** wavelength visible spectrum crest trough reflection refraction transparent translucent opaque transverse waves	**Essential Questions** • Can you create and interpret a model of a transverse wave? • How would you model and explain reflection, refraction, and transmisson? • What is the effect of a prism on white light? • What is the relationship between the color of light and wavelength? **Essential Understandings** • Light has properties of both a wave and a particle. Recent theory identifies light as a small particle, called a photon. A photon moves in a straight line. In both the light wave and photon descriptions, light is energy. • Because light has both electric and magnetic fields, it is referred to as electromagnetic radiation. Light waves move as transverse waves and travel through a vacuum at a speed of approximately 186,000 miles per second (2.99 x 10^8 meters per second). Compared to sound, light travels extremely fast. It takes light from the sun less than 8½ minutes to travel 93 million miles (150 million kilometers) to reach Earth. • Unlike sound, light waves travel in straight paths called rays and do not need a medium through which to move. A ray is the straight line that represents the path of light. A beam is a group of parallel rays. • Light waves are characterized by their wavelengths and the frequency of their wavelengths

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		• The size of a wave is measured as its wavelength, which 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 as long as it is measured to the same point on the next wave.  • Frequency is the number of waves passing a given point every second. The greater the frequency, the greater the amount of energy.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		• Light waves are waves of energy. The amount of energy in a light wave is proportionally related to its frequency: high frequency light has high energy; low frequency light has low energy. The more wavelengths in a light wave in a given period of time, the higher the energy level. Thus gamma rays have the most energy, and radio waves have the least. Of visible light, violet has the most energy and red the least. 

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		• The entire range of electromagnetic radiation (light) is called the electromagnetic spectrum.  • The only difference between the various types of electromagnetic radiation is the amount of energy. Sunlight consists of the entire electromagnetic spectrum. • The wavelengths detectible by the human eye represent only a very small part of the total electromagnetic spectrum. • We see visible light as the colors of the rainbow. Each color has a different wavelength. Red has the longest wavelength and violet has the shortest wavelength. The colors of the visible spectrum from the longest wavelength to the shortest wavelength are: red, orange, yellow, green, blue, and violet (ROYGBV). Most scientists no longer include the color indigo, which used to be included between blue and violet. • Black and white are not spectral colors. Black is when a material absorbs all the visible light and no light is reflected back. Black is a total absence of reflected light. White is a reflection of all visible light together. • Light travels in straight paths until it hits an object, where it bounces off (is reflected), is bent (is refracted), passes through the object (is transmitted),

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		or is absorbed as heat. • The term reflected light refers to light waves that are neither transmitted nor absorbed, but are thrown back from the surface of the medium they encounter. If the surface of the medium contacted by the wave is smooth and polished (e.g., a mirror), each reflected wave will be reflected back at the same angle as the incident wave. The wave that strikes the surface of the medium (e.g., a mirror) is called the incident wave, and the one that bounces back is called the reflected wave. • Refraction means the bending of a wave resulting from a change in its velocity (speed) as it moves from one medium to another (e.g., light moving from the air into water). The frequency of the wave does not change. • The amount of bending of the light wave (refraction) depends on: 1. The density of the material it is entering; 2. The wavelength of the light wave; and 3. The angle at which the original light wave enters the new medium. • Some examples of refraction are when: 1. Refraction causes a setting sun to look flat. 2. A spoon appears to bend when it is immersed in a cup of water. The bending seems to take place at the surface of the water, or exactly at the point where there is a change of density. 3. Shadows on the bottom of a pool are caused because air and water have different densities. 4. A glass prism disperses white light into its individual colors. As visible light exits the prism, it is refracted and separated into a display of colors. • A rainbow is an example of both refraction and reflection. Sunlight is first refracted when it enters the surface of a spherical raindrop, it is then reflected off the back of the raindrop, and once again refracted as it leaves the raindrop. • A prism can be used to refract and disperse visible light. When the different wavelengths of light in visible light pass through a prism, they are bent at different angles (refracted). Dispersion occurs when we see the light separated into a display of colors: ROYGBV. • Dispersion is the separation of light. Dispersion occurs with transparent

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
		surfaces that are not parallel to each other, such as a prism or gemstone facets. • 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 an object. 1. Examples of transparent materials include clear glass, clear plastic food wrap, clean water, and air. 2. Examples of translucent materials include wax paper, frosted glass, thin fabrics, some plastics, and thin paper. 3. Examples of opaque materials include metal, wood, bricks, aluminum foil, and thick paper.

K – 5 SCOPE AND SEQUENCE: EARTH AND SPACE SCIENCE OBJECTIVES

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Weather	SOL K.9a—weather observations can be noted	SOL 1.7a-c—temperature, light, and precipitation changes; daily seasonal relationships; observations recorded over time	SOL 2.6a-c—types and patterns of weather (common storms and weather phenomena; uses and importance of measuring devices and recording and interpreting weather data; measuring and tracking data over time)	SOL 3.9a-d—water cycle (sources, origin of energy to drive cycle; processes involved in the water cycle); importance of water; water conservation	SOL 4.6a-c—weather conditions, phenomena, measurement, tools, predictions	
Solar System; Earth-Moon-Sun Relationships		SOL 1.6 a, b—basic relationships between E/S (sun is source of heat and light; sun's relative position morning/east and afternoon/west)		SOL 3.8a—sequences and patterns (night/day, seasonal changes, simple phases of the moon and tides)	SOL 4.7a-c—organization of solar system (planets, order, size) SOL 4.8a-d—relationships among E/M/S (motions; causes of seasons and phases of the moon; size, position, age, and makeup of E/M/S) SOL 4.8e—historical contributions to understanding of E/M/S	
Oceanography						SOL 5.6a-c—characteristics of the ocean environment (geological, physical, ecological)

Concept	Kindergarten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Earth's Surface Motions and Changes (Geology)						SOL 5.7a-g—changes and motions of Earth's surface (rock types and cycle; history and fossil evidence; Earth's interior; plate tectonics; weathering, erosion; human impact)
Soil			SOL 2.7b—weathering and erosion	SOL 3.7a-d—basic concepts related to soil		

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Oceanography (Suggested Time: 6 weeks) **SOL Reporting Category** Earth/Space Systems and Cycles **Virginia SOL 5.6** The student will investigate and understand characteristics of the ocean environment. Key concepts include a) geological characteristics; b) physical characteristics; and c) ecological characteristics. **Foundational Standards** 5.2; 5.3; 5.4; 5.5	**The student will** • create and interpret a model of the ocean floor and label and describe each of the major features. • research and describe the variation in depths associated with ocean features, including the continental shelf, slope, rise, the abyssal plain, and ocean trenches. • design an investigation (including models and simulations) related to physical characteristics of the ocean environment (depth, salinity, formation of waves, causes of tides, and currents, such as the Gulf Stream). • interpret graphical data related to physical characteristics of the ocean. • explain the formation of ocean currents and describe and locate the Gulf Stream. • design an investigation (including models and simulations) related to ecological relationships of the ocean environment. • interpret graphical data related to the ecological characteristics of the ocean, such as the number of organisms vs. the depth of the water. • analyze how the physical characteristics (depth, salinity, and temperature) of the ocean affect where marine organism can live.	**Essential Questions** • What are the geological characteristics of the ocean floor? • What are the physical characteristics of the ocean water? • What are the ecological characteristics of the communities of marine organisms? • How do physical characteristics of ocean water affect marine organisms? **Essential Understandings** • Oceans cover about 70 percent of the surface of Earth. • Important features of the ocean floor near the continents are the continental shelf, the continental slope, and the continental rise. These areas are covered with thick layers of sediments (sand, mud, rocks). • The depth of the ocean varies. Ocean trenches are very deep, and the continental shelf is relatively shallow. • Ocean water is a complex mixture of gases (air) and dissolved solids (salts, especially sodium chloride). Marine organisms are dependent on dissolved gases for survival. The salinity of ocean water varies in some places depending on rates of evaporation and amount of runoff from nearby land. • The basic motions of ocean water are the waves, currents, and tides. • Ocean currents, including the Gulf Stream, are caused by wind patterns and the differences in water densities (due to salinity and temperature differences). Ocean currents affect the mixing of ocean waters. This can affect plant and animal populations. Currents also affect navigation routes. • As the depth of ocean water increases, the temperature decreases, the pressure increases, and the amount of light decreases. These factors influence the type of life forms that are present at a given depth. • Plankton are tiny free-floating organisms that live in water. Plankton may be animal-like or plant-like. Animal-like plankton are called zooplankton. Plant-like plankton (phytoplankton) carry out most of the photosynthesis on Earth. Therefore, they provide much of Earth's oxygen. Phytoplankton form the base of the ocean food web. Plankton flourish in areas where nutrient-rich water upwells from the deep.

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	• create and interpret a model of a basic marine food web, including floating organisms (plankton), swimming organisms, and organisms living on the ocean floor. **<u>Key Vocabulary</u>** ocean continental shelf continental slope continental rise sediment trenches abyssal plain depth salinity current tides	

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
Unit Geology (Suggested Time: 5 weeks) **SOL Reporting Category** Earth/Space Systems and Cycles **Virginia SOL 5.7** The student will investigate and understand how Earth's surface is constantly changing. Key concepts include a) identification of rock types; b) the rock cycle and how transformations between rocks occur; c) Earth history and fossil evidence; d) the basic structure of Earth's interior; e) changes in Earth's crust due to plate tectonics; f) weathering, erosion, and deposition; and g) human impact. **Foundational Standards** 4.6; 4.8; 5.6	**The student will** • apply basic terminology to explain how Earth's surface is constantly changing. • draw and label the rock cycle and describe the major processes and rock types involved. • compare and contrast the origin of igneous, sedimentary, and metamorphic rocks. • identify rock samples (granite, gneiss, slate, limestone, shale, sandstone, and coal), using a rock classification key. • make plausible inferences about changes in Earth over time based on fossil evidence. This includes the presence of fossils of organisms in sedimentary rocks of Virginia found in the Appalachian Mountains, Piedmont, and Coastal Plain/Tidewater. • describe the structure of Earth in terms of its major layers — crust, mantle, and outer core and inner core — and how Earth's interior affects the surface. • differentiate among the three types of plate tectonic boundaries (divergent, convergent, and transform) and how these relate to the changing surface of Earth and the ocean floor (5.6). • compare and contrast the origin of earthquakes and volcanoes and how	**Essential Questions** • Can you analyze how different types of rocks change during the rock cycle? • What evidence do fossils give us about change over time? • Can you describe the effect of plate tectonics on changes to the Earth's surface and the ocean floor? • What is the relationship between weathering and erosion? • Can you identify and describe the layers of the Earth? • How would you analyze the impact of humans on Earth? **Essential Understandings** • Rocks have properties that can be observed, tested, and described. Composition, grain size and textural features, color, and the presence of fossils help with identification. Classification keys (5.1) can aid this process. • Rocks move and change over time 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. • Depending on how rocks are formed, they are classified as sedimentary (layers of sediment cemented together), igneous (melted and cooled, e.g., lava and magma), and metamorphic (changed by heat and pressure). • Scientific evidence indicates Earth is ancient — approximately 4.6 billion years old. The age of many rocks can be determined very reliably. Fossils provide information about life and conditions of the past. • Scientific evidence indicates that Earth is composed of four concentric layers — 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. • Earth's thermal energy causes movement of material within Earth. Large continent-size blocks (plates) move slowly about Earth's surface, driven by that thermal energy. • Most earthquakes and volcanoes are located at the boundaries of the plates (faults). Plates can move together (convergent boundaries), apart (divergent boundaries), or slip past each other horizontally (transform boundaries, also

Curriculum Information	Essential Knowledge, Skills, and Processes; Key Vocabulary	Essential Questions and Understandings
	they affect Earth's surface. • differentiate between weathering, erosion, and deposition. • design an investigation to locate, chart, and report weathering, • erosion, and deposition at home and on the school grounds. Create a plan to solve erosion and/or deposition problems that may be found. • describe how people change Earth's surface and how negative changes can be controlled. **Key Vocabulary** weathering deposition fault igneous rock sedimentary rock metamorphic rock plate tectonics divergent boundaries convergent boundaries transform boundaries Earth's layers (crust, mantle, outer core, inner core) erosion	called strike-slip or sliding boundaries). • Geological features in the oceans (including trenches and mid-ocean ridges) and on the continents (mountain ranges, including the Appalachian Mountains) are caused by current and past plate movements. • Rocks and other materials on Earth's surface are constantly being broken down both chemically and physically. The products of weathering include clay, sand, rock fragments, and soluble substances. • Materials can be moved by water and wind (eroded) and deposited in new locations as sediment (deposition). • Humans have varying degrees of impact on Earth's surface through their everyday activities. With careful planning, the impact on the land can be controlled.