DINWIDDIE COUNTY Public Schools

Earth Science

Science Curriculum Guide

Dinwiddie County Public Schools provides each student the opportunity to become a productive citizen, engaging the entire community in the educational needs of our children.

Earth Science Curriculum Guide

- The DCPS Curriculum Guide contains key concepts and SOL numbers for each week. These skill areas must be cross referenced with the DOE Enhanced Scope and Sequence and DOE Curriculum Framework.
- Grade Level(s): 9
- Prerequisite:
- Course Description: Students work individually, in groups, and as a class on activities that model or duplicate processes on Earth. The course deals with such topics as man's effect on the earth, the structure of matter, forces, fields, energy, topographic maps, earth motions, the seasons, time, the water cycle, the rock cycle (including weathering and erosion), the formation of sedimentary, igneous, and metamorphic rocks, mountain building, movement of the earth's crust, the geological time scale, meteorology (including clouds, weather instruments, fronts), oceanography, astronomy, and geology (volcanoes, earthquakes, plate tectonics).

Virginia Department of Education Curriculum Frameworks

Virginia Department of Education Curriculum Guides

Unit	Approximate Number of Days Taught	Topic	Targeted SOL
Scientific Investigation	6	**<u>Scientific Investigation and the Nature of Science</u>** ● Introduction to the Branches of Earth Science ● Technology ● Scientific Method/Graphs/Data ● Metric System/Instruments ● Matter/Density	ES. 1 a, c, e, f ES. 2 a, b, c, d
Meteorology	8	**<u>Earth and Space Systems</u>** ● Atmosphere ● Weather ● Climate	ES. 11 a, b, c, d ES. 12 a, b, c, d
Plate Tectonics	6	**<u>Earth Materials and Processes</u>** ● Plate Tectonics ● Earthquakes ● Volcanoes	ES. 7 a, b
Rocks & Minerals	5	**<u>Earth Materials and Processes</u>** ● Minerals ● Nonrenewable/Renewable Resources ● Rocks/Rock Cycle	ES. 4 a, b ES. 5 a, b, c ES. 6 a, b, c, d

Weathering & Erosion	11	**<u>Earth Materials and Processes</u>** **<u>Earth Resources and Human Interactions</u>** ● Weathering and Soils ● Groundwater and Freshwater ● Erosion and Deposition	ES. 8 a, b, c, d, e, f
Geologic Time	7	**<u>Cosmology, Origins and Time</u>** ● Clues to the Past ● Geologic Time	ES. 9 a, b, c, d
Oceanography	6	**<u>Earth and Space Systems</u>** **<u>Cosmology, Origins and Time</u>** ● Oceanography ● Ocean Motion	ES. 10 a, b, c, d, e
Astronomy	10	**<u>Earth and Space Systems</u>** ● Solar System ● Stars and Galaxies ● The Sun-Earth-Moon System ● Space Exploration	ES. 3 a, b, c, d ES. 13 a, b
Geology of Virginia	9	**<u>Earth Materials and Processes</u>** ● Physiographic Regions ● Topography ● Maps ● Rivers and Watersheds ● Virginia Resources ● Virginia Geologic Time	ES. 4 b ES. 6 c ES. 8 f ES. 9 d ES. 10 e

Curriculum Information	Essential Knowledge and Skills Key Vocabulary	Essential Questions and Understandings Teacher Notes and Elaborations
SOL Reporting Category **Scientific Investigation and the Nature of Science** Topic **Introduction to Earth Science** **Virginia SOL ES.1** The student will plan and conduct investigations in which a) volume, area, mass, elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools; b) technologies, including computers, probeware, and geospatial technologies, are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions; c) scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted;	**Cognitive Level (Bloom's Taxonomy, Revised)** • Interpret geospatial technological evidence to identify qualitative data. • Describe the interactions of complex Earth systems. • Analyze or select evidence that best supports scientific theory. • Apply knowledge of latitude and longitude to determine locations on Earth. • Analyze the variables and constants in a scientific investigation. • Interpret data from calculations. • Utilize observations to support explanations of scientific phenomena. • Evaluate scientific evidence required to support hypotheses and explanations. • Analyze and interpret scientific information to form scientific conclusions. • Record data in systematic, properly-labeled, multicell tables, and using data, construct and interpret continuous line graphs, frequency distributions, bar graphs, and other explicating graphics that present a range of parameters, relationships, and pathways. • Interpret data from a graph or table that shows changes in temperature or pressure with depth or altitude. • Apply the concept of mass per unit volume and calculate density without being given a formula. • Measure mass and volume of regular and irregular shaped objects and materials using common laboratory tools, including metric scales and graduated cylinders. **Key Vocabulary** **Astronomy** — **Oceanography** **Bar Graph** — **Pictograph** **Circle (Pie) Graph** — **Scale** **Constant** — **Scientific Law** **Control** — **Scientific Theory**	**Essential Questions** • How can mass, volume, and density of various objects be determined by common laboratory experiments? • How can information be collected, organized, and communicated from experimentation? • How can information be collected and organized through experimentation then presented visually through the use of graphs? • How is the coordinate system of latitude and longitude used to determine map locations? • How can scale, distance, slope, relief, and profiles be determined from analyzing topographic maps? **Essential Understandings** • Density expresses the relationship between mass and volume. • Information and data collected can be organized and expressed in the form of charts, graphs, and diagrams. • Scale relates to actual distance. • Grid systems of latitude and longitude are used to define locations and directions on maps, globes, and charts. • 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 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. • Earth is a dynamic system, and all atmospheric, lithospheric, and hydrospheric processes interrelate and influence one another. • A hypothesis is a tentative explanation that accounts for a set of facts and can be tested by further investigation. Only hypotheses that are testable are valid. A hypothesis can be supported, modified, or rejected based on collected data. Experiments are designed to test hypotheses. • Scientific theories are systematic sets of concepts that offer explanations for observed patterns in nature. Theories provide frameworks for relating data and guiding future research. Theories may change as new data become available. Any valid scientific theory has passed tests designed to invalidate it. • There can be more than one scientific explanation for phenomena. However, with competing explanations, generally one idea will eventually supersede the other as new tools, new observations, and verified data become available. • Changing relevant variables will generally change the outcome. • Scientific laws are generalizations of observational data that describe patterns and relationships. Laws may change as new data become available.

d) maps and globes are read and interpreted, including location by latitude and longitude;
e) variables are manipulated with repeated trials; and
f) current applications are used to reinforce Earth science concepts.

Virginia SOL ES.2

The student will demonstrate an understanding of the nature of science and scientific reasoning and logic. Key concepts include

a) science explains and predicts the interactions and dynamics of complex Earth systems;
b) evidence is required to evaluate hypotheses and explanations;
c) observation and logic are essential for reaching a conclusion; and
d) evidence is evaluated for scientific theories.

Data Table	Triple Beam Balance
Density	Volume
Dependent variable	Water Displacement
Geology	
Graduated Cylinder	
Graph	
Hypothesis	
Independent variable	
Latitude	
Line Graph	
Longitude	
Mass	
Meteorology	

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com

Supplies

World Map
Virginia Map
Graduated Cylinder
Triple Beam Balance
Rock
Wooden block
Ruler

SOL Reporting Category

Earth and Space Systems

Topic

Atmosphere, Weather, Climate

Virginia SOL ES.11

The student will investigate and understand the origin and evolution of the atmosphere and the interrelationship of geologic processes, biologic processes, and human activities on its composition and dynamics. Key concepts include

a) scientific evidence for atmospheric composition changes over geologic time;
b) current theories related to the effects of early life on the chemical makeup of the atmosphere;
c) atmospheric regulation mechanisms including the effects of density differences and energy transfer; and
d) potential changes to

Cognitive Level (Bloom's Taxonomy, Revised)

- **Analyze the array of climate feedback mechanisms that control the Earth's temperature over time, and compare and contrast these feedback mechanisms to those operating on inner planets and the gas giants.**
- **Analyze the evidence for atmospheric compositional change over geologic time including oxygen and carbon sinks and the role of photosynthetic organisms.**
- **Explain how volcanic activity or meteor impacts could affect the atmosphere and life on Earth.**
- **Explain how biologic activity, including human activities, may influence global temperature and climate.**
- **Identify and describe the direction of local winds (land, sea breezes and jet stream).**
- **Read and interpret data from a thermometer, a barometer, and a psychrometer.**
- **Predict weather based on cloud type, temperature, and barometric pressure.**
- **Read and interpret a weather map containing fronts, isobars, and isotherms.**
- **Read and interpret weather station models.**
- **Identify types and origins of air masses, fronts and the accompanying weather conditions.**
- **Read and interpret climate**

Essential Questions

- **What are various weather instruments and how can they used in weather prediction?**
- **What are the conditions necessary for cloud formation?**
- **How do high and low pressure systems with associated fronts bring about changes in weather?**
- **How do latitude, elevation, topography (proximity to mountains), proximity to an ocean, and prevailing winds influence climate?**
- **How is the cyclonic motion seen in storms associated with severe weather?**
- **How do uneven heat distribution and the Coriolis Effect influence local and global wind patterns?**
- **What is the structure and composition of Earth's atmospheric layers?**
- **How have human activities and natural events continued to bring about chemical changes in the atmosphere?**
- **What changes occur as carbon dioxide levels and ozone levels increase in the atmosphere?**

Essential Understandings

- **The composition of Earth's atmosphere has changed over geologic time. Earth's atmosphere is unique in the solar system in that it contains substantial oxygen.**
- **The most primitive atmosphere was comprised of mainly helium and hydrogen. After the moon was formed, the early atmosphere contained mostly CO_2, CO, and water vapor. This atmosphere was then modified by early photosynthetic life.**
- **Early photosynthetic life such as cyanobacteria (blue-green algae) consumed carbon dioxide and generated oxygen. It was only after early photosynthetic life generated oxygen that animal life became possible.**
- **Earth's atmosphere is 21 percent oxygen, 78 percent nitrogen, and 1 percent trace gases. The composition of the atmosphere can change due to human, biologic, and geologic activity. Human activities have increased the carbon dioxide content of the atmosphere. Man-made chemicals have decreased the ozone concentration in the upper atmosphere. Volcanic activity and meteorite impacts can inject large quantities of dust and gases into the atmosphere.**
- **The ability of Earth's atmosphere to absorb and retain heat is affected by the presence of gases like water vapor and carbon dioxide.**
- **Energy transfer between Earth's surface and the atmosphere creates the weather.**
- **Weather and climate are different. Both weather and climate are measurable and, to a certain extent, predictable. Weather describes day-to-day changes in atmospheric conditions. Climate describes the typical weather patterns for a given location over a period of many years. Instrumentation is used to collect weather and climate data.**
- **The four major factors affecting climate are latitude, elevation, proximity to bodies of water, and position relative to mountains. Earth's major climatic zones are the polar, temperate, and tropical zones. Areas near the equator receive more of the sun's energy per unit area than areas nearer the poles.**

the atmosphere and climate due to human, biologic, and geologic activity.

Virginia SOL ES.12

The student will investigate and understand that energy transfer between the sun and Earth and its atmosphere drives weather and climate on Earth. Key concepts include

a) observation and collection of weather data;
b) prediction of weather patterns;
c) severe weather occurrences, such as tornadoes, hurricanes, and major storms; and
d) weather phenomena and the factors that affect climate including radiation, conduction, and convection.

graphs.

- **Label a diagram of global climate zones and the surface movement of ocean currents.**
- **Label a diagram that demonstrates the interaction of Earth's atmosphere and energy transfer (conduction, convection, and radiation).**
- **Analyze the impact of satellite technology on weather prediction and the tracking of severe storms, including hurricanes, and evaluate the cost and benefits of this technology in terms of lives and property saved. Predict the impact on storm preparedness if there were no weather satellites.**

Key Vocabulary

Adaptation	**Air mass**
Air pressure	**Altitude**
Biome	**Blizzard**
Chlorofluorocarbons (CFCs)	**Climate**
Cloud	**Cold front**
Condensation	**Conduction**
Convection	**Corona**
Coronal mass ejections (CMEs)	**Deforestation**
Dew point	**El Nino**
Evaporation	**Front**
Global warming	**Greenhouse effect**
Gulf Stream	**Hibernation**
High pressure	**Humidity**
Hurricane	**Isobar**
Isotherm	**Latitude**
Leeward side	**Low Pressure**
Nimbus	**Occluded front**
Ozone layer	**Polar zone**
Precipitation	**Prominence**
Radiation	**Rain Shadow Effect**
Relative humidity	**Runoff**
Season	**Solar flares**
Station model	**Stationary front**
Temperate Zone	**Temperature**

- **Earth's surface is much more efficiently heated by the sun than is the atmosphere. The amount of energy reaching any given point on Earth's surface is controlled by the angle of sunlight striking the surface and varies with the seasons.**
- **Winds are created by uneven heat distribution at Earth's surface and modified by the rotation of Earth. The Coriolis effect causes deflections of the atmosphere due to the rotation of Earth. Global wind patterns result from the uneven heating of Earth by the sun and are influenced by the Coriolis effect.**
- **Convection in the atmosphere is a major cause of weather. Convection is the major mechanism of energy transfer in the oceans, atmosphere, and Earth's interior.**

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com

Supplies

Weather Map
Thermometer
Barometer
Hurricane Map

	Thermometer	**Thunderstorm**
	Tornado	**Tropics**
	Ultraviolet radiation (UV rays)	**Warm front**
	Windward side	

SOL Reporting Category

Earth Materials and Processes

Topic

Plate Tectonics
Earthquakes
Volcanoes

Virginia SOL ES.7

The student will investigate and understand geologic processes including plate tectonics. Key concepts include

a. geologic processes and their resulting features; and
b. tectonic processes.

Cognitive Level (Bloom's Taxonomy, Revised)

- Analyze the body of evidence for Plate Tectonics Theory (i.e., seafloor age, magnetic information, seismic profiles, laser-measured motion studies, fossil evidence, rock types associated with particular tectonic environments).
- Analyze the various structures produced in convergent plate boundaries.
- Offer interpretations of the tectonic history of an area based on the range and type of rocks found in that area.
- Compare and contrast the tectonic activity of the east coast and the west coast of North America.

Key Vocabulary

Andesitic	Ash
Asthenosphere	Basaltic
Batholith	Caldera
Cinder cone volcano	Composite volcano
Compression	Continental drift
Convection current	Convergent boundary
Core	Crater
Crust	Dike
Divergent boundary	Earthquake
Epicenter	Fault
Focus	Granitic
Hot spot	Intensity
Lava	Liquefaction
Lithosphere	Magma
Magnetic field	Magnetometer
Magnetosphere	Magnitude
Mantle	Mercalli intensity scale
Mid-ocean ridges	Normal fault
Pangaea	Plate
Plate tectonics	Polarity
Primary waves (P-waves)	Pyroclastic flows

Essential Questions

- How can plate tectonics be evidenced by features found in Virginia?
- What are the processes involved at each of the three types of plate boundaries?
- How do the distinctive zones of volcanism and seismic activity relate to plate tectonics?
- How do the three types of volcanism vary from one another?
- How does seismic activity provide evidence for Earth's internal structure?
- What are the key types of evidence that support the theory of plate tectonics (paleomagnetism, fossil correlation, hot spots, Pangaea, continental drift)?
- How do surface processes like weathering, erosion, and deposition continue to act on changes brought about by plate tectonics?

Essential Understandings

- Earth consists of a solid, mostly iron inner core; a liquid, mostly iron outer core; a crystalline but largely plastic mantle; and a rocky, brittle crust.
- Earth's lithosphere is divided into plates that are in motion with respect to one another. The lithosphere is composed of the crust and upper portion of the mantle. There are two different types of lithospheres — oceanic and continental — that have very different physical and mineralogic characteristics. The ocean lithosphere is relatively thin, young, and dense. The continental lithosphere is relatively thick, old, and less dense.
- Most large scale, high-energy events of geologic activity (e.g., earthquakes, volcanoes, and mountain building) occur as a result of relative motion along plate boundaries.
- Plate motion occurs as a consequence of convection in Earth's mantle, including upwelling of material from the deep mantle in rift zones, the lateral movement of tectonic plates, and the sinking dense, old plates at subduction zones.
- Relative plate motions and plate boundaries are convergent (subduction and continental collision), divergent (seafloor spreading), or transform. Major features of convergent boundaries include collision zones (folded and thrust-faulted mountains) and subduction zones (volcanoes and trenches). Major features of divergent boundaries include mid-ocean ridges, rift valleys, fissure volcanoes, and flood lavas. Major features of transform boundaries include strike-slip faults.
- Earthquake activity of varying energy levels and depths is associated with all plate boundaries.
- A volcano is an opening where magma erupts onto Earth's surface. Most volcanic activity is associated with subduction, rifting, or seafloor spreading. Hot spot volcanic activity, such as volcanic islands, is exceptional in that it is not related to plate boundaries but derived from a deep, localized heat source.
- A fault is a break or crack in Earth's crust along which movement has occurred.
- Plate tectonic processes serve as the major driver of the rock cycle. Plate tectonics drive the evolution of Earth's surface features and materials by fractionating material by

Reverse fault	Richter scale
Rift valley	Seafloor spreading
Secondary waves (S-waves)	Seismic waves
Seismogram	Seismograph
Seismologist	Shadow zone
Shear	Shield volcano
Silica	Sill
Strike-slip fault	Surface waves (L-waves)
Tension	Tephra
Transform boundary	Trench
Tsunamis	Vent
Volcanic Neck	Volcano

chemical, mineralogic, and physical properties. Continental drift is a consequence of plate tectonics.

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com
www.usgs.gov

Supplies

World Map
Rock Samples: Granite, Basalt, Andesite, Volcanic Glass(Obsidian)

SOL Reporting Category

Earth Materials and Processes

Topic

Minerals
Nonrenewable/Renewable Resources
Rocks/Rock Cycle

Virginia SOL ES.4

The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include

a) hardness, color and streak, luster, cleavage, fracture, and unique properties

Virginia SOL ES.5

The student will investigate and understand the rock cycle as it relates to the origin and transformation of rock types and how to identify common rock types based on mineral composition and textures. Key concepts include

a) igneous rocks;
b) sedimentary rocks; and
c) metamorphic rocks.

Cognitive Level (Bloom's Taxonomy, Revised)

- **Analyze why certain common metallic elements (iron, aluminum, silicon) are rarely, if ever, found in the native state.**
- **Analyze the distribution and persistence of minerals at or near Earth's surface in terms of Earth's general structure, plate tectonics, and chemical and physical weathering.**
- **Analyze the relationship between the qualities of cleavage, fracture, and hardness and the molecular structure and chemistry of silicates, carbonates, and oxides.**
- **Identify minerals by their physical properties, such as hardness, color, luster, and streak.**
- **Recognize some major rock-forming minerals such as quartz, feldspar, calcite, and mica.**
- **Recognize ore minerals including pyrite, magnetite, hematite, galena, graphite, and sulfur.**
- **Assess the role of fossil fuels and renewable energy sources in the future and compare and contrast the environmental benefits and costs among the various options.**
- **Analyze the advantages and disadvantages of various energy sources.**
- **Comprehend and identify various igneous rock textural features and mineral components with a hand sample or by description, and analyze the significance of these features in terms of mode of origin and history.**
- **Analyze and identify various sedimentary rocks in terms of mode of origin and history, using sedimentary features (grain size, texture, and composition).**
- **Analyze the major groups of metamorphic rocks for mineral composition and textural features**

Essential Questions

- **What are the major elements in rock forming minerals found in Earth's crust?**
- **How can common minerals be identified based on physical and chemical properties?**
- **What are the five defining characteristics of all minerals?**
- **What are some examples of major rock forming minerals and ore minerals?**
- **How are minerals important to human civilization?**
- **How can you differentiate between renewable and nonrenewable resources?**
- **How are fossil fuels formed and extracted to meet the energy needs of society?**
- **What are the advantages and disadvantages of using various energy resources?**
- **What are the ramifications of depleting common energy resources?**
- **What is the rock cycle?**
- **What are the basic classification systems for igneous, sedimentary, and metamorphic rocks?**
- **How does the theory of plate tectonics help explain the rock cycle?**

Essential Understandings

- **There is a difference between rocks and minerals. Most rocks are made of one or more minerals.**
- **A mineral is a naturally occurring, inorganic, solid substance with a definite chemical composition and structure and can be identified based on specific chemical and physical properties.**
- **The major elements found in Earth's crust are oxygen, silicon, aluminum, and iron. The most abundant group of minerals is the silicates, which contain silicon and oxygen. Some common silicates include feldspar and quartz.**
- **The carbonate group of minerals is composed of the carbonate compound CO_3. Some common carbonates are calcite and dolomite.**
- **The oxide group of minerals is composed of oxygen and a metal. Some common oxides include hematite and magnetite.**
- **Minerals are important to human wealth and welfare.**
- **Resources are limited and are either renewable or nonrenewable.**
- **There are advantages and disadvantages to using any energy source.**
- **Modern living standards are supported by extensive use of both renewable and nonrenewable resources.**
- **Extraction and use of any resource carries an environmental cost that must be weighed against economic benefit.**
- **Renewable resources can be replaced by nature at a rate close to the rate at which they are used. Renewable resources include vegetation, sunlight, and surface water.**
- **Nonrenewable resources are replenished very slowly or not at all. Nonrenewable resources include coal, oil, and minerals.**
- **Rocks can be identified on the basis of mineral content and texture.**
- **The processes by which rocks are formed define the three major groups of rocks.**
- **The rock cycle is the process by which all rocks are formed and how basic Earth materials are recycled through time.**
- **Igneous rock forms from molten rock that cools and hardens either below or on Earth's**

Virginia SOL ES.6

The student will investigate and understand the differences between renewable and nonrenewable resources. Key concepts include

a) fossil fuels, minerals, rocks, water, and vegetation;
b) advantages and disadvantages of various energy sources;

and determine the potential parent rock and in terms of the rock cycle.

- **Analyze a sequence of rocks in terms of types, textures, composition, fossils, structural, and weathering features in order to infer the history of the sequence over time.**
- **Classify the following rock types as igneous, metamorphic, or sedimentary: pumice, obsidian, basalt, granite, sandstone, conglomerate, shale, limestone, slate, schist, gneiss, marble, and quartzite.**
- **Differentiate between clastic and non-clastic sedimentary rocks.**
- **Compare and contrast distinguishing characteristics of the crystal structure and textures of extrusive and intrusive igneous rocks.**
- **describe the structure of foliated and unfoliated metamorphic rocks.**

Key Vocabulary

Andesitic	Basaltic
Biomass energy	Cementation
Chemical (sedimentary rock)	Cleavage
Coal	Color
Compaction	Crystal
Detrital/Clastic (sedimentary rock)	Extrusive
Foliated	Fossil fuel
Fracture	Gem
Geothermal energy	Granitic
Hardness	Hydroelectric energy
Igneous	Inexhaustible
Intrusive	Luster
Mafic	Metamorphic
Mineral	Natural gas
Nonfoliated	Nonrenewable
Nuclear energy	Oil

surface. Extrusive igneous rocks have small or no crystals, resulting in fine-grained or glassy textures and include pumice, obsidian, and basalt. Intrusive igneous rocks have larger crystals and a coarser texture and include granite.

- **Sedimentary rocks may be formed either by rock fragments or organic matter being bound together or by chemical precipitation. Clastic sedimentary rocks are made up of fragments of other rocks and include sandstone, conglomerate, and shale. Non-clastic sedimentary rocks include limestone and rock salt.**
- **Metamorphic rocks form when any rock is changed by the effects of heat, pressure, or chemical action. Foliated metamorphic rocks have bands of different minerals and include slate, schist, and gneiss. Unfoliated metamorphic rocks have little or no banding and are relatively homogenous throughout and include marble and quartzite.**

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com
www.usgs.gov
www.geology.com

Supplies

Igneous Rock Collection
Sedimentary Rock Collection
Metamorphic Rock Collection
Mineral Collection
Mineral Test Kit

Ore	**Organic (sedimentary rock)**
Reclamation	**Recycling**
Renewable	**Reserve**
Rock	**Rock cycle**
Sedimentary	**Sediments**
Solar energy	**Volcanic glass**

SOL Reporting Category

Earth Materials and Processes

Earth and Space Systems

Topic

Weathering and Soils Erosion and Deposition

Virginia SOL ES.7
The student will investigate and understand geologic processes including plate tectonics. Key concepts include

a. tectonic processes.

Virginia SOL ES.8
The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

a) processes of soil development;
b) development of karst topography;
c) relationships between groundwater zones, including saturated and unsaturated zones, and the water table;

Cognitive Level (Bloom's Taxonomy, Revised)

- **Interpret a simple groundwater diagram showing the zone of aeration, the zone of saturation, the water table, and an aquifer.**
- **Interpret a simple hydrologic cycle diagram, including evaporation, condensation, precipitation, and runoff.**
- **Analyze the formation of karst in terms of rock type, solubility and permeability, uplift, the water table, and chemical and physical weathering.**
- **Analyze the presence of groundwater in various types of rock terrains, including areas found in each of the physiographic provinces of Virginia.**
-

Key Vocabulary

A Horizon	**Abrasion**
Alluvial fan	**Aquifer**
Artesian well	**B Horizon**
Barrier Island	**Beach**
Bedrock	**C Horizon**
Carbonic acid	**Cave**
Chemical weathering	**Cirque**
Climate	**Column (Organ Pipe)**
Cone of depression	**Contour farming**
Creep	**Deflation**
Delta	**Deposition**
Drainage basin	**Drumlin**
Dunes	**Erosion**
Eskers	**Estuary**
Geyser	**Glacier erosion**

Essential Questions

- **How do surface processes like weathering, erosion, and deposition continue to act on changes brought about by plate tectonics?**
- **What are the key processes that contribute to soil development (i.e. porosity, permeability)?**
- **What are common features of Karst topography, and where can Karst formations be found in Virginia?**
- **How does the movement and storage of surface and groundwater relate to the hydrologic cycle?**

Essential Understandings

- **Weathering, erosion, and deposition are interrelated processes. Weathering is the process by which rocks are broken down chemically and physically by the action of water, air, and organisms. Erosion is the process by which Earth materials are physically incorporated by moving water, ice, or wind for transportation. Deposition is the process by which Earth materials carried by wind, water, or ice settle out and are left in a location when energy levels decrease. The size of the material deposited is proportional to the available energy of the medium of transport.**
- **Soil is formed from the weathering of rocks and organic activity and is composed of loose rock fragments and clay derived from weathered rock mixed with organic material.**
- **Karst topography is developed in areas underlain by carbonate rocks, including limestone and dolomite. Karst topography includes features like caves and sinkholes and forms when limestone is slowly dissolved away by slightly acidic groundwater. Where limestone is abundant in the Valley and Ridge province of Virginia, karst topography is common.**
- **Permeability is a measure of the ability of a rock or sediment to transmit water or other liquids. Water does not pass through impermeable materials. A substantial amount of water is stored in permeable soil and rock underground.**
- **Earth's fresh water supply is finite. Geological processes, such as erosion, and human activities, such as waste disposal, can pollute water supplies.**
- **Water is continuously being passed through the hydrologic cycle. Fresh water is necessary for survival and most human activities.**

d) identification of sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;

Gravity erosion	**Horizon**
Humus	**Ice wedging**
Impermeable	**Karst topography**
Leaching	**Litter**
Loess	**Long shore current**
Mature Stream	**Meander**
Mechanical weathering	**Moraine deposit**
No-till farming	**Old Stream**
Overgrazing	**Oxbow lake**
Oxidation	**Permeable**
Plucking	**Rill and Gully**
Slump	**Soil**
Soil profile	**Spit**
Spring	**Stalactite**
Stalagmite	**Terracing**
Water erosion	**Water table**
Watershed	**Weathering**
Wind erosion	**Young Stream**
Zone of aeration	**Zone of saturation**

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com
www.usgs.org
www.groundwater.org
www.water.epa.gov
www.watersheds.org

Supplies

Clear Plastic Cup
Ice
Straw
Dark Liquid(drinkable)
Groundwater Diagram
Soil Profile
Soil Samples (various types)
Lichen sample
Moss sample

SOL Reporting Category

Cosmology, Origins and Time

Topic

Clues to the Past
Geologic Time

Virginia SOL ES.9

The student will investigate and understand that many aspects of the history and evolution of Earth and life can be inferred by studying rocks and fossils. Key concepts include

a) traces and remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks;
b) superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock;
c) absolute and relative dating have different applications but can be used together to determine the age of rocks and structures;

Cognitive Level (Bloom's Taxonomy, Revised)

- **Describe how life has changed and become more complex over geologic time.**
- **Interpret a simple geologic history diagram, using superposition and cross-cutting relations.**
- **Analyze how radioactive decay provides a reliable method to determine the age of many types of organic and inorganic materials.**
- **Analyze the impact and role of global catastrophes (including asteroid/comet impacts, volcanism, continental collisions, climate collapse) on extinctions and evolution.**
- **Analyze and interpret complex cross sections using both relative and absolute dating to unravel and define the geologic history of the section.**

Key Vocabulary

Absolute age	**Carbon(eous) Film**
Cast	**Cenozoic Era**
Cyanobacteria	**Eon**
Epoch	**Era**
Fossil	**Geologic time scale**
Half-life	**Index fossil**
Isotope	**Mesozoic Era**
Mold	**Natural selection**
Organic evolution	**Original Remains**
Paleozoic Era	**Pangaea**
Period	**Permineralized (Petrified) remains**
Precambrian time	**Principle of Superposition**
Radioactive decay	**Radiometric dating**
Relative age	**Species**

Essential Questions

- **How are fossils formed and how might an index fossil be used in studying the Earth's history?**
- **What is the geologic time scale?**
- **How are absolute and relative dating techniques used to determine the age of rock strata and fossils?**
- **Where are most fossils found in Virginia?**

Essential Understandings

- **The history of Earth and the ages of rocks can be investigated and understood by studying rocks and fossils.**
- **Evidence of ancient, often extinct life is preserved in many sedimentary rocks. A fossil is the remains, impression, or other evidence preserved in rock of the former existence of life. Fossil evidence indicates that life forms have changed and become more complex over geologic time. Some ways in which fossils can be preserved are molds, casts, and original bone or shell.**
- **Relative time places events in a sequence without assigning any numerical ages. Fossils, superposition, and cross-cutting relations are used to determine the relative ages of rocks. Absolute time places a numerical age on an event. Radioactive decay is used to determine the absolute age of rocks.**
- **The age of Earth is about 4.6 billion years.**

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com
www.web.wm.edu/geology/virginia/vafossils/
www.geology.com

and d) rocks and fossils from many different geologic periods and epochs are found in Virginia.	**Trace Fossils** | **Trilobite** **Unconformity** | **Uniformitarianism**	**Supplies** Fossil Collection

SOL Reporting Category

Earth and Space System
Earth Resources and Human Interactions

Topic

Oceanography
Ocean Motion

Virginia SOL ES.10

The student will investigate and understand that oceans are complex, interactive physical, chemical, and biological systems and are subject to long- and short-term variations. Key concepts include

a) physical and chemical changes related to tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations;
b) importance of environmental and geologic implications;
c) systems interactions;
d) features of the seafloor as reflections of tectonic processes; and

Cognitive Level (Bloom's Taxonomy, Revised)

- **Identify the effects of human activities on the oceans.**
- **Analyze the potential impact of a major environmental disaster on the base of the food web and vertebrate organisms; economics; cultures; and future productivity.**
- **Analyze the relationship between moving continents, the presence of ice caps, and ocean circulation over long periods of time.**
- **Relate important ocean conditions, including El Niño, to weather on the continents.**
- **Evaluate the role of the marine environment in the extraction of carbon dioxide in carbonates and the production of oxygen.**
- **Analyze the role of ocean currents in the distribution of heat from the equatorial regions to the poles, and predict what changes may occur as continents move and atmospheric conditions and climate vary.**
- **Compare Atlantic Ocean and Gulf of Mexico water temperatures during the yearly cycle, and relate this to the formation of storms.**
- **Describe how different types of pollution can pollute the Chesapeake Bay even though the pollutant source may be hundreds of miles from the Bay.**

Key Vocabulary

Abyssal plain	**Algae**
Basin	**Benthos**
Bioluminescence	**Breaker**
Chemosynthesis	**Continental shelf**
Continental slope	**Coriolis Effect**
Crest	**Density current**
Estuary	**Mid-ocean ridge**

Essential Questions

- **Why is good stewardship of our oceans important economically and environmentally?**
- **What common bathymetric features are found on a seafloor profile?**
- **What are the key differences between active and passive margins?**
- **What is the relationship between upwelling and an El Nino event?**
- **How do storms, surface currents, and density currents help distribute excess thermal energy throughout the ocean?**

Essential Understandings

- **The ocean is a dynamic system in which many chemical, biological, and physical changes are taking place. The oceans are an important source of food and mineral resources as well as a venue for recreation and transportation. Sea level falls when glacial ice caps grow and rises when the ice caps melt.**
- **Most waves on the ocean surface are generated by wind.**
- **There are large current systems in the oceans that carry warm water towards the poles and cold water towards the equator.**
- **Upwelling brings cold, nutrient-rich water from the deep ocean to the surface and produces areas of rich biological activity.**
- **The tides are the periodic rise and fall of water level caused by the gravitational pull of the sun and moon.**
- **The oceans' resources are finite and should be utilized with care.**
- **Algae in the oceans are an important source of atmospheric oxygen.**
- **The ocean is the single largest reservoir of heat at Earth's surface. The stored heat in the ocean drives much of Earth's weather and causes climate near the ocean to be milder than climate in the interior of continents.**
- **Convection is the major mechanism of energy transfer in the oceans, atmosphere, and Earth's interior.**
- **The topography of the seafloor is at least as variable as that on the continents. Features of the seafloor that are related to plate tectonic processes include mid-ocean ridges and trenches (continental margins, trenches, and mid-ocean ridges). Other major topographic features of the oceans are continental shelves, continental slopes, abyssal plains, and seamounts.**
- **The oceans are environmentally and economically important. Human activities and public policy have important consequences for the oceans. The impact of human activities, such as waste disposal, construction, and agriculture, affect the water quality within watershed systems and ultimately the ocean. Pollution and overfishing can harm or deplete valuable resources.**
- **Estuaries, like the Chesapeake Bay, are areas where fresh and salt water mix, producing variations in salinity and high biological activity. Chemical pollution and sedimentation are great threats to the well-being of estuaries and oceans.**

e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.

Nekton	**Non-point pollution**
Photosynthesis	**Plankton**
Point Pollution	**Pollution**
Reef	**Salinity**
Sewage	**Surface current**
Tidal range	**Tide**
Trench	**Trough**
Upwelling	**Wave**
Wave height	**Wavelength**

Teacher Notes and Elaborations

Resources

Pearson: Earth Science Textbook
LCD Projector
Document Camera
Interactive Notebook
www.khanacademy.org
www.pearsonsuccessnet.com
www.oceanservice.noaa.gov
www.whoi.edu
http://scripps.ucsd.edu/education/careers
http://science.nasa.gov

Supplies

Aquarium
Salt water
Fresh water
Food Coloring

SOL Reporting Category

Earth and Space Systems
Cosmology, Origins and Time
Earth Resources and Human Interactions

Topic

Solar System
Stars and Galaxies
The Sun-Earth-Moon System
Space Exploration

Virginia SOL ES.3
The student will investigate and understand the characteristics of Earth and the solar system. Key concepts include

a. position of Earth in the solar system;
b. sun-Earth-moon relationships (seasons, tides, and eclipses);
c. characteristics of the sun, planets and their moons, comets, meteors, and asteroids; and
d. the history and contributions of space exploration.

Virginia SOL ES.13
The student will investigate and

Cognitive Level (Bloom's Taxonomy, Revised)

- **Analyze the role of 1) the position of Earth in the Solar System; 2) the size of Earth and sun; and 3) Earth's axial tilt in affecting the evolution of the planet and life on the planet.**
- **Analyze historical explanations for the origin of the moon.**
- **Create a model showing the position of Earth, the moon, and the resulting moon phases.**
- **Explain why there is not a solar and lunar eclipse each month.**
- **Create a model showing the position of Earth, moon, and sun during a solar and lunar eclipse.**
- **Differentiate between the inner (terrestrial) planets and the outer (gaseous) planets and their corresponding atmospheric characteristics.**
- **Compare and contrast the internal makeup of the four inner planets and explain why they vary so significantly.**
- **Compare and contrast the atmospheres, planetary makeup, surface conditions, and rotation of the planets.**
- **Compare the classification of the dwarf planet Pluto to the planets in relation to its orbit, and its similarity to other objects in the Kuiper Belt.**

Key Vocabulary

Apparent magnitude	**Asteroid**
Asteroid Belt	**Axis**
Big Bang Theory	**Black hole**
Blue Shift	**Cassini probe**

Essential Questions

- **How can the minor members of the solar system (comets, meteoroids, dwarf planets, Kuiper objects, and asteroids) be characterized?**
- **What are the major contrasts between terrestrial and Jovian planets?**
- **What are the general characteristics, in terms of structure and composition, of the four terrestrial planets?**
- **What are the relative positions of the sun, Earth, and moon during lunar and solar eclipses and during key lunar phases (new, full, quarter)?**
- **What is the relationship between the lunar phase and spring and neap tides?**
- **How has technology increased our understanding of the solar system?**
- **How does the evolution of a star relate to its position on the H-R diagram?**
- **What are the defining characteristics of the three types of galaxies?**
- **How does our current understanding of cosmology support the Big Bang Theory?**
- **How can large intergalactic distances be measured by using light years?**

Essential Understandings

- **The solar system consists of many types of celestial bodies. Earth is the third planet from the sun and is located between the sun and the asteroid belt. It has one natural satellite, the moon. Water occurs on Earth as a solid (ice), a liquid, or a gas (water vapor) due to Earth's position in the solar system.**
- **Earth revolves around the sun tilted on its axis. The axial tilt is responsible for the incidence and duration of sunlight striking a given hemisphere that varies during the Earth's revolution around the Sun, thus causing seasons. Equinoxes and solstices represent four distinct quarterly points signaling the cyclic change of seasons.**
- **The moon revolves around Earth creating the moon phases and eclipses. Solar eclipses occur when the moon blocks sunlight from Earth's surface, while lunar eclipses occur when Earth blocks sunlight from reaching the moon's surface.**
- **The tides are the periodic rise and fall of water level caused by the gravitational pull of the sun and moon.**
- **The sun consists largely of hydrogen gas. Its energy comes from nuclear fusion of hydrogen to helium.**
- **There are essentially two types of planets in our solar system. The four inner (terrestrial) planets consist mostly of solid rock. The four outer planets are gas giants, consisting of thick outer layers of gaseous materials, perhaps with small rocky cores.**
- **The dwarf planet, Pluto, has an unknown composition but appears to be solid. It is part of the Kuiper Belt.**
- **Moons are natural satellites of planets and vary widely in composition.**

understand scientific concepts related to the origin and evolution of the universe. Key concepts include

a) cosmology including the Big Bang theory; and
b) the origin and evolution of stars, star systems, and galaxies.

Circumpolar constellations	**Comet**
Constellation	**Doppler Shift**
Earth	**Electromagnetic spectrum**
Ellipse	**Elliptical Galaxy**
Equinox	**Full moon**
Galaxy	**Galileo Probe**
Giant	**H-R diagram**
Hubble Space Telescope	**Impact basin**
Irregular Galaxy	**Jupiter**
Kuiper Belt	**Light-year**
Lunar eclipse	**Main sequence**
Maria	**Mars**
Mercury	**Meteor**
Meteorite	**Meteoroid**
Milky Way Galaxy	**Moon**
Moon phase	**NEAR (Near Earth Asteroid Rendezvous)**
Nebula	**Neptune**
Neutron star	**New moon**
Observatory	**Oort Cloud**
Orbit	**Penumbra**
Pioneer Probe	**Pluto**
Project Apollo	**Project Gemini**
Project Mercury	**Radio telescope**
Red Shift	**Reflecting telescope**
Refracting telescope	**Revolution**
Rocket	**Rotation**
Satellite	**Saturn**
Solar eclipse	**Solstice**
Space probe	**Space shuttle**
Space station	**Sphere**
Spiral galaxy	**Sun**
Supergiant	**Umbra**
Uranus	**Venus**
Voyager Probe	**Waning**
Waxing	**White dwarf**

- **Comets orbit the sun and consist mostly of frozen gases.**
- **A meteoroid is debris located outside Earth's atmosphere; a meteor is debris located within Earth's atmosphere; and a meteorite is debris that has broken apart into smaller pieces before reaching Earth's surface.**
- **Asteroids are usually leftover debris of the formation of the solar system, or creations of the collisions of other asteroids.**
- **The atmosphere of Venus is mostly carbon dioxide and very dense. The atmosphere of Mars is very thin and mostly carbon dioxide.**
- **Much of our knowledge about the solar system is a result of space exploration efforts. These efforts continue to improve our understanding of the solar system.**
- **The universe is vast in size and very old.**
- **The Big Bang theory is our best current model for the origin of the universe. The Big Bang theory states that the universe began in a very hot, dense state that expanded and eventually condensed into galaxies.**
- **The solar nebular theory is our best current idea for the origin of the solar system. The solar nebular theory explains that the planets formed through the condensing of the solar nebula.**
- **Stars have a finite lifetime and evolve over time. The mass of a star controls its evolution, lifespan, and ultimate fate. Stars form by condensation and gravitational compression of interstellar gas and dust.**
- **The Hertzsprung-Russell diagram illustrates the relationship between the absolute magnitude and the surface temperature of stars. As stars evolve, their position on the Hertzsprung-Russell diagram moves.**
- **Galaxies are collections of billions of stars. The basic types of galaxies are spiral, elliptical, and irregular.**
- **The solar system is located in the Milky Way galaxy.**
- **A light-year is the distance light travels in one year and is the most commonly used measurement for distance in astronomy.**
- **Much of our information about our galaxy and the universe comes from ground-based observations across the electromagnetic spectrum. Much information about other planets comes from ground-based observations from Earth, but also from landers and orbiting spacecraft.**

		Teacher Notes and Elaborations **Resources** **Pearson: Earth Science Textbook** **LCD Projector** **Document Camera** **Interactive Notebook** **www.khanacademy.org** **www.pearsonsuccessnet.com** **http://science.nasa.gov** **www.astronomy.com** **http://stardate.org/nightsky/moon**