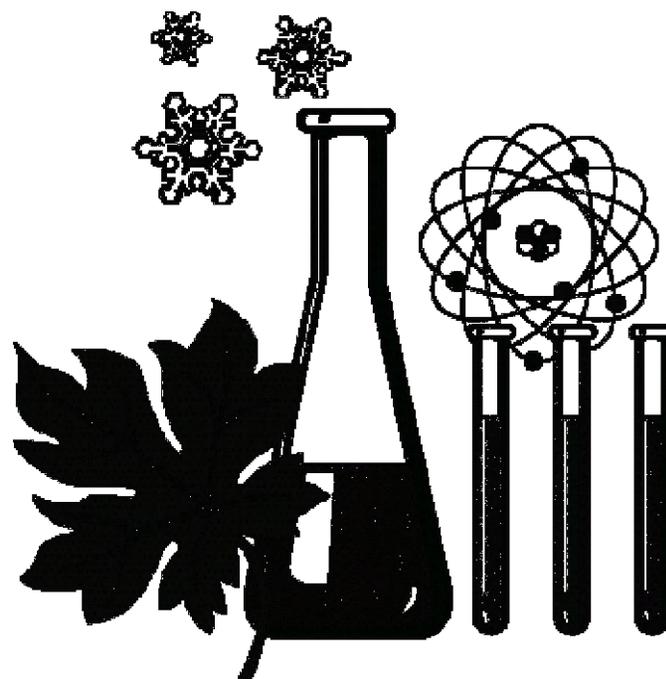


# SCIENCE

# ALIGNED STANDARDS OF LEARNING

# CURRICULUM FRAMEWORK

## HIGH SCHOOL



- HSS-SI 1 The student will plan and conduct investigations in which**
- volume, area, mass elapsed time, direction, temperature, pressure, distance, density, and changes in elevation/depth are calculated utilizing the most appropriate tools;**
  - technologies, including computers, probeware, and geospatial technologies, are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;**
  - scales, diagrams, charts, graphs, tables, imagery, models, and profiles are constructed and interpreted;**
  - maps and globes are read and interpreted, including location by latitude and longitude;**
  - variables are manipulated with repeated trials.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>Density expresses the relationship between mass and volume.</li> <li>Information and data collected can be organized and expressed in the form of charts, graphs, and diagrams.</li> <li>Scale relates to actual distance.</li> <li>Topographic maps and satellite imagery are two-dimensional models that provide information defining three-dimensional landforms. They contain extensive information related to geographic as well as human structures and changes to the land surface, and are useful in understanding geologic processes.</li> <li>Grid systems of latitude and longitude are used to define locations and directions on maps, globes, and charts.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>measure mass and volume of regular and irregular shaped objects and materials using common laboratory tools, including metric scales and graduated cylinders.</li> <li>apply the concept of mass per unit volume and calculate density without being given a formula.</li> <li>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.</li> <li>interpret data from a graph or table that shows changes in temperature or pressure with depth or altitude.</li> <li>interpret landforms, water features, map scale, horizontal distance between points, elevation and elevation changes, latitude and longitude, human-made structures and other pertinent features on 7.5 minute quadrangles on topographic maps.</li> <li>construct profiles from topographic contours.</li> <li>use latitude and longitude down to minutes, with correct north-south and east-west designations, to locate points on a map.</li> </ul>

**HSS-SI 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;**
- d) evidence is evaluated for scientific theories.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• 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               <ul style="list-style-type: none"> <li>a) the natural world is understandable;</li> <li>b) science is based on evidence - both observational and experimental;</li> <li>c) science is a blend of logic and innovation;</li> <li>d) scientific ideas are durable yet subject to change as new data are collected;</li> <li>e) science is a complex social endeavor; and</li> <li>f) scientists try to remain objective and engage in peer review to help avoid bias.</li> </ul> </li> <li>• Earth is a dynamic system, and all atmospheric, lithospheric, and hydrospheric processes interrelate and influence one another.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Changing relevant variables will generally change the outcome.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• analyze how natural processes explain multiple aspects of Earth systems and their interactions (e.g., storms, earthquakes, volcanic eruptions, floods, climate, mountain chains and landforms, geological formations and stratigraphy, fossils) can be used to make predictions of future interactions and allow scientific explanations for what has happened in the past.</li> <li>• make predictions, using scientific data and data analysis.</li> <li>• use data to support or reject a hypothesis.</li> <li>• differentiate between systematically-obtained, verifiable data and unfounded claims.</li> <li>• evaluate statements to determine if systematic science is used correctly, consistently, thoroughly, and in the proper context.</li> <li>• distinguish between examples of observations and inferences.</li> <li>• explain how scientific methodology is used to support, refute, or improve scientific theories.</li> <li>• contrast the formal, scientific use of the term “theory” with the everyday nontechnical usage of “theory.”</li> <li>• compare and contrast hypotheses, theories, and scientific laws. For example, students should be able to compare/contrast the Law of Superposition and the Theory of Plate Tectonics.</li> </ul>

**HSS-SI 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;
- d) evidence is evaluated for scientific theories.

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"><li>• Scientific laws are generalizations of observational data that describe patterns and relationships. Laws may change as new data become available.</li></ul>	

**HSS-ESS1 The student will investigate and understand the characteristics of Earth and the solar system. Key concepts include**

- position of Earth in the solar system;**
- sun-Earth-moon relationships (seasons, tides, and eclipses);**
- characteristics of the sun, planets and their moons, comets, meteors, and asteroids.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>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.</li> <li>The tides are the periodic rise and fall of water level caused by the gravitational pull of the sun and moon.</li> <li>The sun consists largely of hydrogen gas. Its energy comes from nuclear fusion of hydrogen to helium.</li> <li>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.</li> <li>The dwarf planet, Pluto, has an unknown composition but appears to be solid. It is part of the Kuiper Belt.</li> <li>Moons are natural satellites of planets and vary widely in composition.</li> <li>Comets orbit the sun and consist mostly of frozen gases.</li> <li>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.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>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.</li> <li>create a model showing the position of Earth, the moon, and the resulting moon phases.</li> <li>explain why there is not a solar and lunar eclipse each month.</li> <li>create a model showing the position of Earth, moon, and sun during a solar and lunar eclipse.</li> <li>differentiate between the inner (terrestrial) planets and the outer (gaseous) planets and their corresponding atmospheric characteristics.</li> <li>compare and contrast the internal makeup of the four inner planets and explain why they vary so significantly.</li> <li>compare and contrast the atmospheres, planetary makeup, surface conditions, and rotation of the planets.</li> <li>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.</li> <li>compare and contrast the defining characteristics among moons, comets, meteoroids, and asteroids.</li> <li>compare and contrast the characteristics of Venus, Earth, Mercury, and Mars, and interpret various reasons why each planet has such characteristics.</li> <li>predict what conditions we would need to have in place for another celestial object to support life.</li> </ul>

**HSS-ESS1** 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.

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"><li>• Asteroids are usually leftover debris of the formation of the solar system, or creations of the collisions of other asteroids.</li><li>• The atmosphere of Venus is mostly carbon dioxide and very dense. The atmosphere of Mars is very thin and mostly carbon dioxide.</li></ul>	

**HSS-ESS2 The student will investigate and understand how freshwater resources are influence by geologic processes and the activities of humans. Key concepts include**

c) relationships between groundwater zones, including saturated and unsaturated zones, and the water table;  
 d) identification of sources of freshwater including rivers, springs, and aquifers, with reference to the hydrologic cycle.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Water is continuously being passed through the hydrologic cycle. Fresh water is necessary for survival and most human activities.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• interpret a simple groundwater diagram showing the zone of aeration, the zone of saturation, the water table, and an aquifer.</li> <li>• interpret a simple hydrologic cycle diagram, including evaporation, condensation, precipitation, and runoff.</li> <li>• analyze the presence of groundwater in various types of rock terrains, including areas found in each of the physiographic provinces of Virginia.</li> </ul>

- HSS-ESS3 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**
- observation and collection of weather data;**
  - prediction of weather patterns;**
  - severe weather occurrences, such as tornadoes, hurricanes, and major storms;**
  - weather phenomena and the factors that affect climate including radiation, conduction, and convection.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• Energy transfer between Earth’s surface and the atmosphere creates the weather.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• The conditions necessary for cloud formation are air at or below dew point and presence of condensation nuclei. Cloud droplets can join together to form precipitation.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• identify and describe the direction of local winds (land, sea breezes and jet stream).</li> <li>• read and interpret data from a thermometer, a barometer, and a psychrometer.</li> <li>• predict weather based on cloud type, temperature, and barometric pressure.</li> <li>• read and interpret a weather map containing fronts, isobars, and isotherms.</li> <li>• read and interpret weather station models.</li> <li>• identify types and origins of air masses, fronts and the accompanying weather conditions.</li> <li>• read and interpret climate graphs.</li> <li>• label a diagram of global climate zones and the surface movement of ocean currents.</li> <li>• label a diagram that demonstrates the interaction of Earth’s atmosphere and energy transfer (conduction, convection, and radiation).</li> <li>• 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.</li> </ul>

**STANDARD HSS-ESS3      REPORTING CATEGORY: SCIENTIFIC INVESTIGATION      CONTENT: SCIENCE**

**HSS-ESS3      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**

- e) observation and collection of weather data;**
- f) prediction of weather patterns;**
- g) severe weather occurrences, such as tornadoes, hurricanes, and major storms;**
- h) weather phenomena and the factors that affect climate including radiation, conduction, and convection.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"><li>• A tornado is a narrow, violent funnel-shaped column of spiral winds that extends downward from the cloud base toward Earth. A hurricane is a tropical cyclone (counterclockwise movement of air) characterized by sustained winds of 120 kilometers per hour (75 miles per hour) or greater.</li></ul>	

**STANDARD HSS-EMP1 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES    CONTENT: SCIENCE**

**HSS-EMP1    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.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"> <li>• There is a difference between rocks and minerals. Most rocks are made of one or more minerals.</li> <li>• 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.</li> <li>• 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.</li> <li>• The carbonate group of minerals is composed of the carbonate compound CO<sub>3</sub>. Some common carbonates are calcite and dolomite.</li> <li>• The oxide group of minerals is composed of oxygen and a metal. Some common oxides include hematite and magnetite.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• analyze why certain common metallic elements (iron, aluminum, silicon) are rarely, if ever, found in the native state.</li> <li>• 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.</li> <li>• analyze the relationship between the qualities of cleavage, fracture, and hardness and the molecular structure and chemistry of silicates, carbonates, and oxides.</li> <li>• identify minerals by their physical properties, such as hardness, color, luster, and streak.</li> <li>• recognize some major rock-forming minerals such as quartz, feldspar, calcite, and mica.</li> <li>• recognize ore minerals including pyrite, magnetite, hematite, galena, graphite, and sulfur.</li> </ul>

**STANDARD HSS-EMP2 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES CONTENT: SCIENCE**

**HSS-EMP2 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**

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

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• Rocks can be identified on the basis of mineral content and texture.</li> <li>• The processes by which rocks are formed define the three major groups of rocks.</li> <li>• The rock cycle is the process by which all rocks are formed and how basic Earth materials are recycled through time.</li> <li>• Igneous rock forms from molten rock that cools and hardens either below or on Earth’s 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.</li> <li>• 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.</li> <li>• 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.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• analyze and identify various sedimentary rocks in terms of mode of origin and history, using sedimentary features (grain size, texture, and composition).</li> <li>• analyze the major groups of metamorphic rocks for mineral composition and textural features and determine the potential parent rock and in terms of the rock cycle.</li> <li>• 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.</li> <li>• integrate the rock cycle with Plate Tectonics Theory and determine how this is reflected in the geology of Virginia’s five physiographic provinces.</li> <li>• classify the following rock types as igneous, metamorphic, or sedimentary: pumice, obsidian, basalt, granite, sandstone, conglomerate, shale, limestone, slate, schist, gneiss, marble, and quartzite.</li> <li>• differentiate between clastic and non-clastic sedimentary rocks.</li> <li>• compare and contrast distinguishing characteristics of the crystal structure and textures of extrusive and intrusive igneous rocks.</li> <li>• describe the structure of foliated and unfoliated metamorphic rocks.</li> </ul>

**STANDARD HSS-EMP3 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES    CONTENT: SCIENCE**

**HSS-EMP3    The student will investigate and understand geologic processes including plate tectonics. Key concepts include**

- a) geologic processes and their resulting features;**
- b) tectonic processes.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• Virginia has a billion-year-long tectonic and geologic history.</li> <li>• Virginia has five physiographic provinces produced by past episodes of tectonic activity and continuous geologic activity.</li> <li>• Each province has unique physical characteristics resulting from its geologic past.</li> <li>• Geologic processes produce characteristic structures and features.</li> <li>• The five physiographic provinces of Virginia are Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau.</li> <li>• The Coastal Plain is a flat area composed of young, unconsolidated sediments underlain by older crystalline basement rocks. These layers of sediment were produced by erosion of the Appalachian Mountains and Piedmont and then deposited on the Coastal Plain when sea levels were higher in the past.</li> <li>• The Piedmont is an area of rolling hills underlain by mostly ancient igneous and metamorphic rocks. The igneous rocks are the roots of volcanoes formed during an ancient episode of subduction that occurred before the formation of the Appalachian Mountains.</li> <li>• The Blue Ridge is a high ridge separating the Piedmont from the Valley and Ridge Province. The billion-year-old igneous and metamorphic rocks of the Blue Ridge are the oldest in the state.</li> <li>• The Valley and Ridge province is an area with long parallel ridges and valleys underlain by ancient folded and faulted sedimentary rocks. The folding and faulting of the sedimentary rocks occurred during a collision between Africa and North America. The collision, which occurred in the late Paleozoic era, produced the Appalachian Mountains.</li> <li>• The Appalachian Plateau has rugged, irregular topography and is underlain by ancient, flat-lying sedimentary rocks. The area is actually a series of plateaus separated by faults and erosional down-cut valleys. Most of Virginia’s coal resources are found in the plateau province.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• label on a map the physiographic provinces of Virginia.</li> <li>• comprehend the topographic, rock-type and geologic-structural characteristics of each physiographic province of Virginia.</li> <li>• analyze the geologic history of Virginia in terms of the structures, rock types, and topography represented in the five physiographic provinces.</li> <li>• integrate and interpret the rock cycle, plate tectonics, and Virginia’s geology in an interacting diagram.</li> <li>• analyze how multiple continental collisions and rifting events over the last billion years have created the current physiography of Virginia.</li> <li>• comprehend and apply the details of Plate Tectonics Theory to the formation of continents, mountain chains, island arcs, deep open trenches, earthquake zones, and continental and mid-ocean volcanism.</li> <li>• analyze the composition and structure of the continental and oceanic lithosphere in terms of topographic features, density, thickness, and rates of motion.</li> <li>• compare and contrast various types of volcanism and geothermal activity (i.e., Hawaii, Iceland, Mount St. Helens, Catoctin Greenstone, Tambora, the Deccan Traps, and Yellowstone).</li> <li>• compare and contrast different types of current and ancient plate boundaries (i.e., Japan, California, New Madrid, Missouri, the Appalachian system, Iceland, and Tonga).</li> <li>• analyze how seismic waves provide evidence of the structure of the deep Earth including the inner and outer core in terms of composition, density, and viscosity.</li> <li>• 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).</li> </ul>

**STANDARD HSS-EMP3 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES CONTENT: SCIENCE**

**HSS-EMP3 The student will investigate and understand geologic processes including plate tectonics. Key concepts include**

- a) geologic processes and their resulting features;**
- b) tectonic processes.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• 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.</li> <li>• Earthquake activity of varying energy levels and depths is associated with all plate boundaries.</li> </ul>	<ul style="list-style-type: none"> <li>• analyze the various structures produced in convergent plate boundaries.</li> <li>• offer interpretations of the tectonic history of an area based on the range and type of rocks found in that area.</li> <li>• compare and contrast the tectonic activity of the east coast and the west coast of North America.</li> </ul>

**STANDARD HSS-EMP3 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES CONTENT: SCIENCE**

**HSS-EMP3 The student will investigate and understand geologic processes including plate tectonics. Key concepts include**

- a) geologic processes and their resulting features;**
- b) tectonic processes.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<ul style="list-style-type: none"><li>• 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.</li><li>• A fault is a break or crack in Earth’s crust along which movement has occurred.</li><li>• 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 chemical, mineralogic, and physical properties. Continental drift is a consequence of plate tectonics.</li></ul>	

**STANDARD HSS-EMP4 REPORTING CATEGORY: EARTH MATERIALS/PROCESSES CONTENT: SCIENCE**

**HSS-EMP4 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.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"><li>• 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.</li><li>• 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.</li></ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"><li>• analyze the formation of karst in terms of rock type, solubility and permeability, uplift, the water table, and chemical and physical weathering.</li></ul>

**HSS-COT1 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;**
- d) rocks and fossils from many different geologic periods and epochs are found in Virginia.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• The history of Earth and the ages of rocks can be investigated and understood by studying rocks and fossils.</li> <li>• 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.</li> <li>• 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.</li> <li>• The age of Earth is about 4.6 billion years.</li> <li>• In Virginia, fossils are found mainly in the Coastal Plain, Valley and Ridge, and Appalachian Plateau provinces. Most Virginia fossils are of marine organisms. This indicates that large areas of the state have been periodically covered by seawater.</li> <li>• Paleozoic, Mesozoic, and Cenozoic fossils are found in Virginia.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• describe how life has changed and become more complex over geologic time.</li> <li>• interpret a simple geologic history diagram, using superposition and cross-cutting relations.</li> <li>• analyze how radioactive decay provides a reliable method to determine the age of many types of organic and inorganic materials.</li> <li>• analyze the impact and role of global catastrophes (including asteroid/comet impacts, volcanism, continental collisions, climate collapse) on extinctions and evolution.</li> <li>• analyze and interpret complex cross sections using both relative and absolute dating to unravel and define the geologic history of the section.</li> </ul>

**HSS-ERH1 The student will investigate and understand how to identify major rock-forming and ore minerals based on physical and chemical properties. Key concepts include**  
**b) uses of minerals.**

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<ul style="list-style-type: none"> <li>• There is a difference between rocks and minerals. Most rocks are made of one or more minerals.</li> <li>• 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.</li> <li>• 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.</li> <li>• The carbonate group of minerals is composed of the carbonate compound <math>\text{CO}_3</math>. Some common carbonates are calcite and dolomite.</li> <li>• The oxide group of minerals is composed of oxygen and a metal. Some common oxides include hematite and magnetite.</li> <li>• Minerals are important to human wealth and welfare.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• analyze why certain common metallic elements (iron, aluminum, silicon) are rarely, if ever, found in the native state.</li> <li>• 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.</li> <li>• analyze the relationship between the qualities of cleavage, fracture, and hardness and the molecular structure and chemistry of silicates, carbonates, and oxides.</li> <li>• identify minerals by their physical properties, such as hardness, color, luster, and streak.</li> <li>• recognize some major rock-forming minerals such as quartz, feldspar, calcite, and mica.</li> <li>• recognize ore minerals including pyrite, magnetite, hematite, galena, graphite, and sulfur.</li> </ul>

**HSS-ERH2 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;**
- c) resources found in Virginia;**
- d) environmental costs and benefits.**

<b>ESSENTIAL UNDERSTANDINGS</b>	<b>ESSENTIAL KNOWLEDGE AND SKILLS</b>
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• Resources are limited and are either renewable or nonrenewable.</li> <li>• There are advantages and disadvantages to using any energy source.</li> <li>• Virginia has many natural resources.</li> <li>• Modern living standards are supported by extensive use of both renewable and nonrenewable resources.</li> <li>• Extraction and use of any resource carries an environmental cost that must be weighed against economic benefit.</li> <li>• 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.</li> <li>• Nonrenewable resources are replenished very slowly or not at all. Nonrenewable resources include coal, oil, and minerals.</li> <li>• Fossil fuels are nonrenewable and may cause pollution, but they are relatively cheap and easy to use once they are extracted.</li> <li>• In Virginia, major rock and mineral resources include coal for energy, gravel and crushed stone for road construction, silica for electronics, zirconium and titanium for advanced metallurgy, and limestone for making concrete.</li> <li>• Clean water resources, while renewable, are directly impacted by human activity through extraction and pollution.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• analyze the formation of fossil fuels in terms of the rock cycle and Plate Tectonics Theory, and relate the formation of fossil fuels to ancient biologic and atmospheric conditions and changes and locations within Virginia.</li> <li>• analyze how Virginia’s production and use of various natural resources has changed over time. Define and cite differences over time especially in the last 150 years.</li> <li>• evaluate Virginia’s potential as a producer of renewable energy sources.</li> <li>• 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.</li> <li>• analyze the advantages and disadvantages of various energy sources.</li> <li>• analyze a range of emerging energy and mineral resources in Virginia in terms of costs and benefits.</li> <li>• determine the sources of clean water in their community and analyze consumption and supply data.</li> </ul>

**HSS-ERH3** The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

e) dependence on freshwater resources and the effects of human usage on water quality;

f) identification of the major watershed systems in Virginia, including the Chesapeake Bay and its tributaries.

ESSENTIAL UNDERSTANDINGS	ESSENTIAL KNOWLEDGE AND SKILLS
<p>The concepts developed in this standard include the following:</p> <ul style="list-style-type: none"> <li>• Earth’s fresh water supply is finite. Geological processes, such as erosion, and human activities, such as waste disposal, can pollute water supplies.</li> <li>• Water is continuously being passed through the hydrologic cycle. Fresh water is necessary for survival and most human activities.</li> <li>• The three major regional watershed systems in Virginia lead to the Chesapeake Bay, the North Carolina sounds, and the Gulf of Mexico.</li> </ul>	<p>In order to meet this standard, it is expected that students will</p> <ul style="list-style-type: none"> <li>• interpret a simple hydrologic cycle diagram, including evaporation, condensation, precipitation, and runoff.</li> <li>• locate the major Virginia watershed systems on a map (Chesapeake Bay, Gulf of Mexico, and North Carolina sounds).</li> </ul>

