

Virginia High School Science
Curriculum Standards

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| Earth Science | Boardworks High School Earth Science Presentations |
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| ES.4: The student will investigate and understand the characteristics of the Earth and the solar system. | |
| Key concepts include | |
| a) position of the earth in the solar system; and | |
| • 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. | Planets of the Solar System Structure of the Universe |
| • Earth revolves around the sun, tilted on its axis, causing seasons (equinoxes and solstices). | The Rotation of the Earth |
| b) sun-Earth-moon relationships (seasons, tides, and eclipses). | |
| • The moon revolves around Earth creating the moon phases and eclipses. | The Moon |
| • 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 Moon |
| • <i>The tides are the daily, periodic rise and fall of water level caused by the gravitational pull of the sun and moon.</i> | – |
| • <i>Water occurs on Earth as a solid (ice), a liquid, or a gas (water vapor) due to Earth's position in the solar system.</i> | – |
| c) characteristics of the sun, planets and their moons, comets, meteors, and asteroids; and | |
| • The sun consists largely of hydrogen gas. Its energy comes from nuclear fusion of hydrogen to helium. | Properties of Stars Nuclear Fusion |
| • There are essentially two types of planets in our solar system. | Planets of the Solar System |
| • The four inner (terrestrial) planets consist mostly of solid rock. | Planets of the Solar System |
| • Four of the outer planets are gas giants, consisting of thick outer layers of gaseous materials, perhaps with small rocky cores. | Planets of the Solar System |
| • <i>The fifth outer planet, Pluto, has an unknown composition but appears to be solid.</i> | – |
| • <i>Moons are natural satellites of planets that vary widely in composition.</i> | – |
| • <i>Comets orbit the sun and consist mostly of frozen gases.</i> | – |
| • <i>Asteroids are rocky or metallic iron objects ranging in size from millimeters to kilometers. They are the source of most meteorites.</i> | – |
| Skill - • Draw a diagram of the solar system, and label the planets. | Planets of the Solar System Structure of the Solar System |
| d) the history and contribution of the space program. | |
| • <i>Apollo 11 was the first manned landing on the moon.</i> | – |
| • The Hubble Space Telescope has greatly improved our understanding of the universe. | Doppler Effect Observing the Universe |

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| ES.5: 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; and | |
| • <i>Minerals may be identified by their physical properties, such as hardness, color, luster, and streak.</i> | – |
| b) use of minerals. | |
| • <i>A mineral is a naturally occurring, inorganic, solid substance with a definite chemical composition and structure.</i> | – |
| • <i>Most rocks are made of one or more minerals.</i> | – |
| • <i>Some major rock-forming minerals are quartz, feldspar, calcite, and mica.</i> | – |
| • <i>Ore minerals include pyrite, magnetite, hematite, galena, graphite, and sulfur.</i> | – |
| • 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. | Earth's Structure |
| ES.6: 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 (intrusive and extrusive) rocks; | |
| • Igneous rock forms from molten rock that cools and hardens either below or on Earth's surface. | The Rock Cycle Volcanoes |
| • Extrusive igneous rocks have small or no crystals, resulting in fine-grained or glassy textures. | The Rock Cycle |
| • Intrusive igneous rocks have larger crystals and a coarser texture. | The Rock Cycle |
| • Extrusive igneous rocks include pumice, obsidian, and basalt. | The Rock Cycle |
| • Intrusive igneous rocks include granite. | The Rock Cycle |
| b) sedimentary (clastic and chemical) rocks; and | |
| • Sedimentary rocks may be formed either by rock fragments or organic matter being bound together or by chemical precipitation. | Erosion, Transportation and Deposition The Rock Cycle |
| • <i>Sedimentary rocks are clastic or chemical.</i> | – |
| • Clastic sedimentary rocks are made up of fragments of other rocks and include sandstone, conglomerate, and shale. | The Rock Cycle |
| • Non-clastic sedimentary rocks include limestone and rock salt. | The Rock Cycle |
| c) metamorphic (foliated and unfoliated) rocks. | |
| • Metamorphic rocks form when any rock is changed by the effects of heat, pressure, or chemical action. | The Rock Cycle |
| • <i>Metamorphic rocks can be foliated or unfoliated (nonfoliated).</i> | – |
| • <i>Foliated metamorphic rocks have bands of different minerals. Slate, schist, and gneiss are foliated metamorphic rocks.</i> | – |
| • <i>Unfoliated metamorphic rocks have little or no banding and are relatively homogenous throughout. Marble and quartzite are unfoliated metamorphic rocks.</i> | – |
| Skill - • Interpret the rock cycle diagram. | The Rock Cycle |

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| Skill - • Classify the following rock types as igneous, metamorphic, or sedimentary: pumice, obsidian, basalt, granite, sandstone, conglomerate, shale, limestone, slate, schist, gneiss, marble, and quartzite. | The Rock Cycle |
| ES.7: The student will investigate and understand the difference between renewable and nonrenewable resources. Key concepts include | |
| a) fossil fuels, minerals, rocks, water, and vegetation; | |
| • 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. | The Water Cycle Solar Energy |
| • Nonrenewable resources are renewed very slowly or not at all. Nonrenewable resources include coal, oil, and minerals. | Crude Oil Fossil Fuels Formation of Fossil Fuels |
| b) advantages and disadvantages of various energy sources; | |
| • Fossil fuels are nonrenewable and may cause pollution, but they are relatively cheap and easy to use. | Fossil Fuels Formation of Fossil Fuels |
| c) resources found in Virginia; | |
| • <i>In Virginia, major rock and mineral resources include coal for energy, gravel and crushed stone for road construction, and limestone for making concrete.</i> | – |
| d) making informed judgments related to resource use and its effects on Earth systems; and | |
| Skill - Analyze the advantages and disadvantages of various energy sources. | Nuclear Fission Fossil Fuels Formation of Fossil Fuels Climate Change |
| e) environmental cost and benefits. | Climate Change Greenhouse Gases Evidence for Climate Change Loss of Diversity Human Impact on Environment |
| ES.8: The student will investigate and understand geologic processes including plate tectonics. Key concepts include | |
| a) how geologic processes are evidenced in the physiographic provinces of Virginia including the Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau. | |
| • <i>The five physiographic provinces of Virginia are Coastal Plain, Piedmont, Blue Ridge, Valley and Ridge, and Appalachian Plateau.</i> | – |
| • <i>The Coastal Plain is a flat area underlain by young, unconsolidated sediments. These layers of sediment were produced by erosion of the Appalachian Mountains and then deposited on the Coastal Plain.</i> | – |

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| • 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. | – |
| • 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. Some metamorphism of these rocks occurred during the formation of the Appalachian Mountains. | – |
| • 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. | – |
| • 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. Most of Virginia's coal resources are found in the plateau province. | – |
| Skills - • Label on a map and recognize the major features of the physiographic provinces of Virginia. | – |
| b) processes (faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation) and their resulting features; and | |
| • Weathering is the process by which rocks are broken down chemically and physically by the action of water, air, and organisms. | Weathering |
| • Erosion is the process by which Earth materials are transported by moving water, ice, or wind. | Erosion, Transportation and Deposition The Rock Cycle |
| • Deposition is the process by which Earth materials carried by wind, water, or ice settle out and are deposited. | Erosion, Transportation and Deposition The Rock Cycle |
| • Hot spot volcanic activity, such as volcanic islands, is exceptional in that it is not related to plate boundaries. | – |
| • Earthquake activity is associated with all plate boundaries. | Plate Tectonics Earthquake Causes Earthquake Effects |
| • Major features of convergent boundaries include collision zones (folded and thrust-faulted mountains) and subduction zones (volcanoes and trenches). | Earthquake Causes Plate Tectonics |
| • Major features of divergent boundaries include mid-ocean ridges, rift valleys, and fissure volcanoes. | Plate Tectonics Volcanoes |
| • Major features of transform boundaries include strike-slip faults. | – |
| • A fault is a break or crack in Earth's crust along which movement has occurred. | Plate Tectonics |
| • Most active faults are located at or near plate boundaries. Earthquakes result when movement occurs along a fault. | Plate Tectonics Earthquake Causes Earthquake Effects |

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| • <i>When rocks are compressed horizontally, their layers may be deformed into wave-like forms called folds. This commonly occurs during continental collisions.</i> | – |
| • A volcano is an opening where magma erupts onto Earth's surface. Most volcanic activity is associated with subduction, rifting, or sea floor spreading. | Plate Tectonics Volcanoes |
| c) tectonic processes (subduction, rifting and sea floor spreading, and continental collision). | |
| • Earth consists of a solid, mostly iron inner core; a liquid, mostly iron outer core; a rocky, plastic mantle; and a rocky, brittle crust. | Earth's Structure |
| • Relative plate motions and plate boundaries are convergent (subduction and continental collision), divergent (sea floor spreading), or transform. | Plate Tectonics |
| • Ocean crust is relatively thin, young, and dense. | Earthquake Causes |
| • Continental crust is relatively thick, old, and less dense. | Earthquake Causes |
| • Continental drift is a consequence of plate tectonics. | Plate Tectonics |
| ES.9: The student will investigate and understand how freshwater resources are influenced by geological processes and the activities of humans. Key concepts include | |
| a) processes of soil development; and | |
| • Soil is loose rock fragments and clay derived from weathered rock mixed with organic material. | Soil |
| b) development of karst topography. | |
| • <i>Karst topography includes features like caves and sinkholes.</i> | – |
| • <i>Karst topography forms when limestone is slowly dissolved away by slightly acidic groundwater.</i> | – |
| • <i>Where limestone is abundant in the Valley and Ridge province of Virginia, karst topography is common.</i> | – |
| c) identification of groundwater zones including the water table, zone of saturation, and zone of aeration; | |
| <i>Skills - • Interpret a simple groundwater diagram showing the zone of aeration, the zone of saturation, the water table, and an aquifer.</i> | – |
| • <i>Permeability is a measure of the ability of a rock or sediment to transmit water or other liquids.</i> | – |
| d) identification of other sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle; | |
| • <i>Water does not pass through impermeable materials.</i> | – |
| • Interpret a simple hydrologic cycle diagram, including evaporation, condensation, precipitation, and runoff. | The Water Cycle |
| e) dependence on freshwater resources and the effects of human usage on water quality; and | |
| • Geological processes, such as erosion, and human activities, such as waste disposal, can pollute water supplies. | Water Pollution |
| f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries. | |
| • <i>The three major regional watershed systems in Virginia lead to the Chesapeake Bay, the North Carolina sounds, and the Gulf of Mexico.</i> | – |
| • <i>Locate the major Virginia watershed systems on a map (Chesapeake Bay, Gulf of Mexico, and North Carolina sounds).</i> | – |

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| ES.10: The student will investigate and understand that many aspects of the history and evolution of the 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; and | |
| • A fossil is the remains, impression, or other evidence preserved in rock of the former existence of life. | Fossil Record |
| • Some ways in which fossils can be preserved are molds, casts, and original bone or shell. | Fossil Record |
| • Nearly all fossils are found in sedimentary rocks. | Fossil Record |
| Skills - • Describe how life has changed and become more complex over geologic time. | Fossil Record |
| b) superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock; and | |
| • <i>Relative time places events in a sequence without assigning any numerical ages.</i> | – |
| • <i>Fossils, superposition, and crosscutting relations are used to determine the relative ages of rocks.</i> | – |
| • Radioactive decay is used to determine the absolute age of rocks. | Radioactive Dating |
| • <i>Interpret a simple geologic history diagram, using superposition and crosscutting relations.</i> | – |
| c) absolute and relative dating have different applications but can be used together to determine the age of rocks and structures. | |
| • <i>Absolute time places a numerical age on an event.</i> | – |
| d) rocks and fossils from many different geologic periods and epochs are found in Virginia. | |
| • <i>In Virginia, fossils are found mainly in the Coastal Plain, Valley and Ridge, and Appalachian Plateau provinces.</i> | – |
| • <i>Most Virginia fossils are of marine organisms. This indicates that large areas of the state have been periodically covered by seawater.</i> | – |
| • <i>Paleozoic, Mesozoic, and Cenozoic fossils are found in Virginia.</i> | – |
| ES 11: 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 (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations). | |
| • Most waves on the ocean surface are generated by wind. | Heat Transfer and Global Interactions |
| • <i>The tides are the daily, periodic rise and fall of water level caused by the gravitational pull of the sun and moon.</i> | – |
| • There are large current systems in the oceans that carry warm water towards the poles and cold water towards the equator. | Heat Transfer and Global Interactions |
| • Sea level falls when glacial ice caps grow and rises when the ice caps melt. | Climate Change |
| • <i>Upwellings bring cold, nutrient-rich water from the deep ocean to the surface and are areas of rich biological activity.</i> | – |
| • <i>Estuaries, like the Chesapeake Bay, are areas where fresh and salt water mix, producing variations in salinity and high biological activity.</i> | – |

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| b) importance of environmental and geologic implications; and | |
| • Algae in the oceans are an important source of atmospheric oxygen. | The Carbon Cycle |
| e) economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay. | |
| • <i>The oceans are an important source of food and mineral resources as well as a venue for recreation and transportation.</i> | – |
| • Pollution and over-fishing can harm or deplete valuable resources. | Water Pollution |
| • Chemical pollution and sedimentation are great threats to the chemical and biological well-being of estuaries and oceans. | Water Pollution |
| Skill - • Identify the effects of human activities on the oceans. | Water Pollution |
| c) systems interactions (density differences, energy transfer, weather, and climate); and | |
| • The stored heat in the ocean drives much of Earth's weather. | Heat Transfer and Global Interactions |
| • The stored heat in the ocean causes climate near the ocean to be milder than climate in the interior of continents. | Weather and Climate |
| d) features of the sea floor (continental margins, trenches, mid-ocean ridges, and abyssal plains) as reflections of tectonic processes. | |
| • Features of the sea floor that are related to plate tectonic processes include mid-ocean ridges and trenches. | Plate Tectonics |
| • <i>Other major topographic features of the oceans are continental shelves, continental slopes, abyssal plains, and seamounts.</i> | – |
| ES.12: 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 changes over geologic time; | |
| • The early atmosphere contained little oxygen and more carbon dioxide than the modern atmosphere. | The Atmosphere |
| b) current theories related to the effects of early life on the chemical makeup of the atmosphere; and | |
| • Early photosynthetic life such as cyanobacteria (bluegreen algae) consumed carbon dioxide and generated oxygen. | The Atmosphere |
| • It was only after early photosynthetic life generated oxygen that animal life became possible. | The Atmosphere |
| c) comparison of the Earth's atmosphere to that of other planets. | |
| • Earth's atmosphere is 21 percent oxygen, 78 percent nitrogen, and 1 percent trace gases. | The Atmosphere |
| • The atmosphere of Venus is mostly carbon dioxide and very dense. | Planets of the Solar System |
| • The atmosphere of Mars is very thin and mostly carbon dioxide. | Planets of the Solar System |
| d) atmospheric regulation mechanisms including the effects of density differences and energy transfer; and | Heat Transfer and Global Interactions |
| e) potential atmospheric compositional changes due to human, biologic, and geologic activity. | |

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| <ul style="list-style-type: none"> • Human activities have increased the carbon dioxide content of the atmosphere. | Human Impact on the Environment Evidence for Climate Change Greenhouse Gases Climate Change The Carbon Cycle |
| <ul style="list-style-type: none"> • Man-made chemicals have decreased the ozone concentration in the upper atmosphere. | The Impact of Using CFCs |
| <ul style="list-style-type: none"> • Volcanic activity and meteorite impacts can inject large quantities of dust and gases into the atmosphere. | The Atmosphere |
| <ul style="list-style-type: none"> • The ability of Earth's atmosphere to absorb and retain heat is affected by the presence of gases like water vapor and carbon dioxide. | Greenhouse Gases |
| Skills - • Explain how volcanic activity or meteor impacts could affect the atmosphere and life on Earth. | The Atmosphere |
| Skills - • Explain how biologic activity, including human activities, may influence global temperature and climate. | Human Impact on the Environment Evidence for Climate Change Greenhouse Gases The Carbon Cycle |
| ES.13: The student will investigate and understand that energy transfer between the sun and the Earth and its atmosphere drives weather and climate on Earth. Key concepts include | |
| a) observation and collection of weather data; | |
| <ul style="list-style-type: none"> • Weather describes day-to-day changes in atmospheric conditions. | Weather and Climate |
| <ul style="list-style-type: none"> • Climate describes the typical weather patterns for a given location over a period of many years. | Weather and Climate |
| <ul style="list-style-type: none"> • Areas near the equator receive more of the sun's energy per unit area than areas nearer the poles. | Weather and Climate |
| <ul style="list-style-type: none"> • 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. | Heat Transfer and Global Interactions |
| Skills - • Label a diagram of global wind patterns. | Precipitation Clouds |
| Skills - • Read and interpret data from a thermometer, a barometer, and a psychrometer. | Heat Transfer and Global Interactions |
| Skills - • Read and interpret a weather map. | Measuring the Weather |
| b) prediction of weather patterns; | – |
| Skills - • Predict weather based on cloud type, temperature, and barometric pressure. | |
| c) severe weather occurrences, such as tornadoes, hurricanes, and major storms; and | Measuring the Weather |
| <ul style="list-style-type: none"> • A tornado is a narrow, violent funnel-shaped column of spiral winds that extends downward from the cloud base toward Earth. | – |
| <ul style="list-style-type: none"> • 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. | Tropical Cyclones Hurricane Case Studies |
| d) weather phenomena and the factors that affect climate including radiation and convection. | |
| <ul style="list-style-type: none"> • The four major factors affecting climate are latitude, elevation, proximity to bodies of water, and position relative to mountains. | Weather and Climate |

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| <ul style="list-style-type: none"> • 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. | Heat Transfer and Global Interactions |
| <ul style="list-style-type: none"> • <i>Earth's major climatic zones are the polar, temperate, and tropical zones.</i> | – |
| ES.14: The student will investigate and understand scientific concepts related to the origin and evolution of the universe. Key concepts include | |
| a) nebulae; | |
| <ul style="list-style-type: none"> • The solar nebular theory explains that the planets formed through the condensing of the solar nebula. | Planets of the Solar System |
| b) the origin of stars and star systems; | |
| <ul style="list-style-type: none"> • Stars form by condensation of interstellar gas. | The Life Cycle of Stars |
| c) stellar evolution; | |
| <ul style="list-style-type: none"> • 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. | Properties of Stars |
| d) galaxies; and | |
| <ul style="list-style-type: none"> • Galaxies are collections of billions of stars. The basic types of galaxies are spiral, elliptical, and irregular. | Structure of the Universe |
| <ul style="list-style-type: none"> • The solar system is located in the Milky Way galaxy. | Planets of the Solar System Structure of the Universe |
| e) cosmology including the big bang theory. | |
| <ul style="list-style-type: none"> • The big bang theory states that the universe began in a very hot, dense state that expanded and eventually condensed into galaxies. | Planets of the Solar System Doppler Effect |
| <ul style="list-style-type: none"> • A light-year is the distance light travels in one year and is the most commonly used measurement for distance in astronomy. | Astronomical Distances |
| <ul style="list-style-type: none"> • Much of our information about our galaxy and the universe comes from ground-based observations. | Observing the Universe |