

Earth Science

The Earth Science standards connect the study of the Earth's composition, structure, processes, and history; its atmosphere, fresh water, and oceans; and its environment in space. The standards emphasize historical contributions in the development of scientific thought about the Earth and space. The standards stress the interpretation of maps, charts, tables, and profiles; the use of technology to collect, analyze, and report data; and the utilization of science skills in systematic investigation. Problem solving and decision making are an integral part of the standards, especially as they relate to the costs and benefits of utilizing the Earth's resources. Major topics of study include plate tectonics, the rock cycle, Earth history, the oceans, the atmosphere, weather and climate, and the solar system and universe.

The Earth Science standards continue to focus on student growth in understanding the nature of science. This scientific view defines the idea that explanations of nature are developed and tested using observation, experimentation, models, evidence, and systematic processes. The nature of science includes the concepts that scientific explanations are based on logical thinking; are subject to rules of evidence; are consistent with observational, inferential, and experimental evidence; are open to rational critique; and are subject to refinement and change with the addition of new scientific evidence. The nature of science includes the concept that science can provide explanations about nature, can predict potential consequences of actions, but cannot be used to answer all questions.

- 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 global positioning systems (GPS), are used to collect, analyze, and report data and to demonstrate concepts and simulate experimental conditions;
 - c) scales, diagrams, maps, charts, graphs, tables, and profiles are constructed and interpreted;
 - d) variables are manipulated with repeated trials; and
 - e) a scientific viewpoint is constructed and defended (the nature of science).
- ES.2 The student will demonstrate scientific reasoning and logic by
 - a) analyzing how science explains and predicts the interactions and dynamics of complex Earth systems;
 - b) recognizing that evidence is required to evaluate hypotheses and explanations;
 - c) comparing different scientific explanations for a set of observations about the Earth;
 - d) explaining that observation and logic are essential for reaching a conclusion; and
 - e) evaluating evidence for scientific theories.
- ES.3 The student will investigate and understand how to read and interpret maps, globes, models, charts, and imagery. Key concepts include
 - a) maps (bathymetric, geologic, topographic, and weather) and star charts;
 - b) imagery (aerial photography and satellite images);
 - c) direction and measurements of distance on any map or globe; and
 - d) location by latitude and longitude and topographic profiles.

- 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;
 - 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 the space program.
- 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
 - b) uses of minerals.
- 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;
 - b) sedimentary (clastic and chemical) rocks; and
 - c) metamorphic (foliated and unfoliated) rocks.
- ES.7 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) making informed judgments related to resource use and its effects on Earth systems; and
 - e) environmental costs and benefits.
- 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;
 - b) processes (faulting, folding, volcanism, metamorphism, weathering, erosion, deposition, and sedimentation) and their resulting features; and
 - c) tectonic processes (subduction, rifting and sea floor spreading, and continental collision).
- ES.9 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) identification of groundwater zones including the water table, zone of saturation, and zone of aeration;
 - d) identification of other sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;
 - e) dependence on freshwater resources and the effects of human usage on water quality; and
 - f) identification of the major watershed systems in Virginia including the Chesapeake Bay and its tributaries.

- 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
- traces and remains of ancient, often extinct, life are preserved by various means in many sedimentary rocks;
 - superposition, cross-cutting relationships, index fossils, and radioactive decay are methods of dating bodies of rock;
 - absolute and relative dating have different applications but can be used together to determine the age of rocks and structures; and
 - rocks and fossils from many different geologic periods and epochs are found in Virginia.
- 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
- physical and chemical changes (tides, waves, currents, sea level and ice cap variations, upwelling, and salinity variations);
 - importance of environmental and geologic implications;
 - systems interactions (density differences, energy transfer, weather, and climate);
 - features of the sea floor (continental margins, trenches, mid-ocean ridges, and abyssal plains) as reflections of tectonic processes; and
 - economic and public policy issues concerning the oceans and the coastal zone including the Chesapeake Bay.
- 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
- scientific evidence for atmospheric changes over geologic time;
 - current theories related to the effects of early life on the chemical makeup of the atmosphere;
 - comparison of the Earth's atmosphere to that of other planets;
 - atmospheric regulation mechanisms including the effects of density differences and energy transfer; and
 - potential atmospheric compositional changes due to human, biologic, and geologic activity.
- 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
- observation and collection of weather data;
 - prediction of weather patterns;
 - severe weather occurrences, such as tornadoes, hurricanes, and major storms; and
 - weather phenomena and the factors that affect climate including radiation and convection.
- ES.14 The student will investigate and understand scientific concepts related to the origin and evolution of the universe. Key concepts include
- nebulae;
 - the origin of stars and star systems;
 - stellar evolution;
 - galaxies; and
 - cosmology including the big bang theory.