Earth & Space Science
Grades 9-12

Strand:

S7 Earth & Space Sciences The student demonstrates a conceptual understanding of the organization of Earth and other celestial bodies; that is, the student:

Standards: S7a Categorizes the sources of internal energy in the Earth system, and presents evidence that this internal energy drives slow, but constant plate motion.

Components:

S7a1 Describes the sources of Earth's internal heat energy (gravitational energy from the Earth's original formation and the decay of radioactive isotopes)

S7a2 Diagrams on a global scale how Earth's internal heat energy is released to the surface via convection, and relates convection currents in the mantle to plate tectonic motion.

S7a3 Presents evidence (such as magnetic striping in ocean basins and the change in location of hot spot volcanoes) that plate movement is ongoing.

Standards: S7b: Identifies the geologic activity (such as volcanoes and earthquakes) resulting from the release of Earth's internal energy.

Components:

S7b1 Describes volcanoes as a mechanism for the release of Earth's internal heat, and describes the processes that result in volcanic activity at convergent and divergent boundaries, as well as hot spots in the middle of plates.

S7b2 Explains the relationship between plate tectonics and the fault movements that cause earthquakes.

Standards: S7c Identifies the Sun as the external source of energy to the Earth system, and describes the processes within Earth's atmosphere and hydrosphere that are driven by energy transfer from the Sun.

Components:

S7c1 Describes how radiant energy from the Sun drives convection within the atmosphere and oceans, producing winds and ocean currents.

S7c2 Diagrams the potential pathways of light energy that is transmitted to Earth from the Sun (e.g., reflected by atmosphere back into space, absorbed by atmosphere, reflected off of Earth's surface, absorbed into Earth's surface and reradiated as heat energy)

S7c3 Describes how the transfer of energy from the Sun is influenced by such factors as cloud cover, the albedo of Earth's surface, the composition of the atmosphere, Earth's rotation and revolution, and static conditions (e.g., the position of mountains ranges and oceans).

Standards: S7d Categorizes the sources and types of energy in the Earth system, identifying how the process of nuclear fusion in the Sun and other stars provides enormous amounts of energy over billions of years.

Components:

S7d1 Describes how the Sun and other stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium, and how these and other processes in stars have led to the formation of all the other elements.

S7d2 Discusses the constant changes that occur in the Sun, and how solar activity (such as flares and sunspot cycles) can affect life on Earth.

S7d3 Explains the Big Bang Theory, which states that the Universe began in a hot dense state and has been expanding ever since.

Standards: S7e Compares and contrasts the composition of Earth materials and the processes within the geochemical cycle that govern their formation (including rocks, minerals, fossils, and other natural resources)

Components:

S7e1 Identifies common rocks and minerals that make up Earth's crust based on their chemical and physical properties.

S7e2 Relates the formation of igneous, metamorphic and sedimentary rocks to plate tectonic processes driven by Earth's internal energy and surface geologic processes (such as erosion, transport and deposition) driven by external energy from the Sun.

Standards: S7f Presents evidence that Earth is a system containing essentially a fixed amount of each stable chemical atom or element which moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

Components:

S7f1 Presents evidence that Earth is a system containing essentially a fixed amount of each stable chemical atom or element which moves among reservoirs in the solid Earth, oceans, atmosphere, and organisms as part of geochemical cycles.

S7f2 Diagrams and explains multiple pathways of carbon movement between reservoirs (such as from geosphere to atmosphere via volcanic eruptions and fossil fuel combustion; from organisms to geosphere via fossil fuel formation; from organisms to atmosphere via respiration and decomposition, etc.)

Standards: S7g Investigates and displays the relationships among weather, climate, solar input, cloud cover, land features, atmosphere and oceans.

Components:

S7g1 Names and illustrates factors influencing regional and global climate such as solar input, atmospheric circulation, ocean circulation, land features, and atmospheric composition that can change the dynamic equilibrium of Earth's atmosphere.

S7g2 Gives examples to demonstrate how Earth's systems (such as the climate system) contain feedbacks that may oppose changes that occur (and lead to stability) or may encourage more change (and so drive the system toward one extreme or another).

S7g3 Presents how changes to complex patterns and interactions between cloud cover, land features, atmosphere and oceans can have far reaching consequences for the local weather and conditions for animals and plants, but also the climate on Earth as a whole.

Standards: S7h Presents and critiques theories of the origin and evolution of the Solar System.

Components:

S7h1 Describes the solar nebula condensation theory.

S7h2 Recognizes patterns in the physical and chemical characteristics of objects in the Solar System, which provide evidence of Solar System origin (e.g., direction of rotation and revolution of the planets, compositional similarities and differences between planets, etc.).

S7h3 Describes how the known decay rates of radioactive isotopes are used to mathematically determine the absolute age of rocks of terrestrial and extraterrestrial origin, providing evidence of the age of the Solar System.

S7h4 Discusses examples of technology and space explorations and how they contribute to new insights about the origin and evolution of the Solar System.

Standards: S7i Presents and critiques theories of the origin and evolution of the Earth System

Components:

S7i1 Identifies how life on Earth is adapted to certain unique conditions, including the force of gravity that enables the planet to retain an adequate atmosphere, and an intensity of radiation from the Sun that allows water to cycle between liquid and vapor.

S7i2 Describes how the early Earth was very different from the planet we live on today, and gives examples of how interactions among the solid Earth, the oceans, the atmosphere, and organisms have resulted in the ongoing evolution of the Earth system.

S7i3 Describes the atmosphere of early Earth, which contained no molecular oxygen, and relates the development of an oxygen-rich atmosphere to the evolution of photosynthetic plants more than 3 billion years ago (which removed CO2 from the early Earth atmosphere, using C to make sugars and release O2).

Standards: S7j Investigates the nature of stars, and the process of star formation, evolution and destruction.

Components:

S7j1 Describes how billions of stars, in gravitationally-bound clusters called galaxies, form most of the visible mass of the Universe.

S7j2 Describes evidence that although stars differ from each other in size, temperature, and age, they are made up of the same elements that are found on Earth and behave according to the same physical principals.

S7j3 Recognizes that stars are not static objects but rather form, evolve, and eventually die over billions of years. This process of star formation and destruction has been ongoing since the Universe first formed 10 to 20 billion years ago.