High School

Earth's Place in the Universe HS-ESS1

A The Universe and Its Stars HS-ESS1-A

1. The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years. (HS-ESS1-1) HS-ESS1-A-1
2. The study of stars' light spectra brightness is used to identify compositional elements of Stars, their movements, and their distances from Earth. (HS-ESS1-2), (HS-ESS1-3) HS-ESS1-A-2
3. The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fills the universe. (HS-ESS1-2) HS-ESS1-A-3
4. Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode. (HS-ESS1-2),(HS-ESS1-3) HS-ESS1-A-4

B Earth and the Solar System HS-ESS1-B

1. Kepler's laws describe common features of the motions of orbiting objects, including their elliptical paths around the sun. Orbits may change due to the gravitational effects from, or collisions with, other objects in the solar system. (HS-ESS1-4) HS-ESS1-B-1
2. Cyclical changes in the shape of Earth's orbit around the sun, together with changes in the tilt of the planet's axis of rotation, both occurring over hundreds of thousands of years, have altered the intensity and distribution of sunlight falling on the earth. These phenomena cause a cycle of ice ages and other gradual climate changes. (secondary to HS-ESS2-4) HS-ESS1-B-2

C The History of Planet Earth HS-ESS1-C

1. Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5) HS-ESS1-C-1
2. Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6) HS-ESS1-C-2

Earth's Systems HS-ESS2

A Earth Materials and Systems HS-ESS2-A

1. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes. (HS-ESS2-1),(HS-ESS2-2) HS-ESS2-A-1
2. Evidence from deep probes and seismic waves, reconstructions of historical changes in Earth's surface and its magnetic field, and an understanding of physical and chemical processes lead to a model of Earth with a hot but solid inner core, a liquid outer core, a solid mantle and crust. Motions of the mantle and its plates occur primarily through thermal convection, which involves the cycling of matter due to the outward flow of energy from Earth's interior and gravitational movement of denser materials toward the interior. (HS-ESS2-3) HS-ESS2-A-2
3. The geological record shows that changes to global and regional climate can be caused by interactions among changes in the sun's energy output or Earth's orbit, tectonic events, ocean circulation, volcanic activity, glaciers, vegetation, and human activities. These changes can occur on a variety of time scales from sudden to intermediate (ice ages) to very long-term tectonic cycles. (HS-ESS2-4) HS-ESS2-A-3

B Plate Tectonics and Large-Scale System Interactions HS-ESS2-B

1. The radioactive decay of unstable isotopes continually generates new energy within Earth's crust and mantle, providing the primary source of the heat that drives mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) HS-ESS2-B-1
2. Plate tectonics is the unifying theory that explains the past and current movements of the rocks at Earth's surface and provides a framework for understanding its geologic history. Plate movements are responsible for most continental and ocean-floor features and for the distribution of most rocks and minerals within Earth's crust. (ESS2.B Grade 8 GBE),(HS-ESS2-1) HS-ESS2-B-2

C The Roles of Water in Earth's Surface Processes HS-ESS2-C

1. The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks. (HS-ESS2-5) HS-ESS2-C-1

D Weather and Climate HS-ESS2-D

1. The foundation for Earth's global climate systems is the electromagnetic radiation from the sun, as well as its reflection, absorption, storage, and redistribution among the atmosphere, ocean, and land systems, and this energy's re-radiation into space. (HS-ESS2-2),(HS-ESS2-4) HS-ESS2-D-1
2. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) HS-ESS2-D-2
3. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6),(HS-ESS2-4) HS-ESS2-D-3

4 Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere. (secondary to HS-ESS3-6) HS-ESS2-D-4

E Biogeology HS-ESS2-E

1 The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (HS-ESS2-7) HS-ESS2-E-1

Earth and Human Activity HS-ESS3

A Natural Resources HS-ESS3-A

1 Resource availability has guided the development of human society. (HS-ESS3-1) HS-ESS3-A-1

2 All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (HS-ESS3-2) HS-ESS3-A-2

B Natural Hazards HS-ESS3-B

1 Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations. (HS-ESS3-1) HS-ESS3-B-1

C Human Impacts on Earth Systems HS-ESS3-C

1 The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3) HS-ESS3-C-1

2 Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4) HS-ESS3-C-2

D Global Climate Change HS-ESS3-D

1 Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. (HS-ESS3-5) HS-ESS3-D-1

2 Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities. (HS-ESS3-6) HS-ESS3-D-2