HS. Earth's Systems

A Performance Expectations HS.ESS2.ES

1. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to Earth's systems. HS.ESS2.2
2. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. HS.ESS2.3
3. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes. HS.ESS2.5
4. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS.ESS2.6
5. Construct an argument based on evidence about the coevolution of Earth's systems and life on Earth. HS.ESS2.7

B Science and Engineering Practices HS.ES.SEP

1 Developing and Using Models HS.ES.SEP.1

- a Develop a model based on evidence to illustrate the relationships between systems or between components of a system. (HS-ESS2-3),(HS-ESS2-6) HS.ES.SEP.1A

2 Planning and Carrying Out Investigations HS.ES.SEP.2

- a Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-ESS2-5) HS.ES.SEP.2A

3 Analyzing and Interpreting Data HS.ES.SEP.3

- a Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. (HS-ESS2-2) HS.ES.SEP.3A

4 Engaging in Argument from Evidence HS.ES.SEP.4

- a Construct an oral and written argument or counterarguments based on data and evidence. (HS-ESS2-7) HS.ES.SEP.4A

5 Scientific Knowledge is Based on Empirical Evidence HS.ES.SEP.5

- a Science knowledge is based on empirical evidence. (HSESS2-3) HS.ES.SEP.5A
- b Science disciplines share common rules of evidence used to evaluate explanations about natural systems. (HS-ESS2-3) Science includes the process of coordinating patterns of evidence with current theory. (HS-ESS2-3) HS.ES.SEP.5B

C Disciplinary Core Ideas HS.ES.DCI

1. ESS2.A: Earth Materials and Systems HS.ES.DCI.ESS2.A
   - a. Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes (HS-ESS2-2) HS.ES.DCI.ESS2.A.1
   - b. 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.ES.DCI.ESS2.A.2
2. ESS2.B: Plate Tectonics and Large-Scale System Interactions HS.ES.DCI.ESS2.B
   - a. (NYSED) Residual heat from Earth's formation and the radioactive decay of unstable isotopes in Earth's interior continually generate energy that is absorbed by Earth's mantle and crust, driving mantle convection. Plate tectonics can be viewed as the surface expression of mantle convection. (HS-ESS2-3) HS.ES.DCI.ESS2.B.1
   - b. (NYSED) Minerals are the building blocks of igneous, metamorphic, and sedimentary rocks and can be identified using physical and chemical characteristics. These rock types are evidence of stages of constant recycling of Earth material by surface processes and convection currents in the mantle. (HS-ESS2-3) HS.ES.DCI.ESS2.B.2
3. ESS2.C: The Roles of Water in Earth's Surface Processes HS.ES.DCI.ESS2.C
   - a. 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.ES.DCI.ESS2.C.1
4. ESS2.D: Weather and Climate HS.ES.DCI.ESS2.D
   - a. 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.ES.DCI.ESS2.D.1
   - b. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. (HS-ESS2-6),(HS-ESS2-7) HS.ES.DCI.ESS2.D.2
   - c. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. (HS-ESS2-6) HS.ES.DCI.ESS2.D.3
5. ESS2.E: Biogeology HS.ES.DCI.ESS2.E

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

6 PS4.A: Wave Properties HS.ES.DCI.PS4.A

a Geologists use seismic waves and their reflection at interfaces between layers to probe structures deep in the planet. (secondary to HS-ESS2-3) HS.ES.DCI.PS4.A.1

D Crosscutting Concepts HS.ES.CC

1 Energy and Matter HS.ES.CC.1

a The total amount of energy and matter in closed systems is conserved. (HSESS2-6) HS.ES.CC.1A

b Energy drives the cycling of matter within and between systems. (HS-ESS2-3) HS.ES.CC.1B

2 Structure and Function HS.ES.CC.2

a The functions and properties of natural and designed objects and systems can be inferred from their overall structure, the way their components are shaped and used, and the molecular substructures of its various materials. (HS-ESS2-5) HS.ES.CC.2A

3 Stability and Change HS.ES.CC.3

a Much of science deals with constructing explanations of how things change and how they remain stable. (HS-ESS2-7) HS.ES.CC.3A

b Feedback (negative or positive) can stabilize or destabilize a system. (HSESS2-2) HS.ES.CC.3B

4 Interdependence of Science, Engineering, and Technology HS.ES.CC.4

a Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise. (HS-ESS2-3) HS.ES.CC.4A

5 Influence of Engineering, Technology, and Science on Society and the Natural World HS.ES.CC.5

a New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. (HS-ESS2-2) HS.ES.CC.5A