

HS-ESS2-3 Earth’s Systems

California Science Test—Item Content Specifications

# HS-ESS2-3 Earth’s Systems

Students who demonstrate understanding can:

Develop a model based on evidence of Earth’s interior to describe the cycling of matter by thermal convection.

[Clarification Statement: Emphasis is on both a one-dimensional model of Earth, with radial layers determined by density, and a three-dimensional model, which is controlled by mantle convection and the resulting plate tectonics. Examples of evidence include maps of Earth’s three-dimensional structure obtained from seismic waves, records of the rate of change of Earth’s magnetic field (as constraints on convection in the outer core), and identification of the composition of Earth’s layers from high-pressure laboratory experiments.]

Continue to the next page for the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Developing and Using Models  Modeling in 9–12 builds on K–8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).  Develop a model based on evidence to illustrate the relationships between systems or between components of a system.  Connections to Nature of Science  Scientific Knowledge is Based on Empirical Evidence  Science knowledge is based on empirical evidence.  Science disciplines share common rules of evidence used to evaluate explanations about natural systems.  Science includes the process of coordinating patterns of evidence with current theory. | ESS2.A: Earth Materials and Systems   1. 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.   ESS2.B: Plate Tectonics and Large-Scale System Interactions  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. | Energy and Matter  Energy drives the cycling of matter within and between systems.  Connections to Engineering, Technology, and Applications of Science  Interdependence of Science, Engineering, and Technology  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. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

2.1 Ability to develop models

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

2.1.1 Ability to determine components of a scientific event, system, or design solution

2.1.2 Ability to determine the relationships among multiple components of a scientific event, system, or design solution

2.1.3 Ability to determine scope, scale, and grain-size of models, as appropriate for their intended use

2.1.4 Ability to represent mechanisms, relationships, and connections to illustrate, explain, or predict a scientific event

### Disciplinary Core Idea Assessment Targets

#### ESS2.A.7

* Identify and describe the layers of Earth (e.g., solid inner core, a liquid outer core, mantle, and crust)
* Describe how the evidence from deep probes and seismic waves, reconstructions of historical changes of Earth’s surface and its magnetic field, and an understanding of physical and chemical processes have been used to develop the model of Earth’s internal structure
* Describe how convection in Earth’s liquid outer core generates a magnetic field that has reversed polarity throughout Earth’s history as evidenced in the geological record of the seafloor
* Describe thermal convection in terms of the density and temperature of matter
* Describe the role of thermal convection in the mantle in the movement of plates, the cycling of matter at plate boundaries, and the outward flow of energy from Earth’s interior

#### ESS2.B.6

* Describe how the radioactive decay of unstable isotopes is a primary source of heat that drives thermal convection in the mantle and the resulting plate tectonics

### Crosscutting Concept Assessment Target(s)

CCC5 Describe how energy drives the cycling of matter within and between systems

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides seismic or magnetic evidence and a list of relevant and irrelevant components of a model:

* Identifies the relevant components to describe the cycling of matter due to thermal convection in Earth’s interior based on the evidence (2.1.1, ESS2.B.6, and CCC5)

Task provides evidence, an incomplete model of Earth’s interior or Earth’s surface plates describing the cycling of matter due to thermal convection, and a list of relevant and irrelevant components:

* Completes the model based on the evidence (2.1.1, ESS2.A.7, and CCC5)

Task provides evidence about the structure of Earth’s interior or Earth’s surface plates and the cycling of matter due to thermal convection and a list of models:

* Identifies the appropriate model based on the evidence (2.1.2, ESS2.A.7, and CCC5)

Task provides a model of and/or evidence about Earth’s interior or Earth’s surface plates and a list of relevant and irrelevant representations or descriptions:

* Identifies the appropriate representations to describe the mechanisms underlying the cycling of matter based on the model and/or evidence (2.1.3, ESS2.A.7, and CCC5)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Direction of convection currents in the mantle and the relative direction of plate movements
* Relationship between radioactive decay and thermal convection in Earth’s interior
* Empirical evidence of thermal convection affecting plate tectonics (e.g., gradual widening of Atlantic Ocean due to seafloor spreading between divergent plates)
* Use of seismic wave evidence to deduce the composition and structure of the Earth’s interior
* Interpretation of seafloor magnetic data (e.g., magnetic reversals in the Earth’s crust on either side of a mid-ocean ridge)

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Tectonic plates float and move above a sea of magma.
* Plates are deep beneath Earth’s surface.
* Magma originates from the core.
* Convection only occurs in liquids.
* Radioactivity is manmade.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-ESS2-3 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-ESS2-3 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-ESS2-3%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

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