

HS-ESS2-6 Earth’s Systems

California Science Test—Item Content Specifications

# HS-ESS2-6 Earth’s Systems

Students who demonstrate understanding can:

Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

[Clarification Statement: Emphasis is on modeling biogeochemical cycles that include the cycling of carbon through the ocean, atmosphere, soil, and biosphere (including humans), providing the foundation for living organisms. The carbon cycle is a property of the Earth system that arises from interactions among the hydrosphere, atmosphere, geosphere, and biosphere.]

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. | ESS2.D: Weather and Climate  1. Gradual atmospheric changes were due to plants and other organisms that captured carbon dioxide and released oxygen. 2. Changes in the atmosphere due to human activity have increased carbon dioxide concentrations and thus affect climate. | Energy and Matter The total amount of energy and matter in closed systems is conserved. |

## 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.D.8

* Identify the relative concentrations of carbon present in various parts of the carbon cycle including carbon dioxide in the atmosphere, organic molecules in the biosphere, dissolved carbon in the oceans, and sequestered carbon in fossil fuels in the geosphere
* Describe the relationships between the hydrosphere, atmosphere, geosphere, and biosphere as carbon cycles between sources and sinks
* Describe the mechanisms or processes that transfer carbon (e.g., photosynthesis, respiration, decomposition, combustion, and volcanism)
* Describe the role of plants and other photosynthetic organisms in the gradual change in the composition of the atmosphere over Earth’s geologic history

#### ESS2.D.9

* Identify human activities that increase carbon dioxide concentration in the atmosphere
* Explain and predict the effect of increased carbon dioxide concentrations in Earth’s atmosphere on the climate

### Crosscutting Concept Assessment Target(s)

CCC5 Identify that the total amount of energy and matter in closed systems is conserved

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides list of relevant and irrelevant components to develop or complete an incomplete model of the carbon cycle:

* Selects/adds components or labels those components to complete the model of the carbon cycle (2.1.1, ESS2.D.8, and CCC5)

Task provides a scenario and an incomplete model illustrating human activities, such as fossil fuel combustion and/or their effects on the carbon cycle:

* Completes the model to predict changes in the carbon cycle due to human activities (e.g., as burning coal for electricity increases, carbon dioxide concentration in the atmosphere increases) (2.1.1, ESS2.D.9, and CCC5)
* Completes the model to predict environmental changes as a result of human activities (e.g., as carbon dioxide concentration in the atmosphere increases, sea level rises) (2.1.1, ESS2.D.9, and CCC5)

Task provides a diagram of a simple mathematical model of the carbon cycle:

* Determines the relative amounts and rates of carbon transfer between spheres (2.1.2, ESS2.D.8, and CCC5)

Task provides a diagram of the components of the carbon cycle but does not show connections between the pools or illustrate the fluxes:

* Labels connections between components (2.1.3, ESS2.D.8, and CCC5)
* Indicates the direction of carbon transfer between the components (2.1.3, ESS2.D.8, and CCC5)

## California Environmental Principles and Concepts

* EP3: Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.
* EP4: The exchange of matter between natural systems and human societies affects the long-term functioning of both.

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Storage and movement of carbon in various reservoirs (e.g., carbon cycling within the ocean)
* Capture of carbon from the atmosphere by producers
* Impact of the amount of carbon dioxide in the atmosphere on climate
* Model of atmospheric change in the geologic record
* Role of human activity (e.g., fossil fuel usage, agricultural practices, and urban development) on the composition of the atmosphere

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Carbon can be lost during transfer between sinks.
* The carbon cycle is composed of only the processes of photosynthesis and respiration.
* The only source of carbon for living things is the atmosphere.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-ESS2-6 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-ESS2-6 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-ESS2-6%20Evidence%20Statements%20June%202015%20asterisks.pdf)

California Environmental Principles and Concepts <http://californiaeei.org/abouteei/epc/>

California Education and the Environment Initiative <http://californiaeei.org/>

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>

Appendix 2: Connections to Environmental Principles and Concepts <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix2.pdf>

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