# Earth and Space Sciences—High School

# Alternate Item Content Specifications

**Prepared for the California Department of Education by Educational Testing Service**



**Presented August 1, 2020**



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## HS-ESS1-1 Earth’s Place in the Universe

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify components of a model illustrating that the Sun releases light and heat energy that eventually reaches Earth. | 1. Ability to describe components of a model illustrating that the Sun releases light and heat energy, which make life on Earth possible. | Recognize that the Sun is the source of most of the energy on Earth. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation.** [Clarification Statement: Emphasis is on the energy transfer mechanisms that allow energy from nuclear fusion in the sun’s core to reach Earth. Examples of evidence for the model include observations of the masses and lifetimes of other stars, as well as the ways that the sun’s radiation varies due to sudden solar flares (space weather), the 11-year sunspot cycle, and non-cyclic variations over centuries.] *[Assessment Boundary*: *Assessment does not include details of the atomic and sub-atomic processes involved with the sun’s nuclear fusion.]*

### Mastery Statements

Students will be able to:

* Recognize that the light seen during the day comes from the Sun
* Recognize that the Sun produces heat that warms Earth
* Identify that plants and animals need the heat and light of the Sun to survive

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Food chains with the Sun as the start of the food chain.
* A model showing the energy transfer between the Sun and Earth
* The Sun releases energy similar to burning wood or natural gas on Earth, but on a more massive scale.

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS1-1

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess1-1.docx>

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

The *2016 Science Framework for California Public Schools Kindergarten through Grade Twelve* <https://www.cde.ca.gov/ci/sc/cf/cascienceframework2016.asp>

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## HS-ESS1-4 Earth’s Place in the Universe

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Using a model, describe how Earth’s motion causes changes over time (e.g., seasons, ice ages). | 1. Ability to use a model to describe how the Earth’s motion causes changes over time. | Identify orbiting objects in the solar system. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.** [Clarification Statement: Emphasis is on Newtonian gravitational laws governing orbital motions, which apply to human-made satellites as well as planets and moons*.*] *[Assessment Boundary: Mathematical representations for the gravitational attraction of bodies and Kepler’s laws of orbital motions should not deal with more than two bodies, nor involve calculus.]*

### Mastery Statements

Students will be able to:

* Identify the Sun in a diagram of the solar system
* Identify the Moon in a diagram of the solar system
* Identify planets in a diagram of the solar system (does not include name of individual planets)
* Identify how the motion of Earth causes day and night
* Identify how the motion and tilt of Earth causes the seasons
* Identify the season in the northern hemisphere based on the location and tilt of Earth relative to the Sun

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Simple models of the Sun-Moon-Earth system
* Models showing the effect of Earth’s rotation on its axis
* Models showing the effect of Earth’s tilt on which part of Earth receives the most direct sunlight
* Models showing the position of Earth relative to the Sun at different times of the year

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS1-4

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess1-4.docx>

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

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## HS-ESS1-5 Earth’s Place in the Universe

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify the relationship between the motion of continental plates and how materials of different ages are arranged on Earth’s surface. | 1. Ability to identify the relationship between the motion of tectonic plates and how materials of different ages are arranged on Earth’s surface. | Identify that the Earth has continental and oceanic crusts. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.** [Clarification Statement: Emphasis is on the ability of plate tectonics to explain the ages of crustal rocks. Examples include evidence of the ages of oceanic crust increasing with distance from mid-ocean ridges (a result of plate spreading) and the ages of North American continental crust decreasing with distance away from a central ancient core of the continental plate (a result of past plate interactions).]

### Mastery Statements

Students will be able to:

* Identify that Earth has continental and oceanic crusts
* Identify the age of materials based on their arrangement on Earth’s surface
* Identify the relationship between the motion of tectonic plates

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Diagrams showing continental and oceanic crust
* The increasing age of oceanic crust from a ridge to a trench
* The difference in age between continental crust and ocean crust
* The cycle of ocean crust formation and destruction in the continental crust history

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS1-5

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess1-5.docx>

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

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## HS-ESS2-2 Earth’s Systems

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Identify relationships, using a model, of how the Earth’s surface is a complex and dynamic set of interconnected systems (e.g., geosphere, hydrosphere, atmosphere, biosphere). | 1. Ability to identify relationships, using a model, of how Earth’s surface is a complex and dynamic set of interconnected systems. | Recognize that climate change occurs when the Earth’s systems are changed. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Analyze geoscience data to make the claim that one change to Earth’s surface can create feedbacks that cause changes to other Earth’s systems.** [Clarification Statement: Examples should include climate feedbacks, such as how an increase in greenhouse gases causes a rise in global temperatures that melts glacial ice, which reduces the amount of sunlight reflected from Earth’s surface, increasing surface temperatures and further reducing the amount of ice. Examples could also be taken from other system interactions, such as how the loss of ground vegetation causes an increase in water runoff and soil erosion; how dammed rivers increase groundwater recharge, decrease sediment transport, and increase coastal erosion; or how the loss of wetlands causes a decrease in local humidity that further reduces the wetland extent.]

### Mastery Statements

Students will be able to:

* Recognize an effect on climate resulting from a change in an Earth system
* Identify an effect on one system of a change in a different system
* Identify how a change in one system caused an effect in a different system

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Clouds, volcanic eruptions, precipitation, or ice in climate change
* Greenhouse gas effect on global temperature and ice caps
* The effect on the upstream environment (hydrosphere and biosphere) from damming a river
* The effect on the environment (hydrosphere, geosphere, and biosphere) of removing plants and leaving bare soil
* The effect on the atmosphere of removing plants and leaving bare soil
* The effect on the environment (hydrosphere, geosphere, and biosphere) of an overpopulation of herbivores

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS2-2

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess2-2.docx>

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

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## HS-ESS2-3 Earth’s Systems

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Use a model of Earth to identify the motion of the mantle and its plates occurs primarily through thermal convection, which is primarily driven by radioactive decay within Earth’s interior. | 1. Ability to use a model to identify that the motions of the mantle and its plates occur primarily through thermal convection. 2. Ability to identify Earth’s core as the primary source of the heat that drives mantle convection by using a model. | Use a model of Earth to identify the inner core, the outer core, the mantle, and the crust. |

### CA NGSS Performance Expectation

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.]

### Mastery Statements

Students will be able to:

* Identify the inner core of Earth
* Identify the outer core of Earth
* Identify the mantle of Earth
* Identify the crust of Earth
* Identify thermal convection as the cause of the movement of tectonic plates
* Recognize Earth’s core is the primary source of heat that drives mantle convection

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Models of the layers of Earth
* The direction of convection currents in the mantle and the relative direction of plate movements
* The direction of the flow of material (thermal convection) in Earth’s mantle
* Relationship of thermal convection to heat in Earth’s core
* Effect of thermal convection on Earth’s surface and interior

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS2-3

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess2-3.docx>

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

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## HS-ESS2-5 Earth’s Systems

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Observe and identify the effect of water on the Earth’s materials and surface processes (e.g., stream transportation and deposition, erosion, frost wedging). | 1. Identify the effects of water on the Earth's materials and surface processes. | Recognize that water can erode rocks and soil. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.** [Clarification Statement: Emphasis is on mechanical and chemical investigations with water and a variety of solid materials to provide the evidence for connections between the hydrologic cycle and system interactions commonly known as the rock cycle. Examples of mechanical investigations include stream transportation and deposition using a stream table, erosion using variations in soil moisture content, or frost wedging by the expansion of water as it freezes. Examples of chemical investigations include chemical weathering and recrystallization (by testing the solubility of different materials) or melt generation (by examining how water lowers the melting temperature of most solids).]

### Mastery Statements

Students will be able to:

* Identify that water can move rocks and soil
* Identify the effects of fast-moving water on hillsides
* Identify that when fast-moving water slows, it drops rocks and dirt on the bottom of the waterway
* Identify that when water repeatedly freezes in cracks, it can eventually cause the cracks to become bigger
* Identify that layers of soil and rock can build up where fast-moving water slows and drops rock and soil

### Environmental Principles and Concepts

Principle 1—The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Erosion of hillsides after heavy storms moves materials downhill
* Frost wedging causes large rocks to break into smaller pieces
* Creation of layers formed when rock and soil are deposited by water
* Movement of rock and soil down streams

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS2-5

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess2-5.docx>

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

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## HS-ESS3-1 Earth and Human Activity

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Explain the cause and effect relationship between human activity (e.g., population size, where humans live, types of crops grown) and changes in the amounts of natural resources, the occurrence of natural hazards or changes in climate using evidence. | 1. Ability to explain the cause and effect relationship between human activity and changes in the amounts of natural resources using evidence. 2. Ability to explain the cause and effect relationship between human activity and changes in the occurrence of natural hazards using evidence. 3. Ability to explain the cause and effect relationship between human activity and changes in the climate using evidence. | Match the effect of a natural hazard (e.g., hurricanes, floods, droughts) on a human activity. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.** [Clarification Statement: Examples of key natural resources include access to fresh water (such as rivers, lakes, and groundwater), regions of fertile soils such as river deltas, and high concentrations of minerals and fossil fuels. Examples of natural hazards can be from interior processes (such as volcanic eruptions and earthquakes), surface processes (such as tsunamis, mass wasting and soil erosion), and severe weather (such as hurricanes, floods, and droughts). Examples of the results of changes in climate that can affect populations or drive mass migrations include changes to sea level, regional patterns of temperature and precipitation, and the types of crops and livestock that can be raised.]

### Mastery Statements

Students will be able to:

* Identify effect of natural hazards on human activities
* Recognize the relationship between human activities and the amount of natural resources
* Recognize the relationship between human activities and natural hazards
* Recognize the relationship between human activities and climate change

### Environmental Principles and Concepts

Principle 1—The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

Principle 2—The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Principle 3—Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Principle 4—The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Principle 5—Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* The incidence of natural disasters
* Climate trends
* Changes in sea level and coastline over time
* Relationships between current population density and impact of natural disasters
* Relationships between current population density and availability of natural resources

### Additional Assessment Boundaries

* Natural hazards are limited to volcanic eruptions, earthquakes, flooding waves, landslides, soil erosion, floods, and droughts.

### Additional References

California Science Test Item Specification for HS-ESS3-1

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess3-1.docx>

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

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## HS-ESS3-3 Earth and Human Activity

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Compare models to determine the effects of a conservation strategy to manage natural resources and to sustain human society and plant and animal life. | 1. Ability to identify effects of a conservation strategy to manage natural resources and to sustain human society and plant and animal life. | Identify human activities that result in positive or negative impacts on land, ocean, atmosphere, or biosphere resources. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.** [Clarification Statement: Examples of factors that affect the management of natural resources include costs of resource extraction and waste management, per-capita consumption, and the development of new technologies. Examples of factors that affect human sustainability include agricultural efficiency, levels of conservation, and urban planning*.] [Assessment Boundary: Assessment for computational simulations is limited to using provided multi-parameter programs or constructing simplified spreadsheet calculations.]*

### Mastery Statements

Students will be able to:

* Identify positive environmental impacts due to human activities
* Identify negative environmental impacts due to human activities
* Recognize the effects of conservation strategies
* Identify appropriate conservation strategies for environmental challenges

### Environmental Principles and Concepts

Principle 1—The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

Principle 2—The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Principle 3—Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Principle 4—The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Principle 5—Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Human population growth and impact on natural systems
* Changes in biodiversity due to human impact
* Farming practices
* Urban development practices
* Strategies to save water
* Strategies to increase the use of clean energy

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS3-3

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess3-3.docx>

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

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## HS-ESS3-6 Earth and Human Activity

| California Science Connector | Focal Knowledge, Skills, and Abilities | Essential Understanding |
| --- | --- | --- |
| Use representations to identify the relationships among Earth systems and how those relationships are being modified due to human activity (e.g., increase in atmospheric carbon dioxide, increase in ocean acidification, effects on organisms in the ocean (coral reef), carbon cycle of the ocean, possible effects on marine populations). | 1. Ability to use representations to identify the relationships among Earth systems and how those relationships are being modified due to human activity. | Recognize that some human activities have negative consequences for Earth’s air, water, plants, and animals. |

### CA NGSS Performance Expectation

Students who demonstrate understanding can:

**Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.** [Clarification Statement: Clarification Statement: Examples of Earth systems to be considered are the hydrosphere, atmosphere, cryosphere, geosphere, and/or biosphere. An example of the far-reaching impacts from a human activity is how an increase in atmospheric carbon dioxide results in an increase in photosynthetic biomass on land and an increase in ocean acidification, with resulting impacts on sea organism health and marine populations.] *[Assessment Boundary: Assessment does not include running computational representations but is limited to using the published results of scientific computational models.]*

### Mastery Statements

Students will be able to:

* Identify a negative effect on Earth’s systems caused by human activity
* Recognize the relationship between Earth’s systems and how human activity affects the relationship
* Use evidence to identify a change in Earth’s systems due to human activity

### Environmental Principles and Concepts

Principle 1—The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.

Principle 2—The long-term functioning and health of terrestrial, freshwater, coastal, and marine ecosystems are influenced by their relationships with human societies.

Principle 3—Natural systems proceed through cycles that humans depend upon, benefit from, and can alter.

Principle 4—The exchange of matter between natural systems and human societies affects the long-term functioning of both.

Principle 5—Decisions affecting resources and natural systems are based on a wide range of considerations and decision-making processes.

### Possible Phenomena or Contexts

*Note that the list in this section is not exhaustive or prescriptive.*

**Possible contexts include the following:**

* Effect of increases in ocean temperatures on marine life
* Acidification of surface waters
* Changes in precipitation trends
* Decreases in available freshwater resources
* Soil erosion caused by farming or ranching practices
* Air or water pollution

### Additional Assessment Boundaries

* None listed at this time

### Additional References

California Science Test Item Specification for HS-ESS3-6

<https://www.cde.ca.gov/ta/tg/ca/documents/itemspecs-hs-ess3-6.docx>

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