

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

California Science Test—Item Content Specifications

**HS-ESS1-1 Earth's Place in the Universe**

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 in the form of radiation.

| 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. | ESS1.A: The Universe and Its Stars  1. The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.  PS3.D: Energy in Chemical Processes and Everyday Life Nuclear fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation. *(secondary to HS-ESS1-1)* | Scale, Proportion, and Quantity The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. |

[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.*]

## 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

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

### Disciplinary Core Idea Assessment Targets

#### ESS1.A.5

* Identify the source of the Sun’s fuel as mainly hydrogen
* Identify helium and energy as the products of fusion processes in the Sun
* Use evidence to develop the model that the Sun, like all stars, has a life span based primarily on its initial mass and that the Sun’s life span is approximately 10 billion years

#### PS3.D.6

* Describe the process of radiation being released due to fusion processes and how that energy reaches Earth
* Use a model to predict how the relative amounts of hydrogen to helium change as the Sun ages
* Describe qualitatively that the scale of energy released by fusion processes is much greater than the scale of energy released by chemical processes
* Identify that the amounts of energy flowing out of the Sun over its life span cannot be produced by chemical processes but rather fusion processes

### Crosscutting Concept Assessment Target(s)

CCC3 Identify that the significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides a Hertzsprung-Russell diagram for star sequences based on luminosity and temperature:

* Identifies the location of the Sun on the main sequence, relating its position to luminosity and mass (2.1.1, ESS1.A.5, and CCC3)

Task provides an incomplete model for the evolutionary track of main sequence stars as they age, which provides a representation for proto-stars, as well as very mature red giants nearing the end of their lifetimes:

* Completes the model by adding the Sun, correctly predicting that the Sun’s total lifetime will be about 10 to 11 billion years (2.1.1, ESS1.A.5, and CCC3)

Task provides a comparison of solar observations:

* Identifies the limitation of a theoretical model, as well as drawing conclusions about features of Earth (such as its atmosphere and magnetic field) that act as obstacles to observing features of stars (2.1.3, ESS1.A.5, PS3.D.6, and CCC3)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* A data set describing the mass, diameter, composition, and energy outputs of the Sun
* A graph of the hydrogen to helium ratio in the Sun over time
* A Hertzsprung-Russell diagram comparing the Sun to other stars
* A demonstration of how energy transfers in the Sun and between the Sun and Earth
* A graph of average solar radiation reaching Earth and/or number of sunspots over a period of time

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Stars release energy with a combustion reaction similar to burning wood or natural gas on Earth, but on a more massive scale.
* Stars are eternal, discrete objects that do not rotate, move, or change.
* Stars do not experience the force of gravity.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-ESS1-1 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-ESS1-1 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-ESS1-1%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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