Tracing Sunlight

Build an evidence-based model of the Sun's life span and energy flow.

ES.ESS1.1 "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 convert matter to energy that eventually reaches Earth in the form of radiation."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle each stage in the Sun's life span, underline evidence that supports the passage's model, and number the steps that move energy from the core to Earth.

From the Sun's Core to Earth

1. About 4.6 billion years ago, a cloud of gas and dust collapsed under gravity. Its center heated until hydrogen nuclei could fuse. This marked the Sun's entry into its long main-sequence stage. In the core, hydrogen nuclei ultimately form helium nuclei. The helium produced has slightly less mass than the hydrogen used; some mass becomes energy. The equation $E = mc^2$ describes this conversion. Measurements of particles called neutrinos arriving from the Sun, along with its observed light, support a model in which fusion powers the core. The Sun is still in this stage today.

2. Energy made in the core does not shoot straight to Earth. Most of it first moves outward through the Sun's dense interior, where radiation is repeatedly absorbed and reemitted. Motion of hot gas carries energy through the outer layers. At the visible surface, the Sun releases radiation, including visible light, infrared, and ultraviolet. This radiation crosses space to Earth in about eight minutes. Sunlight warms the ground and supplies energy for photosynthesis. A useful model must show both the change from mass to energy in the core and the path energy takes before reaching Earth. It should not show one unchanged photon traveling directly from the core.

3. Core hydrogen will not last forever. In roughly five billion years, the Sun will leave the main sequence as its core hydrogen supply runs low. Its outer layers will swell, forming a red giant; fusion of helium will later occur in its core. The Sun lacks enough mass to end as a supernova. Instead, it will shed its outer layers, leaving a hot, dense white dwarf that slowly cools. Astronomers observe stars at different stages and use their masses, temperatures, and brightness to test models of stellar aging. These observations help predict the Sun's future, which no human can watch unfold directly.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which observation from the passage supports placing fusion in the Sun's core? How would you add that observation to a model?

2. Write a sequence for a model showing how matter in the core becomes radiation that reaches Earth.

3. Place the Sun's present stage and its next two stages in order. Why should your model not end with a supernova?

4. A model shows one unchanged photon traveling straight from the core to Earth. What should be changed to match the passage?

3 YOUR TURN

Your own words

Draw a labeled model of the Sun's life span, from the collapsing cloud to the white dwarf. Zoom in on today's Sun to show how fusion converts some mass to energy and how that energy reaches Earth, and add two brief evidence notes supporting your model.

ANSWER KEY

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PART 1 · READ AND MARK

Circle each stage in the Sun's life span, underline evidence that supports the passage's model, and number the steps that move energy from the core to Earth. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which observation from the passage supports placing fusion in the Sun's core? How would you add that observation to a model?	**Neutrinos arriving from the Sun support core fusion. Add a note near the core that neutrinos from the Sun have been measured.**
2	Write a sequence for a model showing how matter in the core becomes radiation that reaches Earth.	**Hydrogen fuses into helium in the core, converting some mass to energy. Energy moves outward through the dense interior and outer gas layers. Radiation leaves the visible surface and crosses space to Earth.**
3	Place the Sun's present stage and its next two stages in order. Why should your model not end with a supernova?	**Main sequence, red giant, white dwarf. The Sun lacks enough mass to end as a supernova.**
4	A model shows one unchanged photon traveling straight from the core to Earth. What should be changed to match the passage?	**Show energy moving through the dense interior as radiation is absorbed and reemitted, then through the outer layers by moving gas. Show radiation traveling to Earth after it leaves the visible surface.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Life span: collapsing cloud → main-sequence Sun today → red giant → white dwarf. Zoom-in labels: hydrogen nuclei fuse into helium in the core; some mass becomes energy → radiation is repeatedly absorbed and reemitted in the dense interior → moving hot gas carries energy through outer layers → radiation leaves the visible surface → radiation reaches Earth. Evidence notes: Neutrinos arriving from the Sun support core fusion. Observations of stars with different masses, temperatures, and brightness help test the life-span model.

Accept models that distinguish energy moving through the Sun from radiation crossing space to Earth. Evidence notes should identify observations, not just repeat predicted stages.