Atoms on the Move

Trace how stars make and spread elements.

ESS.1.c "Obtain, evaluate, and communicate information about how nuclear fusion in stars and supernovas leads to the formation of all other elements."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two cause-and-effect statements about how elements form, and circle one piece of observational evidence. Number three steps that move material from a star into a later planet.

Where Did the Nail Come From?

1. An iron nail and the oxygen in your lungs have a history older than Earth. The early universe made mostly hydrogen and helium, with a little lithium. Inside stars, gravity squeezes matter until temperatures and pressures allow atomic nuclei to fuse. Fusion joins smaller nuclei into larger ones and releases energy in many of these steps. Stars like the Sun can make carbon and oxygen. In massive stars, later stages of fusion can build elements as heavy as iron. Building still heavier nuclei by ordinary fusion does not release energy, so a massive star cannot keep its core supported that way.

2. When a massive star's iron-rich core can no longer support its own weight, the core collapses. The collapse can trigger a supernova, an explosion that throws the star's outer layers into space. Extreme conditions during and after the explosion can make new nuclei, including some heavier than iron. Some heavy elements also form when nuclei capture neutrons during events such as collisions of neutron stars. This means the claim that every heavy element comes only from supernovas is too simple. Gas and dust carrying these elements spread through space, where they may join clouds that later form new stars and planets.

3. A scientist cannot watch an ancient atom form, but can test the story with light. Each element absorbs or emits a distinctive pattern of wavelengths. When astronomers detect an iron pattern in a star and patterns from other elements in a supernova's expanding debris, they identify what is present. The patterns alone do not reveal every step that formed those atoms. Scientists also compare observations with models of fusion, collapse, and neutron capture. Together, the evidence supports a chain of causes: stars build many elements, violent events make or scatter others, and later worlds inherit that material.

2 ANSWER WITH EVIDENCE

Use the passage

1. How can fusion make oxygen in a star, and why does ordinary fusion stop releasing energy when it tries to build nuclei heavier than iron?

2. Trace a cause-and-effect path from the collapse of a massive star's core to elements becoming part of a new planet.

3. A sign says, "Every heavy element forms only in a supernova." Use two details from the passage to evaluate this claim.

4. What can patterns in starlight and supernova debris tell astronomers, and what can those patterns not show on their own?

3 YOUR TURN

Your own words

Write a museum label for an iron nail displayed beside an oxygen tank. In 75 to 95 words, explain how their atoms formed and reached Earth, then include one statement about light-pattern evidence and one caution about what that evidence cannot show on its own.

ANSWER KEY

Atoms on the Move

HIGH SCHOOL · ESS.1.c

PART 1 · READ AND MARK

Underline two cause-and-effect statements about how elements form, and circle one piece of observational evidence. Number three steps that move material from a star into a later planet. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How can fusion make oxygen in a star, and why does ordinary fusion stop releasing energy when it tries to build nuclei heavier than iron?	**Fusion joins smaller nuclei into larger ones, allowing stars to make oxygen. Ordinary fusion that builds nuclei heavier than iron does not release energy.**
2	Trace a cause-and-effect path from the collapse of a massive star's core to elements becoming part of a new planet.	**Core collapse can trigger a supernova that throws material into space. Element-bearing gas and dust spread and may join a cloud that later forms a planet.**
3	A sign says, "Every heavy element forms only in a supernova." Use two details from the passage to evaluate this claim.	**The claim is too simple. Massive stars make elements as heavy as iron through fusion, and some heavy elements form when nuclei capture neutrons during neutron-star collisions.**
4	What can patterns in starlight and supernova debris tell astronomers, and what can those patterns not show on their own?	**Distinctive light patterns identify elements that are present. They cannot show every step by which those atoms formed.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

This nail and this oxygen tank hold atoms older than Earth. In massive stars, fusion built iron through several stages, while stars also made oxygen by fusing lighter nuclei. When a massive star collapsed, an explosion could scatter both elements into space. That material could join a cloud that later formed Earth. Astronomers find distinctive light patterns from elements in stars and supernova debris, evidence that those elements are present. Those patterns alone cannot show every step of an atom's formation, so scientists test the story against physical models.

Accept other accurate paths from stellar material to Earth. For the museum label, look for distinct explanations of element formation, dispersal, what light patterns establish, and their limit.