Where Iron Began

Follow evidence from the early universe to Earth

ESS.3.b "Construct an evidence-based explanation of the connections among various cosmic phenomena, citing leading scientific theories."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two observations that serve as evidence, circle the names of two scientific theories, and number four events in order from the early universe to Earth's iron.

An Iron Atom's Long Journey

1. Imagine tracing an iron atom in a meteorite backward through cosmic history. Distant galaxies show redshift: their light is stretched as space expands. Astronomers also detect a faint microwave glow from every direction, a cooled remnant of a hot early universe. Together, these observations support the Big Bang theory, which describes an expanding universe that began in a hot, dense state. As that universe cooled, it formed mostly hydrogen and helium, not much iron. The theory explains where the first star-building material came from, but most iron formed much later.

2. Gravity pulled some early gas into dense clouds. As a cloud contracted, its center heated until hydrogen nuclei fused, releasing energy and forming a star. The theory of stellar nucleosynthesis explains how stars build heavier nuclei through nuclear reactions. In massive stars, a sequence of fusion stages can produce elements up to iron in their cores. Light from stars contains distinctive spectral lines, which reveal elements in their outer layers. Those lines provide evidence that stars contain elements heavier than hydrogen and helium. Fusion explains how cosmic matter changes, while gravity explains why enough matter gathers for a star to form.

3. When a massive star exhausts fuel in its core, the core collapses and the star may explode as a supernova. Observed supernova debris shows spectral lines from heavy elements, evidence that explosions spread those elements into space. Later, gravity can gather enriched gas and dust into a new star and planets. Our solar system formed from such material; Earth contains iron that existed before Earth formed. Finding iron on Earth is therefore part of a longer story about matter moving and changing. The chain links cosmic expansion, star formation, element production, stellar explosions, and planet formation.

2 ANSWER WITH EVIDENCE

Use the passage

1. How do redshift and the microwave glow support the Big Bang theory's account of the first star-building material?

2. How do gravity and fusion work together to turn early gas into a star?

3. How does the theory of stellar nucleosynthesis connect massive stars to the heavy elements detected in space?

4. Why did a supernova have to occur before some of its heavy elements could become part of a new planetary system?

3 YOUR TURN

Your own words

A museum label claims, "The iron in a bicycle frame formed inside Earth." Write a replacement label of five or six sentences that traces the iron from the early universe to the frame. Connect at least three cosmic phenomena, name the Big Bang theory and the theory of stellar nucleosynthesis, and cite two distinct observations from the passage as evidence.

ANSWER KEY

Where Iron Began

HIGH SCHOOL · ESS.3.b

PART 1 · READ AND MARK

Underline two observations that serve as evidence, circle the names of two scientific theories, and number four events in order from the early universe to Earth's iron. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How do redshift and the microwave glow support the Big Bang theory's account of the first star-building material?	**Redshift shows that space expands, and the microwave glow is a remnant of a hot early universe. Together they support the Big Bang theory, which explains the origin of the early hydrogen and helium that later formed stars.**
2	How do gravity and fusion work together to turn early gas into a star?	**Gravity pulls gas into a contracting cloud. Its center heats until hydrogen nuclei fuse, releasing energy and forming a star.**
3	How does the theory of stellar nucleosynthesis connect massive stars to the heavy elements detected in space?	**The theory explains how nuclear reactions in stars build heavier elements, including iron in massive stars. Spectral lines from stars and supernova debris provide evidence that heavy elements exist in stars and are spread into space.**
4	Why did a supernova have to occur before some of its heavy elements could become part of a new planetary system?	**A supernova spreads heavy elements into space. Gravity can later gather the enriched gas and dust into a new star and planets.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Redshift in distant galaxies supports the Big Bang theory, which explains why the early universe contained mostly hydrogen and helium. Gravity gathered some of that gas into stars. According to the theory of stellar nucleosynthesis, fusion in massive stars made iron. Spectral lines in observed supernova debris show that explosions spread heavy elements into space. Gravity later gathered some enriched material into the solar system, including Earth. People mined Earth's iron and made it into the steel of a bicycle frame.

Accept explanations that correctly distinguish where early hydrogen and helium formed from where iron formed. For the replacement label, check for five or six sentences, both named theories, at least three connected phenomena, and two distinct observations used as evidence.