

Signals From Space

Use three astronomical clues to explain an expanding universe.

HS-ESS1-2 "Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Underline the observation in each paragraph, then number the evidence clues 1, 2, and 3. In the margin, write a short note showing how each clue supports the Big Bang theory.

Three Clues to Cosmic History

- ① When astronomers spread a galaxy's light into a spectrum, they see dark or bright lines linked to particular elements. For distant galaxies, these familiar lines are shifted toward the red end of the spectrum. This red shift means the light waves have been stretched while traveling through space. A useful comparison is dots drawn on a balloon: as the balloon inflates, every dot moves farther from the others. In a similar way, space is expanding, so most distant galaxies are moving away from us. More distant galaxies usually show larger red shifts, supporting an expanding universe.
- ② Another clue comes from the cosmic microwave background, a faint glow of microwave radiation arriving from every direction in space. It is not light from a nearby object. Instead, it is cooled radiation left over from an early time when the universe was much hotter and denser. As the universe expanded, this radiation stretched to longer wavelengths and cooled. Scientists measured a nearly uniform background with tiny temperature differences. The Big Bang theory predicts such remnant radiation from a hot, dense early universe. Its existence and properties therefore support the idea that the universe has changed greatly since its beginning.
- ③ A third line of evidence concerns ordinary matter, the atoms in stars, planets, and interstellar gas. Spectra from stars and gas clouds reveal which elements are present because each element produces a recognizable pattern of lines. Observations show that ordinary matter is mostly hydrogen, with much of the rest helium. By mass, the overall amounts are close to three quarters hydrogen and one quarter helium, although stars also contain small amounts of heavier elements. Big Bang theory predicts that an early hot universe made mostly hydrogen and helium. The agreement between predicted and observed proportions strengthens the explanation, especially when combined with red shift and the microwave background.

2 ANSWER WITH EVIDENCE _____ Use the passage

1 How do red-shifted spectral lines from distant galaxies support the claim that the universe is expanding?

2 What is the cosmic microwave background, and why does it support the Big Bang theory?

3 What composition of ordinary matter is observed, and how does it match a Big Bang prediction?

4 Construct a brief explanation using all three clues to show why scientists support the Big Bang theory.

3 YOUR TURN _____ Your own words

Write a four-sentence museum label titled "How We Know." State the Big Bang explanation, then connect red shift, the cosmic microwave background, and the hydrogen-helium composition of ordinary matter to that explanation.

PART 1 • READ AND MARK

Underline the observation in each paragraph, then number the evidence clues 1, 2, and 3. In the margin, write a short note showing how each clue supports the Big Bang theory. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	How do red-shifted spectral lines from distant galaxies support the claim that the universe is expanding?	The shifted lines show that light waves were stretched as space expanded, meaning most distant galaxies are moving away from us. Larger red shifts for more distant galaxies further support expansion.
2	What is the cosmic microwave background, and why does it support the Big Bang theory?	It is faint, cooled microwave radiation arriving from every direction in space. It supports the theory because it matches the predicted remnant radiation from a much hotter, denser early universe.
3	What composition of ordinary matter is observed, and how does it match a Big Bang prediction?	Ordinary matter is about three quarters hydrogen and one quarter helium by mass, with small amounts of heavier elements. This matches the prediction that the early universe made mostly hydrogen and helium.
4	Construct a brief explanation using all three clues to show why scientists support the Big Bang theory.	Red shifts show that space is expanding and distant galaxies are moving away. The cosmic microwave background is cooled remnant radiation from a hot, dense early universe. Observed amounts of hydrogen and helium match Big Bang predictions, so the three independent clues support the theory together.

PART 3 • YOUR TURN (SAMPLE ANSWER)

The Big Bang theory explains that the universe began in a hot, dense state and has expanded over time. Red-shifted lines in galaxy spectra show that distant galaxies are moving away as space expands. The cosmic microwave background is cooled radiation left from the early hot universe. The observed abundance of about three quarters hydrogen and one quarter helium also matches what the theory predicts.

Accept accurate paraphrases that identify all three evidence sources and explain their connection to the Big Bang theory. For the open response, require four sentences and a clear causal link between each clue and the explanation.