Clues in Light

Read the evidence for a hot beginning and an expanding universe.

ESS.1A.1 "Describe the Big Bang theory and summarize observations (e.g., cosmic microwave background radiation, Hubble's law, and redshift caused by the Doppler effect) as evidence to support the formation and expansion of the universe."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two statements about what the Big Bang theory proposes, circle one observation that supports an early hot state, and number two clues of expansion 1 and 2. Use your marks to connect each claim with evidence.

What Light Tells Us

1. Imagine rewinding a movie of the night sky, not to a tiny ball sitting in darkness, but to a time when the observable universe was far hotter and denser. The Big Bang theory describes the universe expanding from that early state about 13.8 billion years ago. Space itself expanded, so the theory does not require matter to blast outward into a preexisting empty room. As expansion continued, the universe cooled. Particles formed atoms, and gravity later gathered matter into stars and galaxies. Scientists test this account by looking for traces of that early heat and for signs that space is still expanding.

2. One trace is the cosmic microwave background, a faint microwave glow arriving from all directions. It comes from light released when the young universe cooled enough for electrons and nuclei to form neutral atoms, about 380,000 years after the Big Bang. Before then, light repeatedly scattered off free electrons. Once atoms formed, light could travel much farther without scattering. As space expanded, the light's wavelength stretched from a hot early glow into microwaves we detect today. Its nearly uniform temperature across the sky supports the idea that the early universe was hot and dense, rather than a collection of unrelated local events.

3. Galaxies offer another test. Astronomers compare the known pattern of an element's light with the same pattern from a galaxy. In many galaxies, that pattern shifts toward longer, redder wavelengths. For nearby galaxies, this redshift can be described with the Doppler effect: light waves from a receding source arrive stretched. Across great cosmic distances, the expansion of space itself stretches light during its journey. Hubble's law describes a larger pattern: on average, galaxies farther away recede faster than closer ones. That distance-speed relationship fits a universe whose space is expanding. Together, redshift and the microwave background connect ongoing expansion to a hot beginning.

2 ANSWER WITH EVIDENCE

Use the passage

1. A visitor says the Big Bang was matter exploding into a room of empty space. How would you correct that idea?

2. Why does a faint microwave glow arriving from all directions support the idea of a hot early universe?

3. A galaxy's light shifts toward longer wavelengths. How can this support expansion, and what causes the shift across great cosmic distances?

4. One galaxy is 100 million light-years away, and another is 200 million light-years away. Which would Hubble's law predict is receding faster, and how does that pattern support expansion?

3 YOUR TURN

Your own words

Write a 75 to 95 word museum label for a visitor who thinks the Big Bang was an explosion into empty space. Correct that idea, use the cosmic microwave background, redshift, and Hubble's law as evidence, and invent an everyday comparison for one piece of evidence; name one way your comparison falls short.

ANSWER KEY

Clues in Light

HIGH SCHOOL · ESS.1A.1

PART 1 · READ AND MARK

Underline two statements about what the Big Bang theory proposes, circle one observation that supports an early hot state, and number two clues of expansion 1 and 2. Use your marks to connect each claim with evidence. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	A visitor says the Big Bang was matter exploding into a room of empty space. How would you correct that idea?	**The theory describes the universe expanding from a hot, dense early state. Space itself expanded; matter did not explode into a preexisting empty room.**
2	Why does a faint microwave glow arriving from all directions support the idea of a hot early universe?	**The glow is ancient light released when the young universe cooled enough for atoms to form. Expansion stretched that light into the microwaves detected today.**
3	A galaxy's light shifts toward longer wavelengths. How can this support expansion, and what causes the shift across great cosmic distances?	**The redshift indicates recession. The Doppler effect can describe the shift for nearby galaxies, while the expansion of space stretches light traveling across great cosmic distances.**
4	One galaxy is 100 million light-years away, and another is 200 million light-years away. Which would Hubble's law predict is receding faster, and how does that pattern support expansion?	**The galaxy 200 million light-years away would generally recede faster. Faster recession at greater distances fits a universe whose space is expanding.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The Big Bang was not a blast into an empty room. Space expanded from a hot, dense early state. The cosmic microwave background is ancient light, now stretched into microwaves, that reaches us from all directions. Many galaxies have redshifted light, showing that they are receding; Hubble's law shows that farther galaxies generally recede faster. Think of dots on a stretching rubber band: distant dots separate faster. Unlike a rubber band, space is not a strip sitting inside a larger room.

Accept different everyday comparisons if they clarify an observation and identify a genuine limit. For redshift, accept a Doppler explanation for nearby galaxies, but do not require students to describe distant cosmological redshift as solely a Doppler effect.