Clues Across Space

Use galaxy data and ancient light to examine the expanding universe.

ESS.1A "Students will develop an understanding of the universe, its development, immense size, and composition. Describe the Big Bang theory and summarize observations (e.g., cosmic microwave background radiation, Hubble's law..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two different observations that support the Big Bang model, then circle the distance and speed values for the closest and farthest galaxies in the table to trace the pattern of expansion.

How Can We Tell Space Is Expanding?

1. Imagine light traveling between galaxies for millions of years. The Big Bang theory says the observable universe was once in a hot, dense state about 13.8 billion years ago. Space has since expanded and cooled. This was not matter exploding into empty space from one central point. Instead, distances between widely separated galaxies have generally increased.

2. Astronomers split galaxy light into a spectrum and compare its lines with lines measured in a lab. When a distant galaxy's lines shift toward longer, redder wavelengths, they call this a redshift. Like the Doppler effect for a receding source, redshift signals increasing separation. For distant galaxies, expanding space stretches the light as it travels.

IDEALIZED GALAXY MEASUREMENTS (1 MPC IS ABOUT 3.26 MILLION LIGHT-YEARS)

Distance (Mpc)	Recession speed (km/s)
50	3,500
100	7,000
200	14,000
300	21,000

3. The table models galaxy measurements: speeds come from redshift, while distances come from other methods. A distance-speed pattern supports Hubble's law, the idea that more distant galaxies generally recede faster. A different clue is the cosmic microwave background, faint radiation detected in every direction. This light began in the early, hot universe and stretched to microwave wavelengths as space expanded.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare the galaxies at 50 Mpc and 200 Mpc. How do both their distances and recession speeds change?

2. How does a shift in a distant galaxy's spectrum provide evidence that its separation from us is increasing?

3. What pattern in the table supports Hubble's law? Use two rows as evidence.

4. What does the cosmic microwave background tell us about the early universe that the table does not show?

3 YOUR TURN

Your own words

A newly measured galaxy is 250 Mpc away. In three or four sentences, estimate its recession speed from the table, show how you found it, and explain how this prediction and the cosmic microwave background support different parts of the Big Bang model.

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PART 1 · READ AND MARK

Underline two different observations that support the Big Bang model, then circle the distance and speed values for the closest and farthest galaxies in the table to trace the pattern of expansion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare the galaxies at 50 Mpc and 200 Mpc. How do both their distances and recession speeds change?	**The distance increases fourfold, from 50 to 200 Mpc. The speed also increases fourfold, from 3,500 to 14,000 km/s.**
2	How does a shift in a distant galaxy's spectrum provide evidence that its separation from us is increasing?	**Its spectral lines shift toward longer, redder wavelengths. For a distant galaxy, expanding space stretches its light as the separation increases.**
3	What pattern in the table supports Hubble's law? Use two rows as evidence.	**More distant galaxies recede faster. For example, the galaxy at 100 Mpc recedes at 7,000 km/s, while the one at 300 Mpc recedes at 21,000 km/s.**
4	What does the cosmic microwave background tell us about the early universe that the table does not show?	**It is leftover light from the early, hot universe. The table shows a relationship between present-day galaxy distances and recession speeds.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The table shows 70 km/s of recession speed for each Mpc, so I predict 17,500 km/s at 250 Mpc. That speed follows the same distance-speed pattern as the listed galaxies. This pattern supports the expansion of space. The cosmic microwave background is leftover light from the early, hot universe, so it supports the model's account of an earlier hot state.

Accept equivalent comparisons and explanations grounded in the passage. For the open task, look for 17,500 km/s, a valid calculation or comparison, and distinct roles for the distance-speed pattern and cosmic microwave background.