Stars by the Numbers

Read H-R diagram data to compare stellar size, brightness, and type

ESS.1A.2 "Interpret information from the Hertzsprung -Russell diagram to differentiate types of stars, including our sun, according to size, magnitude, and classification."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two sentences that explain the H-R diagram's directions, circle the sentence that explains absolute magnitude numbers, and number the three star-class descriptions in the order they appear. Use your marks to interpret the table.

Where Stars Belong

1. Imagine plotting stars as points instead of drawing them as glowing circles. On a Hertzsprung-Russell (H-R) diagram, surface temperature runs from hot on the left to cool on the right. Brightness rises upward. Astronomers often use absolute magnitude for brightness, the magnitude a star would have at a standard distance. Lower absolute magnitude numbers mean brighter stars.

2. A star's place on this diagram helps reveal its classification. Main-sequence stars form a band from hot and bright to cool and faint. White dwarfs sit below that band because they are hot but faint. Red supergiants appear high on the cool side: their huge surfaces release much light even when their surfaces are relatively cool.

3. The table records approximate readings for five stars on an H-R diagram. Surface temperature and absolute magnitude locate each star; size compares its radius with the Sun's radius. These are not apparent magnitudes, which depend on distance from Earth. Read across a row, then compare rows: two stars with similar temperatures can differ greatly in size, brightness, and classification.

APPROXIMATE H-R DIAGRAM READINGS

Star	Surface temperature (K)	Absolute magnitude	Radius (Sun = 1)	Classification
Sun	5,770	4.8	1	Main sequence
Sirius A	9,900	1.4	1.7	Main sequence
Betelgeuse	3,500	-5.6	about 700	Red supergiant
Sirius B	25,000	11.3	0.008	White dwarf
Proxima Centauri	3,000	15.5	0.15	Main sequence

2 ANSWER WITH EVIDENCE

Use the passage

1. How do Sirius A and the Sun compare in size and absolute magnitude? What classification do they share?

2. Betelgeuse and Proxima Centauri are both cool stars. Use their sizes and absolute magnitudes to explain why they have different classifications.

3. Which star belongs toward the lower left of an H-R diagram? Explain using its temperature, absolute magnitude, size, and classification.

4. Put Sirius A, the Sun, and Proxima Centauri in order along the main sequence from upper left to lower right. Which table values support your order?

3 YOUR TURN

Your own words

Invent a main-sequence star that could lie between the Sun and Proxima Centauri on an H-R diagram. Give a plausible surface temperature, absolute magnitude, and radius compared with the Sun, then explain how those values support its classification.

ANSWER KEY

Stars by the Numbers

HIGH SCHOOL · ESS.1A.2

PART 1 · READ AND MARK

Underline the two sentences that explain the H-R diagram's directions, circle the sentence that explains absolute magnitude numbers, and number the three star-class descriptions in the order they appear. Use your marks to interpret the table. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How do Sirius A and the Sun compare in size and absolute magnitude? What classification do they share?	**Sirius A has 1.7 times the Sun's radius and is brighter, with absolute magnitude 1.4 versus 4.8. Both are main-sequence stars.**
2	Betelgeuse and Proxima Centauri are both cool stars. Use their sizes and absolute magnitudes to explain why they have different classifications.	**Betelgeuse is a red supergiant, with a radius about 700 times the Sun's and a bright absolute magnitude of -5.6. Proxima Centauri is a much smaller, fainter main-sequence star, with a radius of 0.15 and an absolute magnitude of 15.5.**
3	Which star belongs toward the lower left of an H-R diagram? Explain using its temperature, absolute magnitude, size, and classification.	**Sirius B belongs toward the lower left. It is hot at 25,000 K but faint at absolute magnitude 11.3; its radius is 0.008 times the Sun's, and it is a white dwarf.**
4	Put Sirius A, the Sun, and Proxima Centauri in order along the main sequence from upper left to lower right. Which table values support your order?	**Sirius A, Sun, Proxima Centauri. Their temperatures decrease from 9,900 to 5,770 to 3,000 K, while their absolute magnitudes increase from 1.4 to 4.8 to 15.5, meaning they become fainter.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My star has a surface temperature of 4,100 K, an absolute magnitude of 9, and a radius 0.6 times the Sun's. It would lie to the right of and below the Sun, but to the left of and above Proxima Centauri. Its cooler temperature, fainter magnitude, and smaller size fit the main sequence between those two stars.

Accept reasonable approximate values for the invented star if its temperature is between 3,000 and 5,770 K, its absolute magnitude is between 4.8 and 15.5, and its radius is between 0.15 and 1 solar radius. For the questions, accept equivalent comparisons that correctly distinguish lower absolute magnitude numbers as brighter.