Stars by Coordinates

Use temperature and magnitude to interpret stellar properties

ESS.1.b "Interpret the Hertzsprung-Russell diagram to analyze the properties of stars, including density, magnitude, temperature, rates of fusion, and spectral class."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the sentence that tells you which way temperature changes across an H-R diagram, and circle the sentence that explains how magnitude numbers relate to brightness. Number the table rows from 1, brightest, to 4, faintest, using their absolute magnitudes.

Reading the Stars

(1) An H-R diagram places temperature across its horizontal axis, hottest at left, and brightness upward. Absolute magnitude measures brightness at a standard distance; smaller numbers mean brighter stars. The table gives four star types as temperature and absolute magnitude pairs. Treat each pair as coordinates for finding where that star type belongs on an H-R diagram.

STAR TYPES AS H-R DIAGRAM COORDINATES

Star type	Class; temperature	Absolute magnitude	Mean density	Core fusion
Blue main-sequence star	O; 35,000 K	−5	Low	Rapid
Sun-like main-sequence star	G; 5,800 K	+5	Moderate	Moderate
Red dwarf	M; 3,000 K	+13	High	Slow
White dwarf	DA; 12,000 K	+12	Extremely high	None

(2) On the main sequence, hotter, brighter stars generally fuse hydrogen faster than cooler, fainter stars. This band runs from upper left to lower right on an H-R diagram. Spectral classes O, B, A, F, G, K, and M run from hottest to coolest. Position alone does not reveal density: comparing density also requires information about a star's mass and size.

(3) A white dwarf is a compact stellar remnant. Though hot, it is faint because its tiny surface area emits little total light. Its density is extremely high, and it has no sustained core fusion. White dwarfs lie below the main sequence. Spectral classes describe light patterns: O, G, and M label ordinary stars, while DA identifies a white dwarf showing hydrogen lines.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare the O star and the G star. Which belongs farther left and higher on an H-R diagram? How do their core fusion rates compare?

2. Where does the M red dwarf belong relative to the G star on an H-R diagram? Compare their mean densities and core fusion rates.

3. The DA white dwarf is hotter than the G star but fainter. Where does it belong relative to the G star, and why can a hotter star be fainter?

4. The DA white dwarf and M red dwarf are both faint. Use their temperatures, spectral classes, and core fusion rates to explain why they belong in different regions of an H-R diagram.

3 YOUR TURN

Your own words

Invent a plausible main-sequence star that would fall between the G star and M red dwarf in both temperature and absolute magnitude. Give it a spectral class, temperature, absolute magnitude, mean density, and core fusion rate, then explain its position compared with those two stars.

ANSWER KEY

Stars by Coordinates

HIGH SCHOOL · ESS.1.b

PART 1 · READ AND MARK

Underline the sentence that tells you which way temperature changes across an H-R diagram, and circle the sentence that explains how magnitude numbers relate to brightness. Number the table rows from 1, brightest, to 4, faintest, using their absolute magnitudes. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare the O star and the G star. Which belongs farther left and higher on an H-R diagram? How do their core fusion rates compare?	**The O star belongs farther left because it is hotter and higher because its absolute magnitude is smaller. Its core fusion is rapid, compared with the G star's moderate rate.**
2	Where does the M red dwarf belong relative to the G star on an H-R diagram? Compare their mean densities and core fusion rates.	**The M red dwarf belongs farther right and lower because it is cooler and fainter. Its mean density is higher, and its core fusion is slower.**
3	The DA white dwarf is hotter than the G star but fainter. Where does it belong relative to the G star, and why can a hotter star be fainter?	**The DA white dwarf belongs left of and below the G star. Its tiny surface area emits less total light despite its higher temperature.**
4	The DA white dwarf and M red dwarf are both faint. Use their temperatures, spectral classes, and core fusion rates to explain why they belong in different regions of an H-R diagram.	**The hotter DA white dwarf belongs left of the cool M red dwarf, although both are low on the diagram. DA identifies a white dwarf with no sustained core fusion; the M red dwarf is a main-sequence star that fuses hydrogen slowly.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My star is class K, with a surface temperature of 4,500 K and an absolute magnitude of +7. It would lie right of and below the G star, but left of and above the M red dwarf. I would expect its mean density to be higher than the G star's but lower than the M red dwarf's. Its core fusion would be slower than the G star's but faster than the M red dwarf's.

Accept temperatures strictly between 3,000 K and 5,800 K and magnitudes strictly between +5 and +13, with a consistent position. Class K is appropriate for many plausible choices; density and fusion comparisons should be reasonable inferences, not treated as exact values read from H-R coordinates.