

24.1 Stars, radiation and scale

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS flux • luminosity

Objective

Stars, radiation and scale. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

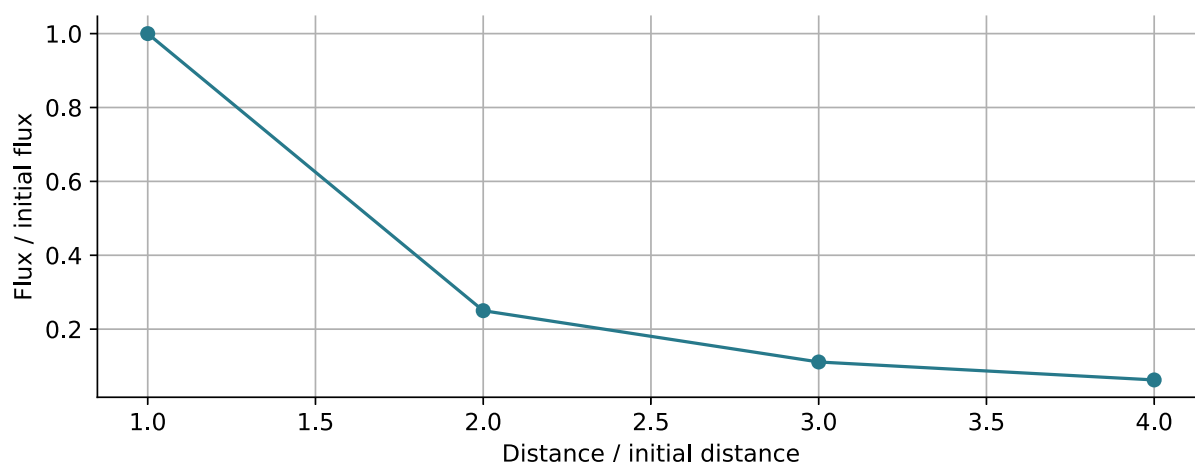
1 Key knowledge and worked examples

■ What would explain this observation?

- Two stars can have the same apparent brightness while having different luminosities. Distance changes the **flux** reaching an observer.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- **Luminosity** is total power emitted; flux is power received per area. A stellar spectrum carries information about surface temperature and composition. Fusion transfers energy as light nuclei combine.
- luminosity: Total emitted power; flux: Power received per unit area.



■ Choose evidence that can test it

- For isotropic emission without absorption, flux follows an inverse-square relationship with distance. Observed brightness alone therefore cannot establish luminosity.
 - Keep distance units consistent, identify which quantities are intrinsic to the star, and distinguish observational evidence from a model of stellar evolution. Do not confuse a red giant stage with every possible final remnant.
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■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: distance doubles while luminosity remains fixed. Use F proportional to $1/d^2$. Flux ratio = $1/2^2 = 1/4$. A flux of 12 units becomes 3 units. This assumes no change in absorption or source output.

Example:

A source gives flux 18 units. Find flux at three times the distance. Use the same sequence: known quantities $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- The Sun is not expected to become a supernova. Redshift can support cosmological expansion; it does not mean every nearby object must move away from every observer.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Apparent brightness alone always determines a star luminosity. This claim is false: The Sun is not expected to become a supernova. Redshift can support cosmological expansion; it does not mean every nearby object must move away from every observer.

Key:

Stars, radiation and scale: For isotropic emission without absorption, flux follows an inverse-square relationship with distance. Observed brightness alone therefore cannot establish luminosity.

2 Practice

2.1 At fixed luminosity, what happens to flux when distance doubles? Choose one answer.

- **A** It halves
- **B** It becomes one quarter
- **C** It doubles

[1]

2.2 A source gives flux 18 units. Find flux at three times the distance. Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: Apparent brightness alone always determines a star luminosity. [2]

2.4 Total emitted power: write the technical term. [1]

3 Exam-style questions

3.1 Identical sources have fluxes 8 and 2 units. Find their distance ratio. What ambiguity arises if luminosity is not known? [4]

Solutions

2.1 B For isotropic emission without absorption, flux follows an inverse-square relationship with distance. Observed brightness alone therefore cannot establish luminosity.

2.2 At three times the distance, $\text{flux} = 18/3^2 = 2$ units.

2.3 False. The Sun is not expected to become a supernova. Redshift can support cosmological expansion; it does not mean every nearby object must move away from every observer.

2.4 luminosity. luminosity means Total emitted power.

3.1 The fainter source is twice as far under inverse-square propagation and equal absorption. Different luminosity or absorption can also lower flux; flux alone is insufficient without calibration.