INTERNATIONAL BACCALAUREATE · IB DIPLOMA · PHYSICS · HL • EXERCISE SHEET

24.1 Stars, radiation and scale

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS flux • luminosity

Objective

Stars, radiation and scale. Original classroom practice for IB HL; not an official IB paper.

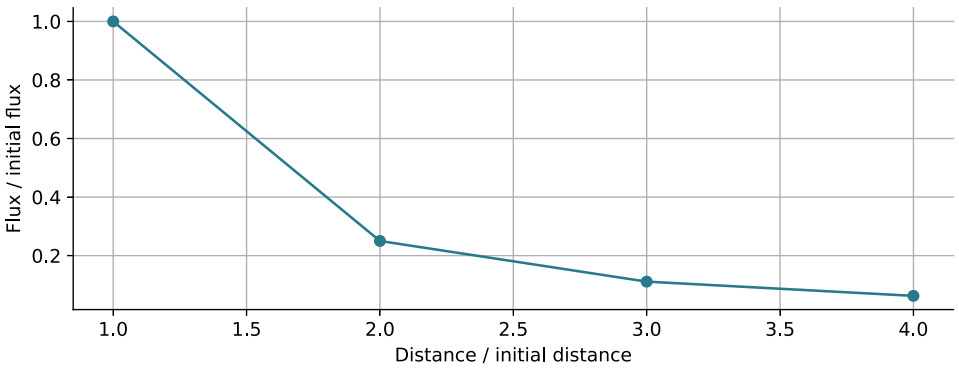
1 Key knowledge and worked examples

What would explain this observation?

- Two stars can have the same apparent brightness while having different luminosities. Distance changes the **flux** reaching an observer.

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.

In the lab: 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.

Work from known quantities

- 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.

Your turn: A source gives flux 18 units. Find flux at three times the distance.

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.

Not true: Apparent brightness alone always determines a star luminosity. Apparent brightness depends on distance as well as luminosity (F = L/4 pi d^2). A dim-looking star may be very luminous but far away, so brightness alone cannot fix luminosity without a distance.

Key:

- Luminosity is total power emitted; flux is power received per area.
- For isotropic emission without absorption, flux follows an inverse-square relationship with distance.
- Watch for: the Sun is not expected to become a supernova.

Write from a flux of 5 units

- A source gives flux 45 units.
- Find the flux at three times the distance. Apparent brightness alone does not give luminosity.

2 Practice

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

- **A** It doubles
- **B** It halves
- **C** It becomes one quarter [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 C Flux follows an inverse-square law, F proportional to 1/d^2, because the same luminosity spreads over a sphere of area 4 pi d^2. Doubling d gives 1/4 of the flux - not a half.

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

2.3 False. Apparent brightness depends on distance as well as luminosity (F = L/4 pi d^2). A dim-looking star may be very luminous but far away, so brightness alone cannot fix luminosity without a distance.

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.