

Exercise walk-through

24.1

Stars, radiation and scale

International Baccalaureate · IB Diploma · Physics · HL

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

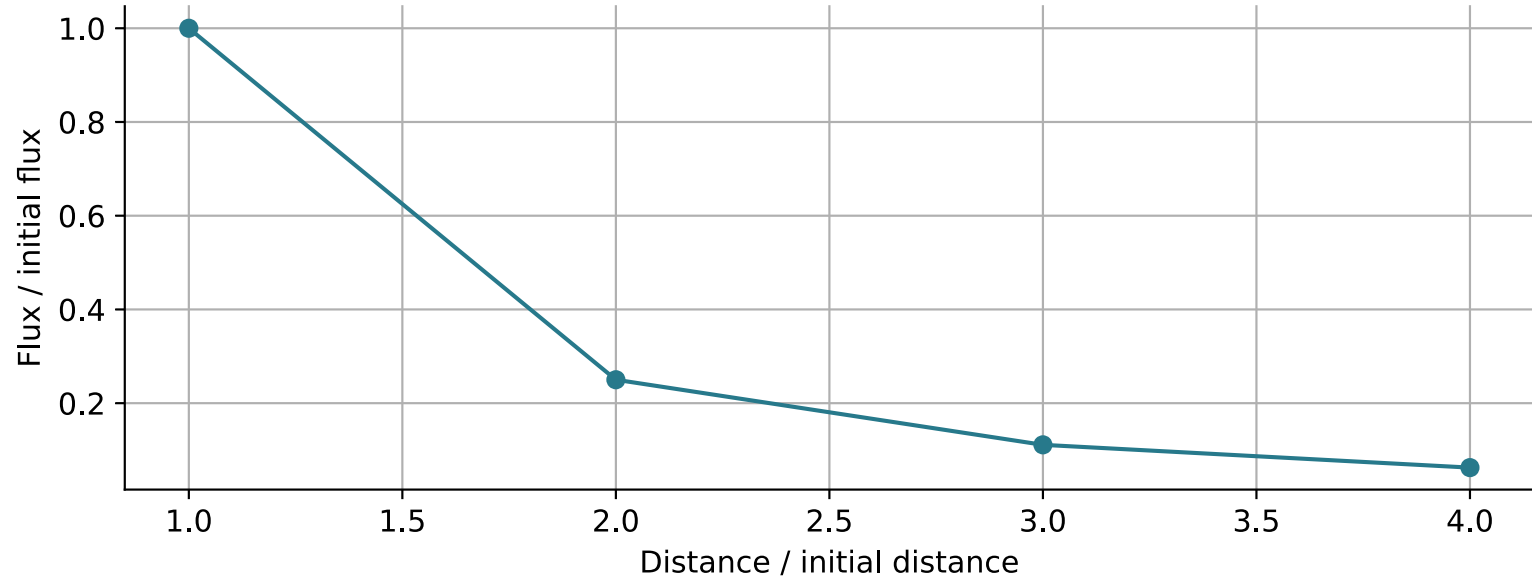
■ What would explain this observation?

- 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.

Exercises 2.1·2.3

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]

Exercises 2.1-2.3

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]

2.1 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 A source gives flux 18 units. Find flux at three times the distance. Show the relation, substitution and units.

[2]

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

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

[2]

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.

Exercises 2.4·3.1

2.4 Total emitted power: write the technical term.

[1]

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

[4]

Exercises 2.4·3.1

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

2.4 luminosity. luminosity means Total emitted power.

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

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.