

**12\*** This question is about spectroscopic measurements of stellar distances.

Describe how absorption spectra are formed and how they are useful in establishing the spectral class of a star.

Explain how determining the value for the absolute brightness and apparent brightness of a star can lead to a measurement of the distance to a star.

The following example may help in your explanation:

Star **X** is known to have three times the absolute brightness of star **Y** but both appear to be equally bright in the sky. The distance to star **Y** has been measured as 12 parsecs.

[6]

**END OF QUESTION PAPER**

10 This question is about measuring stellar distances by parallax.

The parallax of the star Sirius is 0.38 arc seconds.

One light year is the distance light travels in one year.

Calculate the distance to Sirius in light years.

$$\text{Earth-Sun distance} = 1 \text{ AU} = 1.5 \times 10^{11} \text{ m}$$

$$1 \text{ year} = 3.2 \times 10^7 \text{ seconds}$$

distance = ..... light year [3]

11 Explain why turbulence in the atmosphere limits the resolution of ground-based optical telescopes (lines 7–39).

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..... [2]

- 29 The electric potential at a distance  $r$  from a positive point charge  $Q$  is 450 V. The potential increases to 500 V when the distance from the point charge decreases by 1.5 m.

What is the value of  $r$ ?

- A 1.5 m
- B 7.9 m
- C 15 m
- D 29 m

Your answer

[1]

- 30 The relativistic factor  $\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$

Which statement about this factor is correct?

- A At the speed of sound  $\gamma$  is close to zero.
- B  $\gamma \rightarrow 1$  as  $v \rightarrow c$ .
- C  $\gamma$  predicts the time dilation factor so that moving clocks run slower as  $v \rightarrow c$ .
- D  $\gamma^2$  is the factor by which the total energy of a moving particle is greater than its rest energy.

Your answer

[1]

SECTION C

Answer **all** the questions.

36 This question considers some of the evidence for a Hot Big Bang start to our expanding universe.

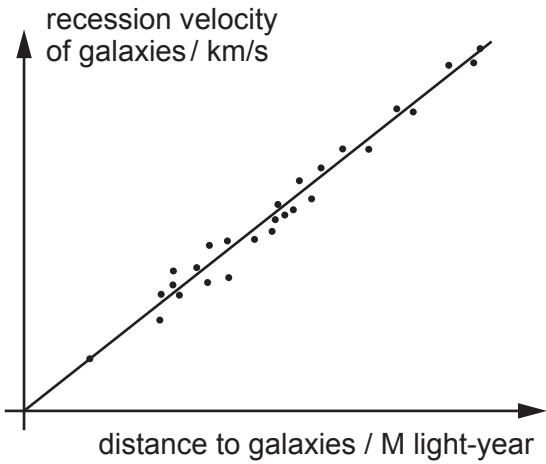


Fig. 36.1

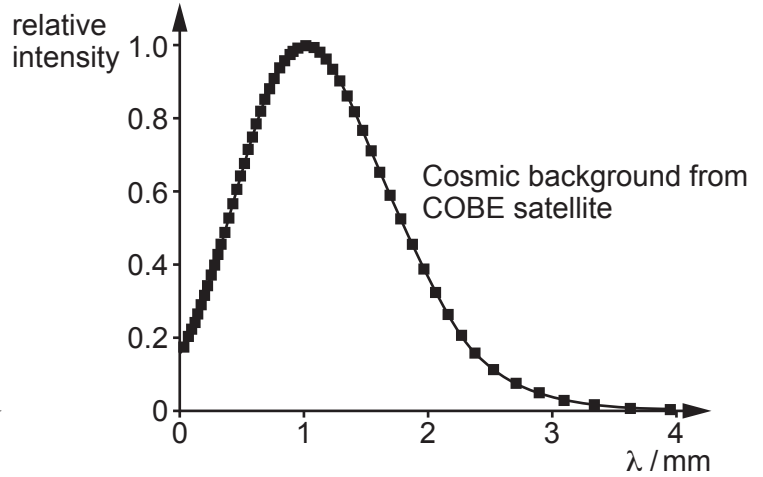


Fig. 36.2

(a) Explain how the graph(s) show evidence that the universe started from:

(i) a big bang expansion

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..... [2]

(ii) a hot state.

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..... [2]

- (b) The intensity spectrum of thermal radiation depends on temperature  $T$ . Photons at the **peak** of intensity have energy  $\varepsilon \approx 5kT$ .

Use this approximation and data from **Fig. 36.2** to estimate the temperature of the cosmic microwave background radiation (CMBR).

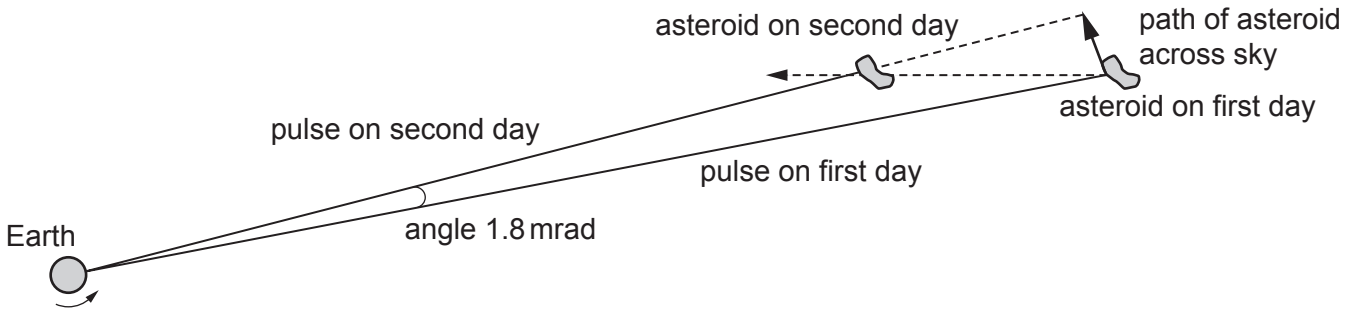
temperature = ..... K [4]

- 35 An asteroid is tracked from the Earth by radar pulses.  
 A pulse places it at a distance of 44.444 light-minutes from Earth.  
 After 24 hours a second pulse places it 44.204 light-minutes from Earth.

(a) Use this data to calculate the average velocity of approach of the asteroid relative to Earth.

relative velocity = .....  $\text{ms}^{-1}$  [2]

- (b) The path of the asteroid is shown in **Fig. 36.1**. After 24 hours the angular shift in position of the asteroid relative to Earth is 1.8 mrad.



**Fig. 36.1** (not to scale)

Estimate the velocity component of the asteroid perpendicular to its direction from Earth.  
 Make your method clear.

perpendicular velocity = .....  $\text{ms}^{-1}$  [3]