

10 (a) State Hubble’s law.

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.....

..... [2]

(b) A star in a distant galaxy emits radiation that has a maximum intensity of emission at a wavelength of 4.62×10^{-7} m.

Observations of the galaxy made on the Earth detect the maximum intensity of emission from the star at a wavelength of 4.91×10^{-7} m.

(i) Explain why the observed wavelength and the emitted wavelength have different values.

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..... [2]

(ii) Calculate the speed of the star relative to the Earth.

speed = ms^{-1} [2]

(iii) The wavelength of maximum intensity of emission is used to determine a value for the surface temperature of the star.

Explain how the temperature determined using the observed wavelength compares with the true value of temperature determined using the emitted wavelength.

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..... [2]

(c) A value for the Hubble constant is $2.3 \times 10^{-18} \text{ s}^{-1}$.

Use your answer in (b)(ii) to determine the distance of the star in (b) from the Earth.

distance = m [2]

[Total: 10]

10 (a) Explain how redshift leads to the idea that the Universe is expanding.

[3]

(b) Stars in a distant galaxy emit radiation. The total luminosity of the stars in the galaxy is $1.90 \times 10^{36} \text{ W}$.
The emission spectrum of the radiation contains a line X at a wavelength of 658 nm.

Radiation from the galaxy is observed on the Earth. The observed radiation has a radiant flux intensity of $8.42 \times 10^{-16} \text{ W m}^{-2}$. In the observed emission spectrum, line X is at a wavelength of 726 nm.

Determine:

(i) the distance d of the galaxy from the Earth

$d =$

m [2]

(ii) the speed v of the galaxy relative to the Earth.

$v =$

ms^{-1} [2]

- (c) Observations of many galaxies, such as the one in (b), lead to many pairs of values of d and v . Plotting these values reveals a trend.

- (i) On Fig. 10.1, sketch the variation of v with d .

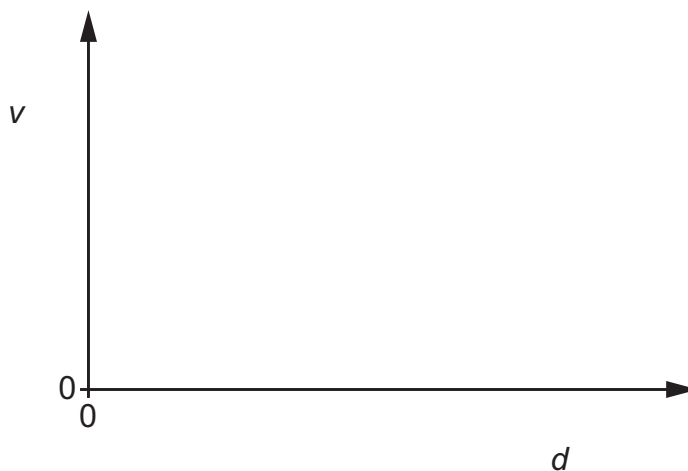


Fig. 10.1

[2]

- (ii) State the name of the quantity represented by the gradient of the line in Fig. 10.1.

..... [1]

[Total: 10]