

Chapter 12

Short answer question

This question is about the expansion of the Universe.

- (a) The speed of light is $3.0 \times 10^8 \text{ m s}^{-1}$. Show that the distance light will travel through space in one year is about 10^{16} m .
(Assume one year = $3.2 \times 10^7 \text{ s}$)

Distance = speed \times time

$$\begin{aligned} &= 3 \times 10^8 \times 3.2 \times 10^7 \\ &= 9.6 \times 10^{15} \cong 1 \times 10^{16} \text{ m} \end{aligned}$$

- (b) (i) During the past century it has been possible to observe galaxies which are receding from Earth.
One such galaxy is observed in the area of the sky known as Virgo. The distance to this galaxy is 10 000 million light years.
Explain why the galaxy is observed as it was 10 000 million years ago.

Light takes 10,000 million years to reach the earth

- (ii) Show that the galaxy is about $1.0 \times 10^{26} \text{ m}$ from Earth.

$$\begin{aligned} \text{Distance} &= (10,000 \times 10^6) \times (1 \times 10^{16}) \\ &= 1 \times 10^{26} \text{ m} \end{aligned}$$

- (c) The light from the galaxy shows 'red-shift'. This is thought to be due to the expansion of space and is called 'cosmological red-shift'.

- (i) Explain what is meant by 'red-shift'.

Shift of spectral lines towards the red end of the spectrum

- (ii) Explain how the expansion of space causes a cosmological red-shift.

Wavelength stretches with the expanding universe (Doppler effect)

- (iii) The cosmological red-shift is greater for galaxies farther away from the Earth. Describe how the model of an expanding Universe explains this observation.

Light has been travelling towards the earth for longer hence more red shift for more expansion.