Mark scheme for Extension Worksheet – Option E, Worksheet 1

1 The place between Mars and Jupiter is a particular region which keeps changing as the planets move; the asteroid belt is scattered over a very large area in between the orbits of Mars and Jupiter. [2]

2 The star's high numerical value of apparent magnitude means that is appears faint; when it is brought to 10 pc it appears brighter, i.e. its real distance is greater than 10 pc. [2]

3 **a** Star X appears brighter from the Earth; because it has a lower numerical value of apparent magnitude. [2]

b X has a lower luminosity and yet appears brighter; this can be because it is closer to the Earth. [2]

4 **a** Star Q; because it has a greater apparent brightness. [2]

b The luminosity of Q is less than that of P and yet it appears brighter; so it has to be closer. [2]

5 $\frac{L_X}{L_e} = \frac{b_X}{b_e}\frac{4\pi d_X^2}{4\pi d_e^2} = \frac{b_X}{b_e}\frac{d_X^2}{d_e^2}$; so

$$12 = \frac{8.1 \times 10^{-8}}{1400}\frac{d_X^2}{d_e^2} \Rightarrow d_X = 4.55 \times 10^5 \times d_e = 4.55 \times 10^5 \text{ AU}$$

$$d_X = 4.55 \times 10^5 \times 1.50 \times 10^{11} \times \frac{1}{9.46 \times 10^{15}} \times \frac{1}{3.26} = 2.1 \text{ pc}$$

[3]

6 The distance would be calculated from $b = \frac{L}{4\pi d^2} \Rightarrow d = \sqrt{\frac{L}{4\pi b}}$; the effect of dust would be that the measured value of apparent brightness would be smaller; and hence the calculated value of distance would be greater than the actual value. [3]

7 A study of the spectrum of a star can give information on its surface temperature; its chemical composition; whether the star rotates or not/the presence of a magnetic field. [3]

8 **a** At position A the brighter of the stars is hidden from view; since in that case the drop in apparent brightness is greater. [2]

b Line from position A to next big drop in apparent brightness. [1]

c The period of rotation; and the separation of the stars. [2]

9 With a period of 12 days we find an average absolute magnitude, $\bar{M} = -2.83\log_{10} 12 - 1.81 = -4.864$; hence from the magnitude distance formula

$\bar{m} - \bar{M} = 5\log\frac{d}{10} \Rightarrow \frac{d}{10} = 10^{\frac{5.8-(-4.864)}{5}}$; i.e. $d = 1.4 \times 10^3$ pc [3]

10 The ratio of the apparent brightness at the extremes of the star is

$$\frac{b_H}{b_L} = 2.512^{6.2-5.2} = 2.512\,;$$

since the distance does not change this also the ratio of luminosities i.e.

$$2.512 = \frac{\sigma 4\pi R_H^2 T^4}{\sigma 4\pi R_L^2 T^4} = \frac{R_H^2}{R_L^2}\text{; hence } \frac{R_H}{R_L} = \sqrt{2.512} = 1.58 \approx 1.6$$

[3]

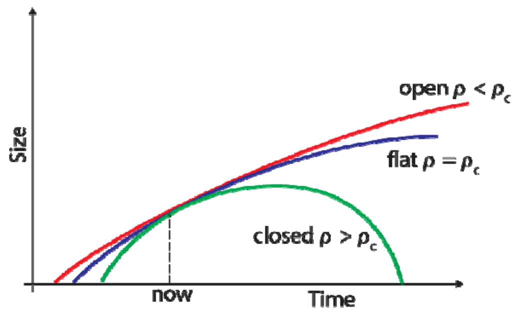
11 Spectroscopic parallax makes use of the formula $d = \sqrt{\frac{L}{4\pi b}}$ to measure distance and so requires knowledge of luminosity and apparent brightness; apparent brightness can easily be measured with a CCD camera; the luminosity can be determined if we know the temperature of the star (obtained form its spectrum) and the stellar type so the HR can be used to find luminosity. [3]

12 If we accept that the redshift is due to the Doppler effect; then the redshift is evidence for motion of galaxies away form each other, i.e. evidence for an expanding universe. [2]

OR We may accept that the redshift is due to space stretching in between galaxies; and so evidence for an expanding universe. [2]

13 In the Newtonian model of the universe there is an infinite number of stars uniformly distributed in an infinite universe; any thin shell a distance d from an observer contains a number of stars proportional to d^2; and since the apparent brightness varies with $\frac{1}{d^2}$ each shell contributes the same amount of apparent brightness; but there is an infinite number of such shells in the Newtonian model and so infinite apparent brightness at the observer. [4]

14



[3]

15 Referring to the diagram of the previous question we see that with the three models drawn coincident at the present time; their starting points are different. [2]

