AQA

A Level

A Level Physics

ASTROPHYSICS: Stars 1

Name:

MME

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Total Marks: /30

1. The distances to stars are so large that is is convenient to use units other than m.

Total for Question 1: 8

(a) Define, in words, the units AU and ly. [2]

(b) Show that 1 pc=3.1×10^{16} m. One astronomical unit is equivalent to 1.5×10^{11} m. [2]

(c) Calculate the distance to a star whose parallax angle measures 0.30 arcseconds. Give your answer in AU, ly and pc. [3]

(d) Suggest why the parallax method for determining distances is limited to approximately 100 pc? [1]

2. Stars were traditionally classified by their apparent brightness. This is a technique with origins dating back to the Ancient Greeks. Since then, numerous other classifications have been proposed.

(a) State the major problem with the Hipparchus scale. [1]

(b) The stars Vega and Bellatrix have apparent magnitudes of 0.0 and 1.6, respectively. On the apparent magnitude scale, a star with a magnitude of 6 is one hundred times less bright than one with an apparent magnitude of 1 and the scale is logarithmic i.e. $\frac{magnitude_6}{magnitude_5} = \frac{magnitude_5}{magnitude_4}$. How many time brighter than Bellatrix is Vega? [4]

A star's absolute magnitude, M, is defined as the apparent magnitude it would have were it at a distance of 10 pc. Given that each increment on the magnitude scale represents a factor of $100^{1/5}$, it can be shown that $y - x = 2.5 \log \frac{I_x}{I_y}$, where I_x and I_y are the intensities of the light emitted by stars with apparent magnitudes x and y.

(c) The inverse square law states that the intensity of radiation emitted from a spherical body decays according to the equation $I = \frac{P}{4\pi r^2}$, where P is radiant power and r is distance from the body. Show that the intensity of the light emitted by a star is related to the intensity of the light were it at a distance of 10 pc by the equation $\frac{I_{10}}{I} = \frac{r^2}{100}$. [3]

(d) By assuming that I_x is the intensity at a distance of 10 pc, show that $y - M = 5 \log \frac{r}{10}$. [3]

3. The Sirius system is the brightest star system visible in the night sky. Sirius B is a white dwarf with a luminosity of only 0.056 $L_\odot$ and a peak spectral wavelength of $\lambda_{max} = 1.2 \times 10^{-7}$ m. In contrast, the red supergiant Betelgeuse has a peak wavelength of $\lambda_{max} = 8.5 \times 10^{-7}$ m and a surface temperature of 3400 K. The luminosity of our sun $(L_\odot)$ is 3.85×10^{26} W.   Total for Question 3: 11

  (a) Define the term *black body*.   [1]

  (b) Sketch a graph to show how the reradiated power per m^2 of a black body varies with the wavelength of the emitted radiation. Include on your sketch three curves for bodies with temperatures of 3000 K, 4000 K and 5000 K,   [3]

(c) Arnav is asked to calculate the wavelength of starlight from Zeta using a diffraction grating. He measures the angle between the beam and the eighth-order maximum as 0.14°and uses a grating with a slit spacing of 1 mm. What is the wavelength of the light used? [3]

(d) Using a combination of Wien's displacement law and Stefan's law, calculate the radius of Sirius B. [4]