Questions

1 *(IB)*

a) The star Wolf 359 has a parallax angle of 0.419 arcsecond.

(i) Describe how this parallax angle is measured.

(ii) Calculate the distance in light-year from Earth to Wolf 359.

(iii) State why the method of parallax can only be used for stars at a distance less than a few hundred parsecond from Earth.

b) The ratio

$$\frac{\text{apparent brightness of Wolf 359}}{\text{apparent brightness of the Sun}} \text{ is } 3.7 \times 10^{-15}.$$

Show that the ratio

$$\frac{\text{luminosity of Wolf 359}}{\text{luminosity of the Sun}} \text{ is } 8.9 \times 10^{-4}.$$

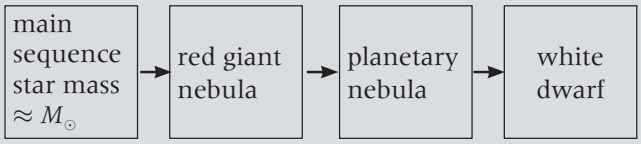
(11 marks)

2 The average intensity of the Sun's radiation at the surface of the Earth is 1.37×10^3 Wm^{-2}. Calculate (a) the luminosity and (b) the surface temperature of the Sun.

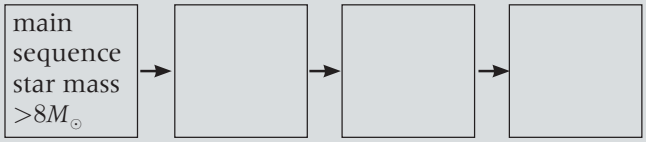
The mean separation of the Earth and the Sun $= 1.50 \times 10^{11}$ m, radius of the Sun $= 6.96 \times 10^8$ m, Stefan–Boltzmann constant $= 5.67 \times 10^{-8}$ Wm^{-2} K^{-4}. (4 marks)

3 *(IB)*

The diagram below is a flow chart that shows the stages of evolution of a main sequence star such as the Sun. (Mass of the Sun, the solar mass $= M_\odot$)



a) Copy nad complete the boxes below to show the stages of evolution of a main sequence star that has a mass greater than $8M_\odot$.



b) Outline why:

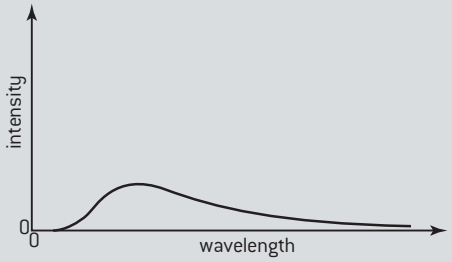
(i) white dwarf stars cannot have a greater mass than $1.4M_\odot$

(ii) it is possible for a main sequence star with a mass equal to $8M_\odot$ to evolve into a white dwarf. (6 marks)

4 *(IB)*

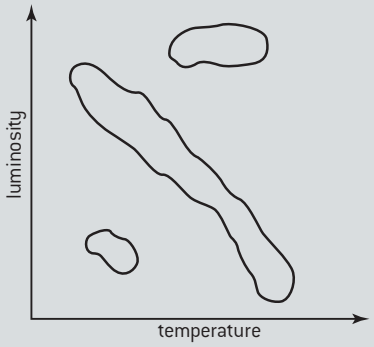
a) Define *luminosity*.

b) The sketch-graph below shows the intensity spectrum for a black body at a temperature of 6000 K.



On a copy of the axes, draw a sketch-graph showing the intensity spectrum for a black body at 8000 K.

c) A sketch of a Hertzsprung–Russell diagram is shown below.



Copy the diagram above and identify the:

(i) main sequence (label this M)

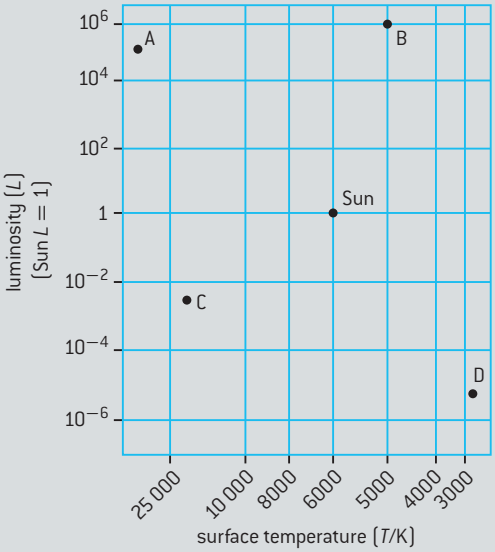
(ii) red giant region (label this R)

(iii) white dwarf region (label this W).

d) In a Hertzsprung–Russell diagram, luminosity is plotted against temperature. Explain why the diagram alone does not enable the luminosity of a particular star to be determined from its temperature. (8 marks)

5 *(IB)*

The diagram below shows the grid of a Hertzsprung–Russell (HR) diagram on which the positions of the Sun and four other stars A, B, C and D are shown.



a) Name the type of stars shown by A, B, C, and D.

b) Explain, using information from the HR diagram and without making any calculations, how astronomers can deduce that star B is larger than star A.

c) Using the following data and information from the HR diagram, show that star B is at a distance of about 700 pc from Earth.

Apparent brightness of the Sun = 1.4×10^3 W m^{-2}

Apparent brightness of star B = 7.0×10^{-8} W m^{-2}

Mean distance of the Sun from Earth = 1.0 AU

1 parsec = 2.1×10^5 AU (11 marks)

6 *(IB)*

a) State what is meant by *cosmic microwave background radiation*.

b) Describe how the cosmic microwave background radiation provides evidence for the expanding universe. (5 marks)

7 *(IB)*

a) In an observation of a distant galaxy, spectral lines are recorded. Spectral lines at these wavelengths cannot be produced in the laboratory. Explain this phenomenon.

b) Describe how Hubble's law is used to determine the distance from the Earth to distant galaxies.

c) Explain why Hubble's law is not used to measure distances to nearby stars or nearby galaxies (such as Andromeda). (6 marks)

8 *(IB)*

One of the most intense radio sources is the Galaxy NGC5128. Long exposure photographs show it to be a giant elliptical galaxy crossed by a band of dark dust. It lies about 1.5×10^7 light years away from Earth.

a) Describe any differences between this galaxy and the Milky Way.

Hubble's law predicts that NGC5128 is moving away from Earth.

b) (i) State Hubble's law.

(ii) State and explain what experimental measurements need to be taken in order to determine the Hubble constant.

c) A possible value for the Hubble constant is 68 km s^{-1} Mpc^{-1}. Use this value to estimate:

(i) the recession speed of NGC5128

(ii) the age of the universe. (10 marks)

9 **a)** Describe what is meant by a *nebula*.

b) Explain how the Jeans criterion applies to star formation. (3 marks)

10 Outline how hydrogen is fused into helium in:

a) stars of mass similar to that of the Sun

b) stars of mass greater than ten solar masses. (6 marks)