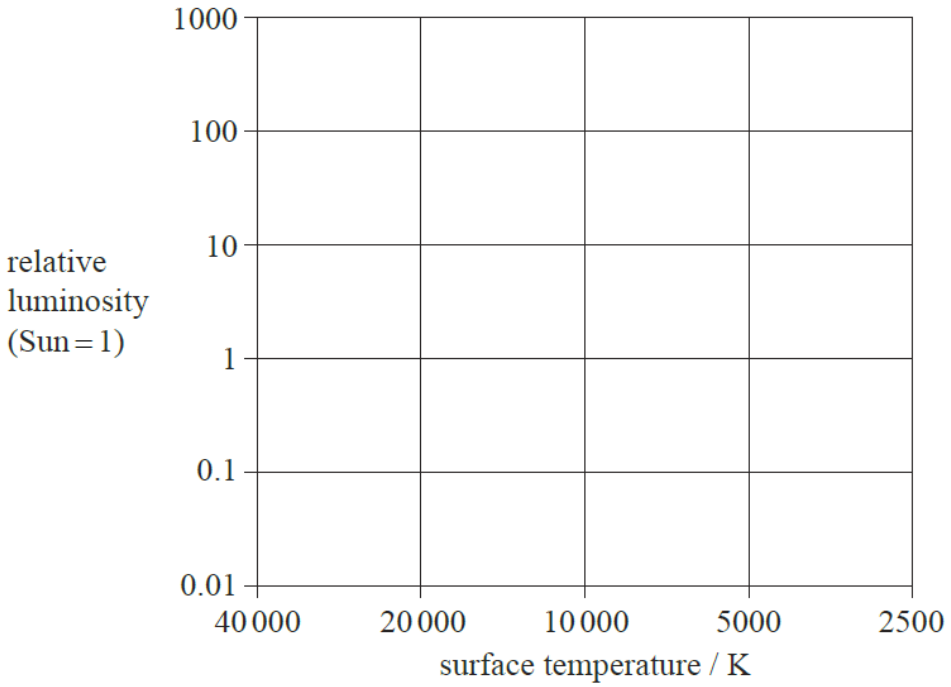
# Astro-practice-3 *[85 marks]*

This question is about the properties of a star.

1a. The peak in the radiation spectrum of a star X is at a wavelength of 300 nm. *[2 marks]*

Show that the surface temperature of star X is about 10000 K.

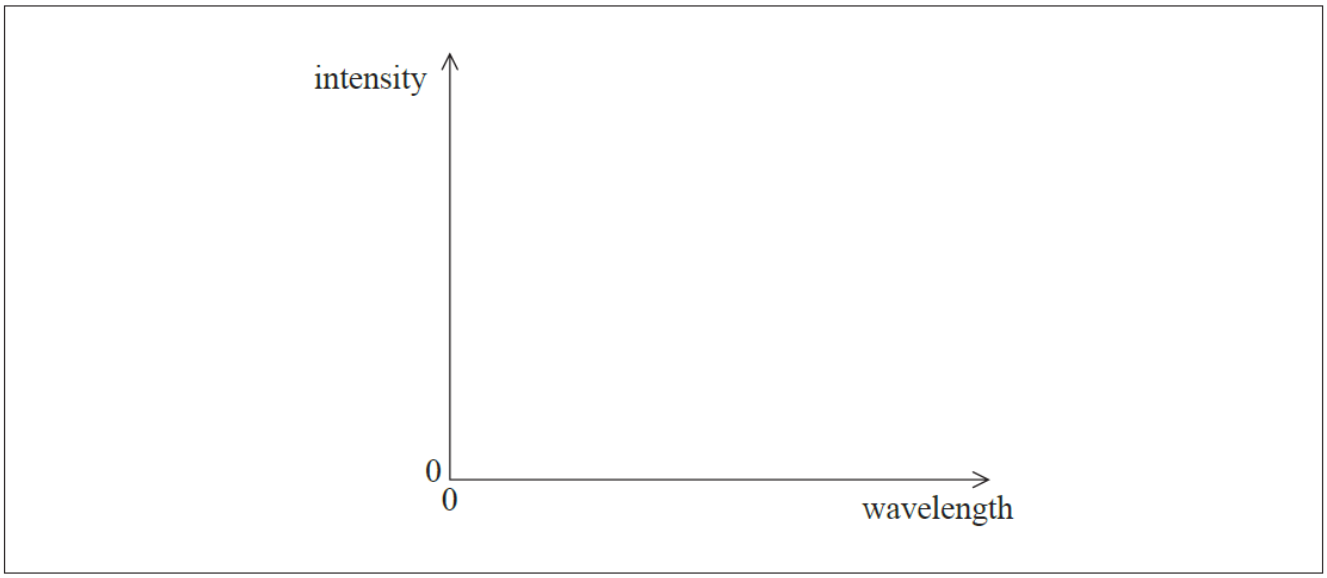
1b. On the Hertzsprung–Russell diagram, label the position of star X with the letter X. *[1 mark]*




This question is about cosmology.

2a. Cosmic microwave background radiation was discovered by Penzias and Wilson in 1964. State **two** characteristics of the cosmic microwave background radiation. *[2 marks]*

2b. (i) Using the axes below, sketch a graph to show the variation with wavelength of the intensity of the cosmic background radiation. *[6 marks]*

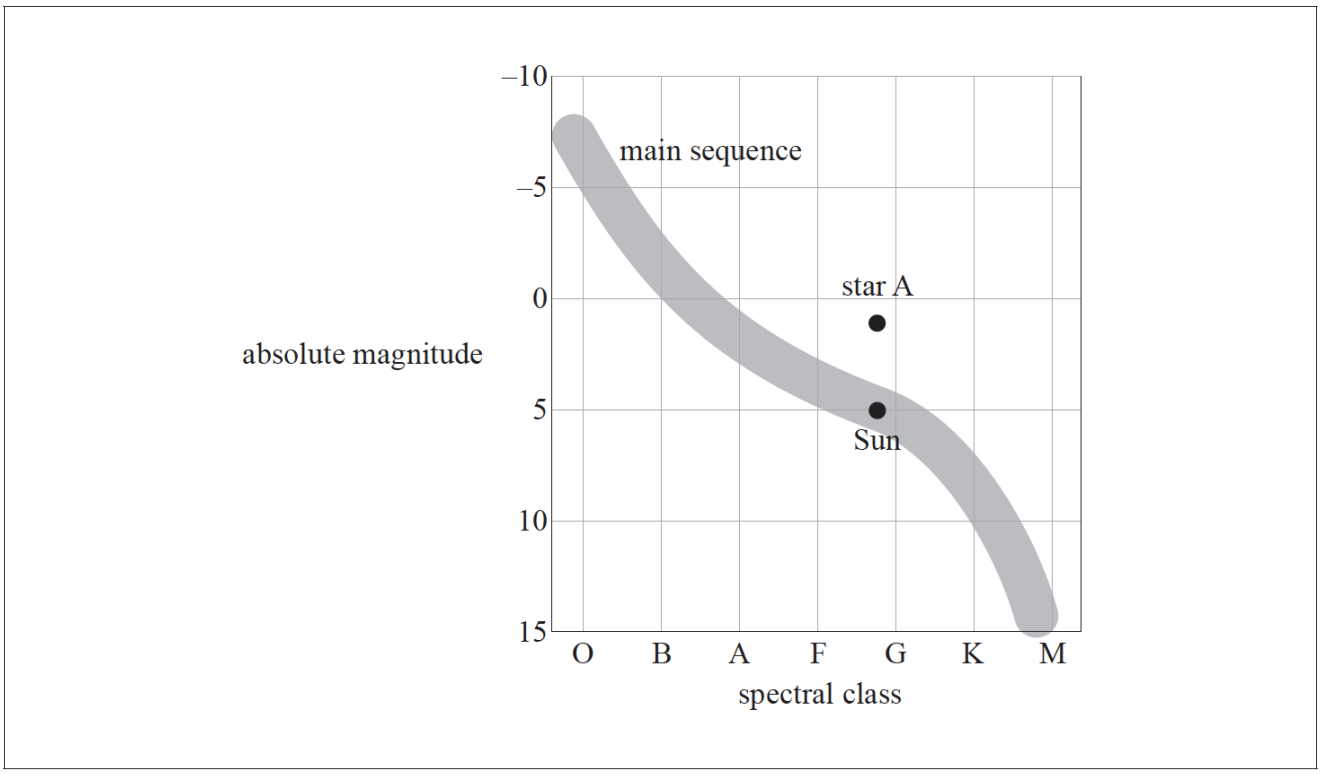



(ii) Explain how the graph may be used to determine the temperature of the cosmic background radiation.

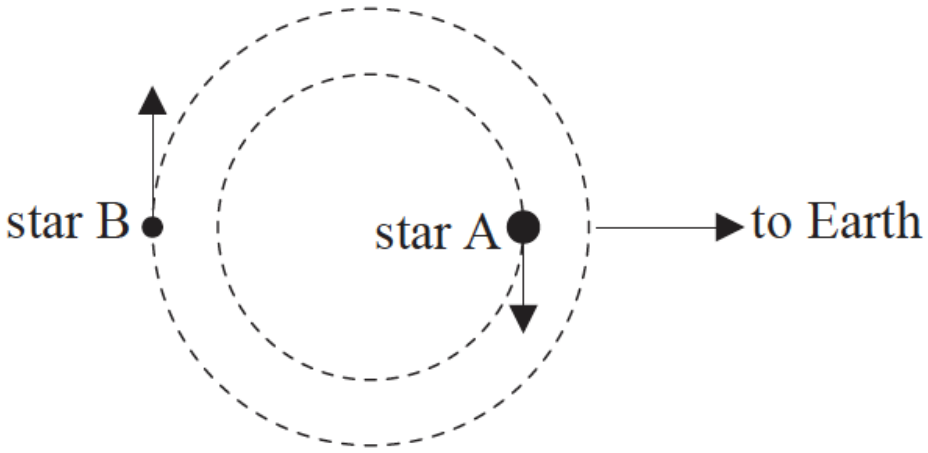
(iii) Discuss how the discovery of the cosmic background radiation provides evidence for the Big Bang.

This question is about stars.

The Hertzsprung–Russell (HR) diagram shows the Sun, a star labelled A and the main sequence.




3a. Star A is part of a binary star system. The diagram shows the orbit of star A and the orbit of its companion, star B. *[2 marks]*

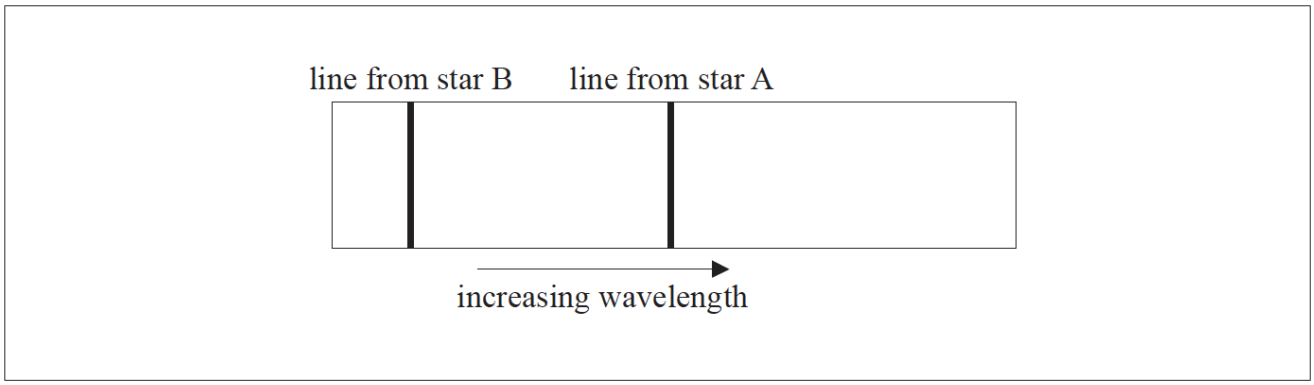



The temperature of star A is $T_A$, the temperature of star B is $T_B$ and $\frac{T_A}{T_B} = 0.60$.

The radius of star A is $R_A$, the radius of star B is $R_B$ and $\frac{R_A}{R_B} = 270$.

Show that the luminosity of star A is $9.4 \times 10^3$ times greater than the luminosity of star B.

3b. The diagram below shows the spectrum of the stars as observed from Earth. The spectrum shows one line from star A and one line from star B, when the stars are in the position shown in the diagram (b). *[2 marks]*




On the spectrum draw lines to show the approximate positions of these spectral lines after the stars have completed one quarter of a revolution.

This question is about Cepheid stars.

4. A Cepheid star and non-Cepheid star both belong to the same distant galaxy. Explain, stating the quantities that need to be measured, how the luminosity of the non-Cepheid star may be determined. *[2 marks]*

This question is about cosmology.

5a. Theoretical studies indicate that the universe may be open, closed or flat. *[4 marks]*

(i) State, by reference to critical density, the condition that must be satisfied for the universe to be flat.

(ii) In a flat universe, the rate of expansion would be slowing down. Suggest a reason for this.

(iii) Outline why it has been difficult to determine whether the universe is open, closed or flat.

5b. Outline **one** piece of experimental evidence that supports the fact that the universe is expanding. *[2 marks]*

This question is about the star Naos (Zeta Puppis).

The following data are available for the star Naos.

Surface temperature = $4.24 \times 10^4$K
Radius = $7.70 \times 10^9$m
Apparent magnitude = +2.21
Parallax angle = $3.36 \times 10^{-3}$ arcseconds

6. The distance to Naos may be determined by the method of stellar parallax. The diagram shows the star Naos and the Earth in its orbit around the Sun. *[3 marks]*


(i) Draw lines on the diagram above in order to indicate the parallax angle of Naos.

(ii) Outline how the parallax angle of Naos may be measured.

This question is about some of the properties of the star Aldebaran and also about galactic distances.

7a. Aldebaran is a red giant star in the constellation of Taurus. *[7 marks]*

(i) Describe the differences between a constellation and a stellar cluster.

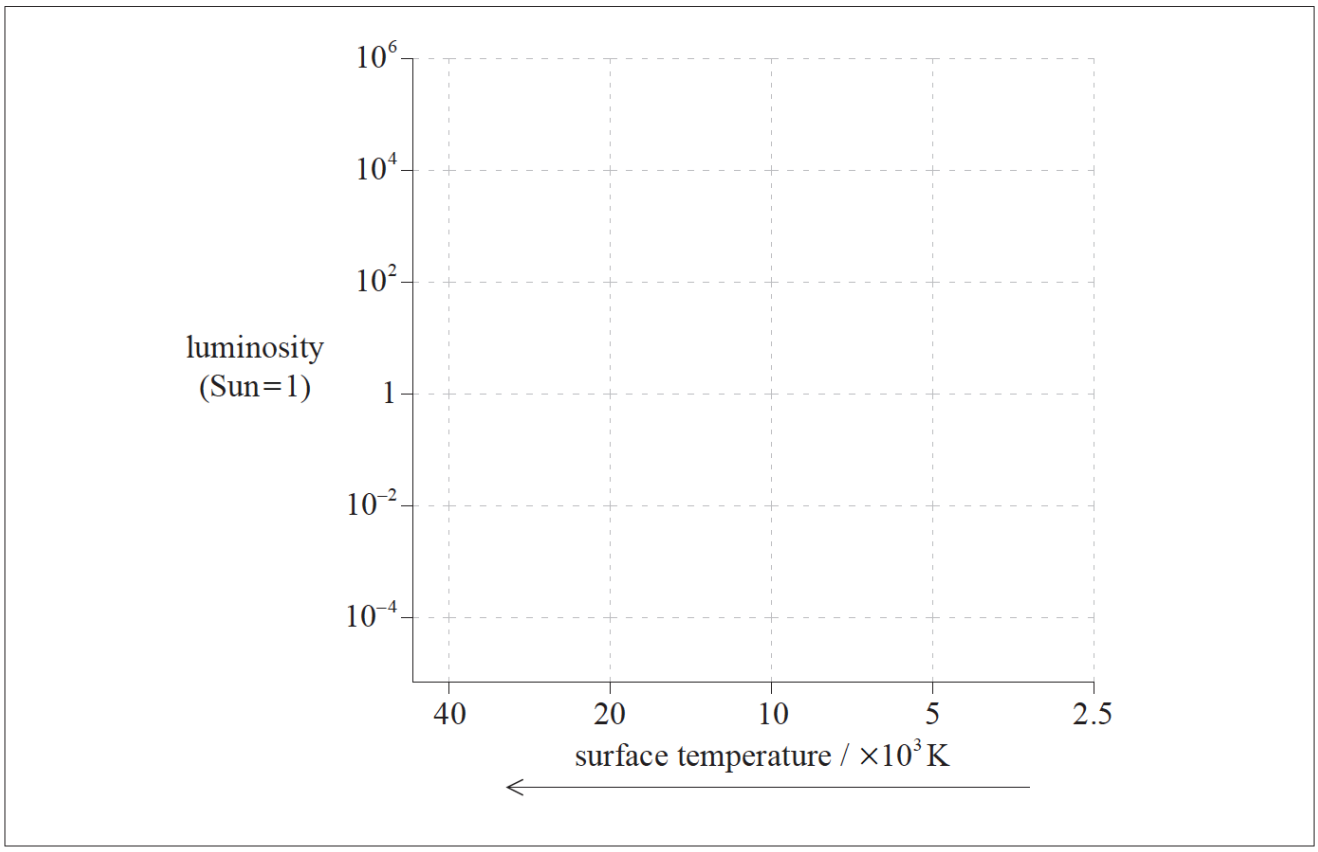
(ii) Define the *luminosity* of a star.

(iii) The apparent brightness of Aldebaran is $3.3 \times 10^{-8}$ W m$^{-2}$ and the luminosity of the Sun is $3.9 \times 10^{26}$ W. The luminosity of Aldebaran is 370 times that of the Sun. Show that Aldebaran is at a distance of 19 pc from Earth. (1 pc=$3.1 \times 10^{16}$ m)

7b. Distances to galaxies may be determined by using Cepheid variable stars. *[5 marks]*

By considering the nature and properties of Cepheid variable stars, explain how such stars are used to determine galactic distances.

This question is about stellar distances and stellar properties.




8a. On the grid of the Hertzsprung–Russell (HR) diagram shown, draw a line to represent the approximate position of the main sequence. *[2 marks]*

8b. Barnard's star is a main sequence star that is 1.8 pc from Earth. *[2 marks]*

(i) Define the *parsec*.

(ii) Calculate the parallax angle of Barnard's star as measured from Earth.

8c. Outline, using your answer to (b)(ii) and a labelled diagram, how the distance of Barnard's star from Earth is measured. *[3 marks]*

8d. The apparent brightness of Barnard's star is $3.6\times10^{-12}\text{Wm}^{-2}$ and its surface temperature is 3800 K. *[6 marks]*

Given that 1 pc$=3.1\times10^{16}$m, show for Barnard's star

(i) that its luminosity is of the order of $10^{23}$W.

(ii) that its surface area is of the order of $10^{16}\text{m}^2$.

This question is about the development of the universe.

9a. Light from distant galaxies, as seen by an observer on Earth, shows a red-shift. Outline why this observation suggests that the universe is expanding. *[2 marks]*

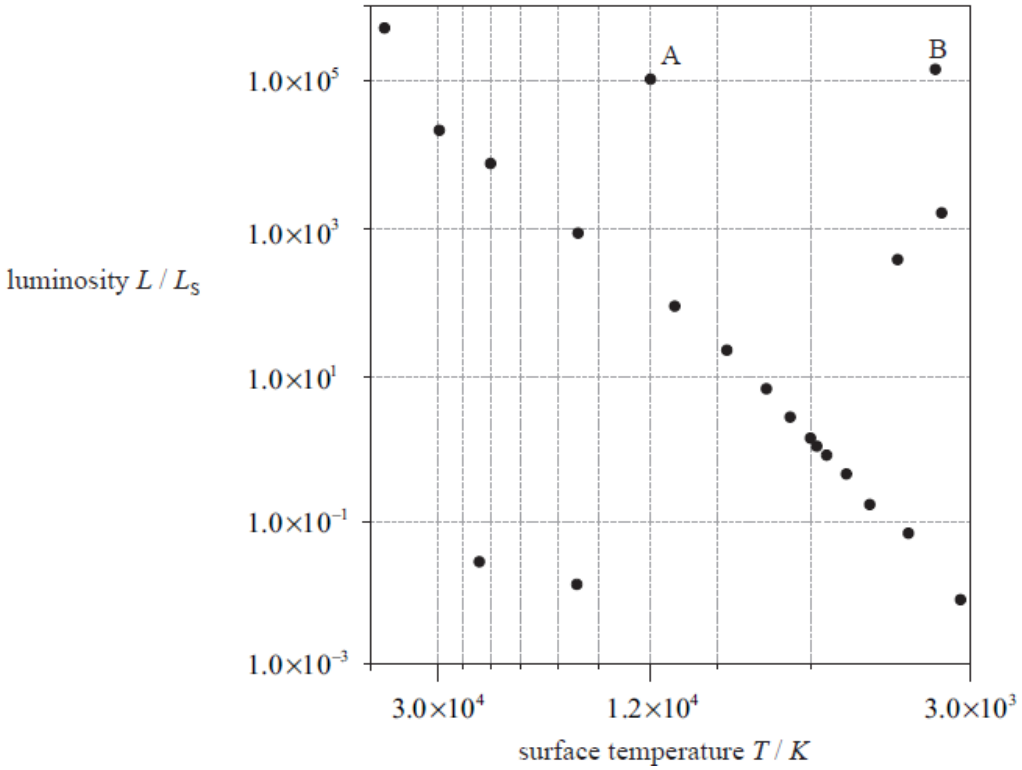
9b. The future development of the universe is determined by the relationship between the apparent density of the universe and the critical density. *[5 marks]*

(i) Define the term *critical density*.

(ii) Discuss how the density of the universe determines its future development. Your discussion should include **one** problem associated with determining the density of the universe.

This question is about the Hertzsprung–Russell (HR) diagram and using it to determine some properties of stars.

The diagram below shows the grid of a HR diagram, on which the positions of selected stars are shown. ($L_S$ = luminosity of the Sun.)




10a. (i) Draw a circle around the stars that are red giants. Label this circle R. *[3 marks]*

(ii) Draw a circle around the stars that are white dwarfs. Label this circle W.

(iii) Draw a line through the stars that are main sequence stars.

10b. Explain, without doing any calculation, how astronomers can deduce that star B has a larger diameter than star A. *[3 marks]*

10c. Using the following data and information from the HR diagram, show that star A is at a distance of about 800 pc from Earth. *[4 marks]*

Apparent brightness of the Sun $=1.4\times10^{3}\text{Wm}^{-2}$
Apparent brightness of star A $= 4.9\times10^{-9}\text{Wm}^{-2}$
Mean distance of Sun from Earth $=1.0$ AU
1 pc $= 2.1\times10^{5}$AU

10d. Explain why the distance of star A from Earth cannot be determined by the method of stellar parallax. *[1 mark]*

This question is about cosmology.

11a. State how the observed red-shift of many galaxies is explained. *[1 mark]*

11b. Explain how the cosmic microwave background (CMB) radiation is consistent with the Big Bang model. *[2 marks]*

11c. Calculate the temperature of the universe when the peak wavelength of the CMB was equal to the wavelength of red light ($7.0\times10^{-7}$m). *[2 marks]*

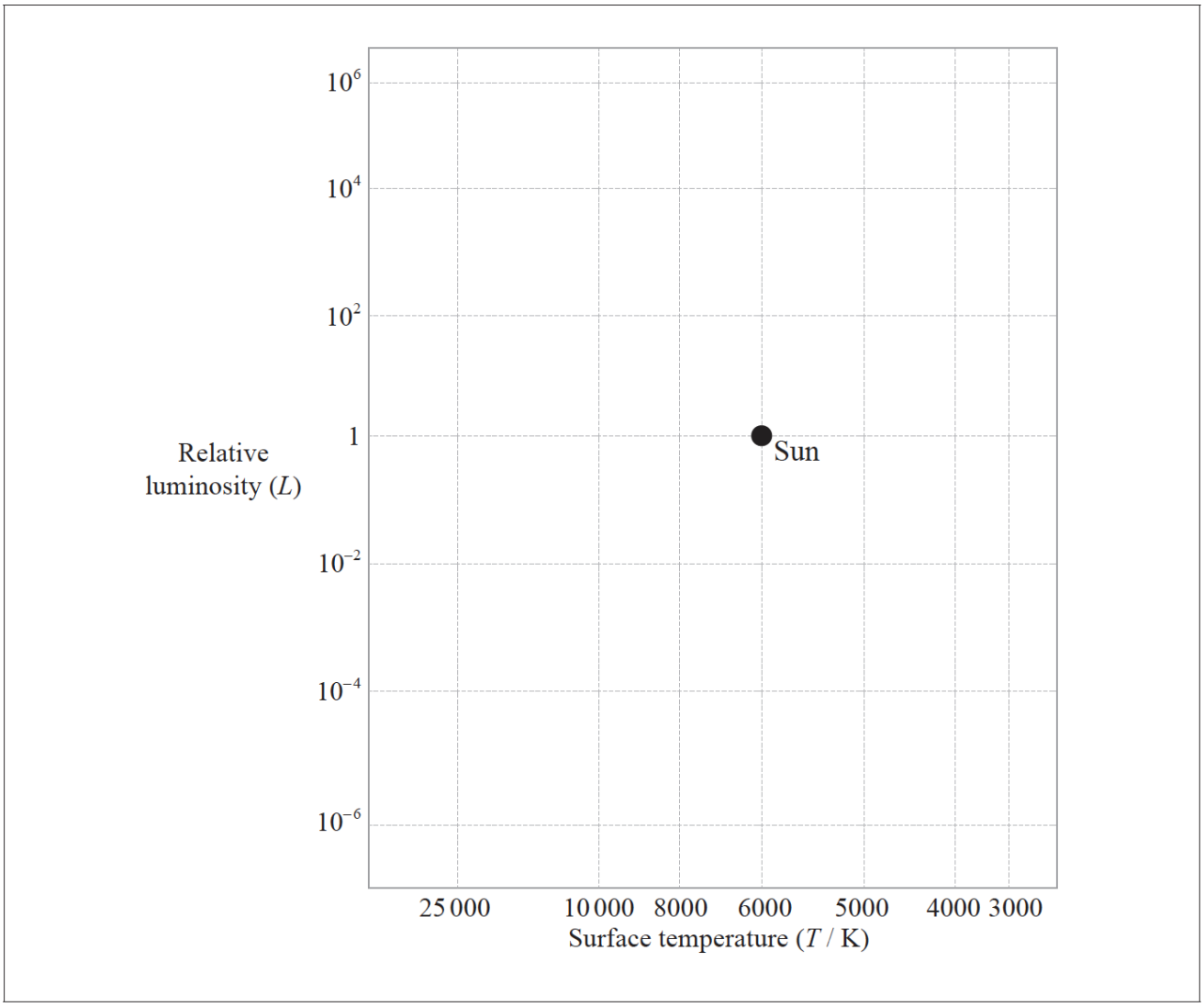
This question is about the properties of a star.

12a. Describe what is meant by a *[3 marks]*

(i) constellation.

(ii) stellar cluster.

12b. *[2 marks]*




On the Hertzsprung–Russell diagram above,

(i) label the position of Betelgeuse with the letter B.

(ii) sketch the position of main sequence stars.

This question is about the characteristics of the stars Procyon A and Procyon B.

13. The stars Procyon A and Procyon B are both located in the same stellar cluster in the constellation Canis Minor. Distinguish between a constellation and a stellar cluster. *[2 marks]*

Constellation:

Stellar cluster:

This question is about the Big Bang model and red-shift.

14a. Describe what is meant by the Big Bang model. *[1 mark]*

In the 1960s, Penzias and Wilson discovered a uniform cosmic background radiation (CMB) in the microwave region of the electromagnetic spectrum.

14b. (i) Explain how the CMB is consistent with the Big Bang model. *[3 marks]*

(ii) State why the red-shift of light from galaxies supports the Big Bang model.