1 The table has information on two stars.

Star	Apparent magnitude	Absolute magnitude	Spectral class
Sirius	−1.4	−1.4	A
Rigel	0.12	−7.1	B

(a)   State the difference between apparent magnitude and absolute magnitude.

_____

_____

_____

(2)

(b)   Sirius has an intensity of 1.18×10^{-7} Wm^{-2} at the Earth. The distance between Sirius and the Earth is 8.13×10^{13} km.

Calculate the luminosity of Sirius.
Give an appropriate unit for your answer.

luminosity _____ unit _____

(3)

(c)   State which star in the table is closer to the Earth.
Explain your reasoning.

_____

_____

_____

(2)
(Total 7 marks)

2 (a)   Define

(i)   apparent magnitude,

_____

_____

(ii)   absolute magnitude.

_____

_____

(2)

(b)   Bellatrix and Elinath are two stars with the same apparent magnitude. The distance from the Earth to Bellatrix is 470 light years and its absolute magnitude is –4.2.

(i)   Calculate the distance to Bellatrix in parsecs.

_____

_____

(ii)   Calculate the apparent magnitude of Bellatrix.

_____

_____

_____

_____

(iii)   Elinath has an absolute magnitude of –3.2. State, giving a reason, which of the two stars is closer to the Earth.
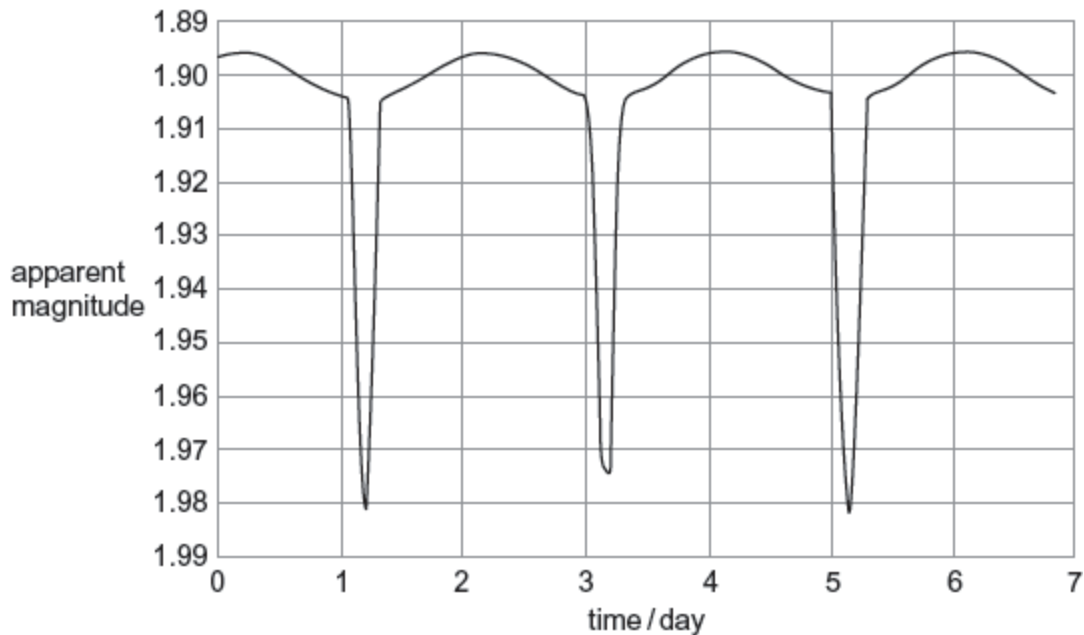
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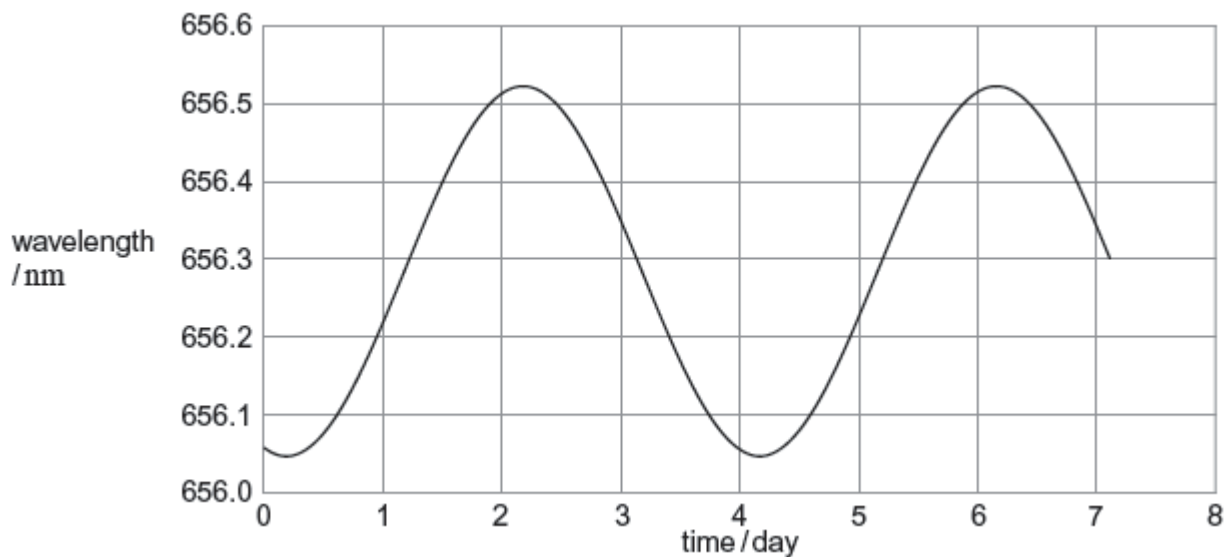
(6)
(Total 8 marks)

3 Menkalinan is an eclipsing binary star system in the constellation of Auriga. **Figure 1** shows the variation in apparent magnitude with time (light curve) for Menkalinan.

Figure 1

Analysis of the spectrum of one of the stars shows a periodic variation in wavelength. **Figure 2** shows the results for one of the spectral lines in the Hydrogen Balmer series. The wavelength for this line as measured for a source in a laboratory on the Earth is 656.28 nm.

Figure 2

(a) Describe the physical processes that give rise to the shape of each graph. Go on to show how the information in the graphs can be used to determine properties, such as the speed and period, of the Menkalinan binary system. You should include appropriate calculations in your answer.

The quality of your written communication will be assessed in your answer.

(6)

(b)   The black body temperature of each star is approximately 9200 K.

Explain why a Hydrogen Balmer line was chosen for the analysis of wavelength variation.

_____

_____

_____

_____

_____

(2)

(c)   The distance from the Earth to Menkalinan is 7.7×10^{17} m.

Calculate the value of the absolute magnitude of Menkalinan when it appears dimmest.

absolute magnitude = _____

(3)

(Total 11 marks)

4   Sirius is a binary system consisting of two stars, Sirius A and Sirius B, the properties of which are summarised below.

	Sirius A	**Sirius B**
absolute magnitude	1.4	11.2
apparent magnitude	−1.4	8.4
diameter / 10^3 km	2400	12
black-body temperature/K	10 000	25 000

(a)   Calculate the distance to Sirius, giving an appropriate unit.

distance = _____

(3)

(b)   (i)   Calculate the ratio

$$\frac{\text{power output of Sirius A}}{\text{power output of Sirius B}}$$

ratio = _____

(2)

(ii)   Show that data in the table suggests that one star is about 8000 times brighter than the other.

_____

_____

_____

(2)

(iii)   With reference to the spectra of the two stars, explain why the value in part b (ii) is much greater than the answer to part b (i).
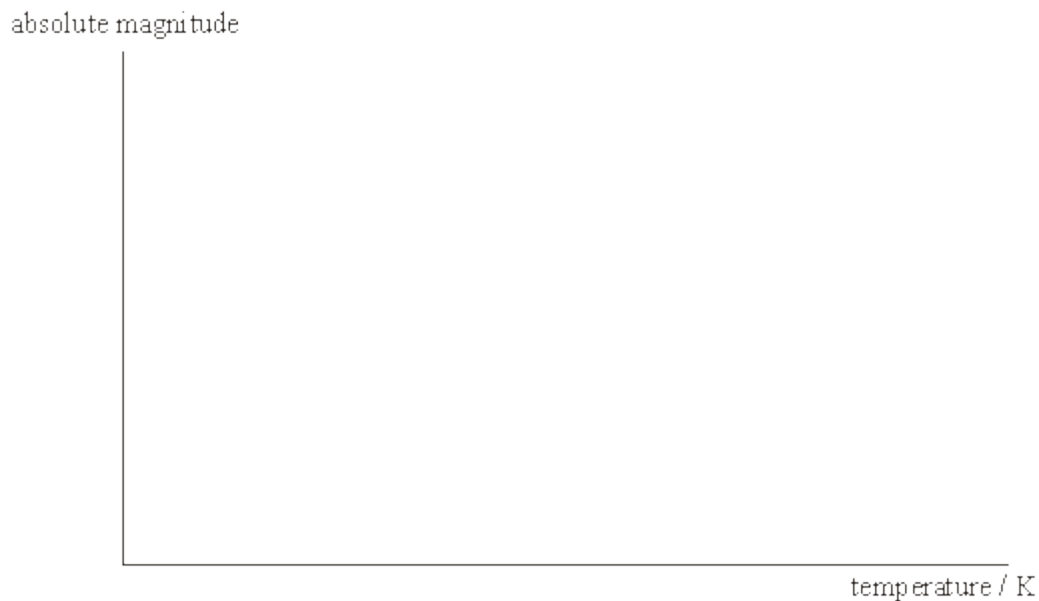
_____

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_____

(3)
(Total 10 marks)

5   (a)   Define the *absolute magnitude* of a star.

_____

_____

(1)

(b)   The figure below shows the axes of a Hertzsprung-Russell (H-R) diagram.

absolute magnitude

temperature / K

(i)   On each axis indicate a suitable range of values.

(ii)   Label with an S the current position of the Sun on the H-R diagram.

(iii)   Label the positions of the following stars on the H-R diagram:

      (1)   star W, which is significantly hotter and brighter than the Sun,

      (2)   star X, which is significantly cooler and larger than the Sun,

      (3)   star Y, which is the same size as the Sun, but significantly cooler,

      (4)   star Z, which is much smaller than the Sun, and has molecular bands as an important feature in its spectrum.

(7)

(Total 8 marks)