

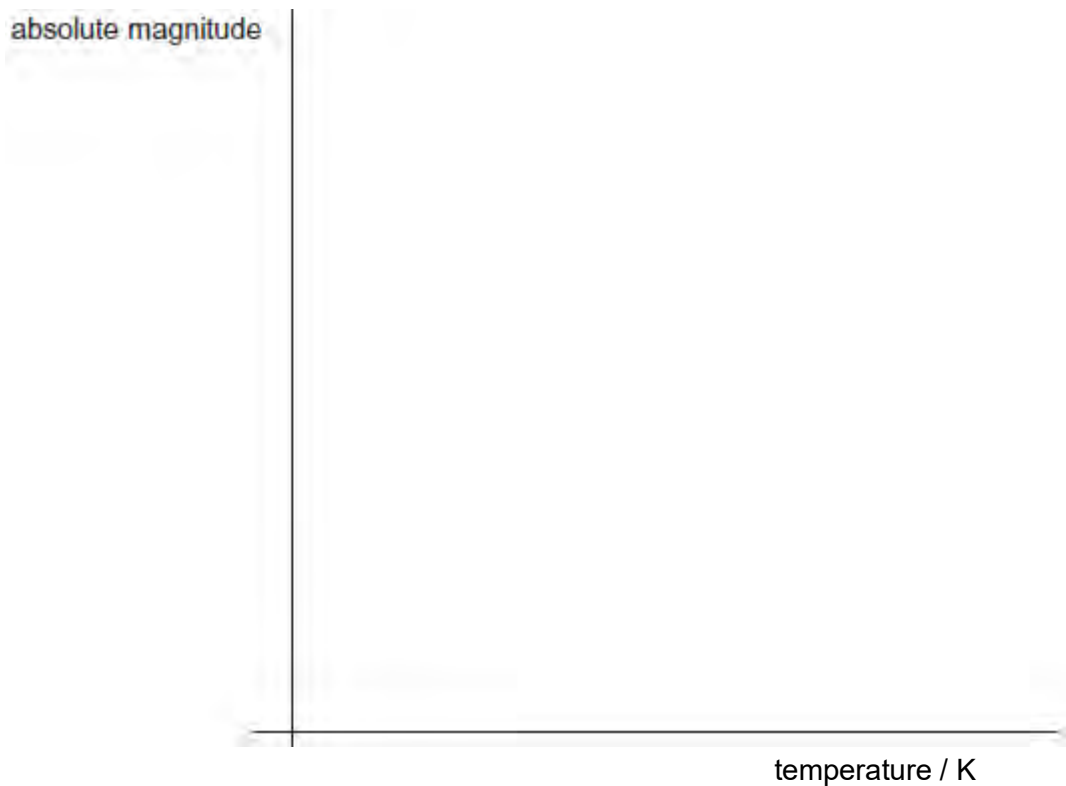
Q1.(a) Define the term absolute magnitude.

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(1)

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

Mark suitable scales on the absolute magnitude and temperature axes.



(2)

(c) Label a possible position of each of the following stars on the diagram above:

(i) the Sun

(1)

(ii) star W, which has the same intrinsic brightness as the Sun, but has a significantly higher temperature

(1)

(iii) star X, which has a similar spectrum to the Sun, but is significantly larger (1)

(iv) star Y, which is significantly larger than the Sun and has prominent absorption lines of neutral atoms and titanium oxide (TiO) in its spectrum. (1)

(d) How does the diameter of star W, in part (ii), compare with the diameter of the Sun? Explain your answer.

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(3)
(Total 10 marks)

Q2.(a) The table summarises some of the properties of two stars in the constellation of Ursa Minor.

name	apparent magnitude	radius of star radius of the Sun	spectral class
Polaris	2.0	50	F
Kocab	2.0	50	K

(i) Using these data, describe and explain **one** similarity and **one** difference in the appearance of the two stars as seen with the unaided eye by an observer on the Earth.

similarity.....

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.....
difference.....
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(2)

(ii) Deduce which of the two stars is further from the Earth.

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(3)

(b) Ursa Minor also contains the galaxy NGC 6251. Measurements indicate that the light from the galaxy has a red shift, z , of 0.025 and that the galaxy is 340 million light years from Earth.

(i) Use these data to calculate a value for the Hubble constant.

value $\text{k ms}^{-1} \text{ Mpc}^{-1}$

(3)

(ii) Use your answer to part (b)(i) to estimate a value for the age of the Universe. State an appropriate unit for your answer.

age unit

(3)
(Total 11 marks)

Q3. (a) Bellatrix and Betelgeuse are stars in the constellation of Orion. Some of their properties are summarised below.

	Bellatrix	Betelgeuse
absolute magnitude	-6.0	-2.7
apparent magnitude	0.4	1.6
black-body temperature / K	22 000	2 400

(i) Explain what is meant by absolute magnitude.

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(1)

(ii) Which of the two stars is closer to the Earth? Explain your answer.

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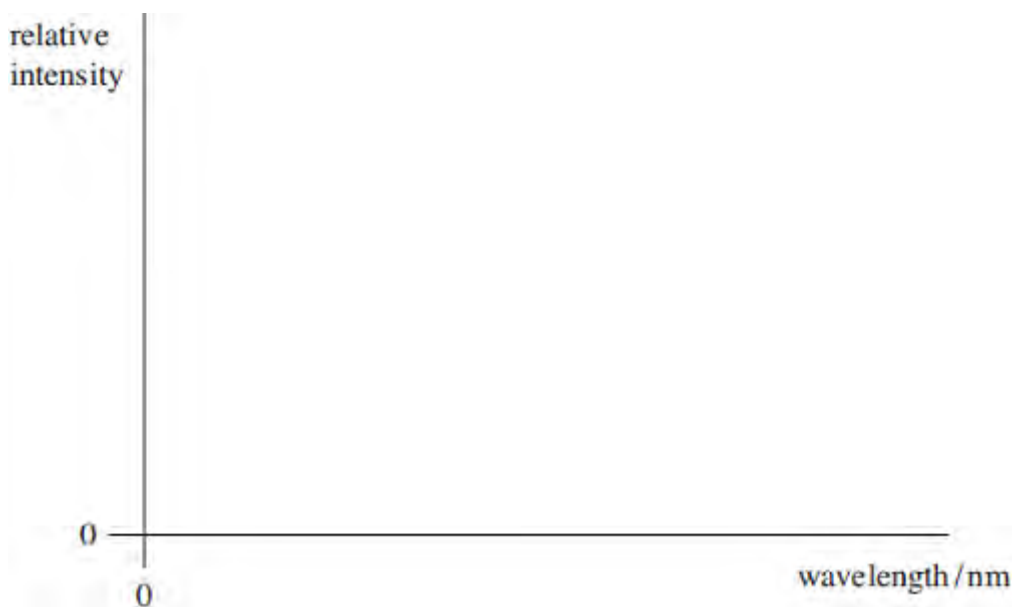
(1)

(b) (i) Calculate the wavelength of the peak intensity in the black-body radiation curve of Bellatrix.

answer = m

(2)

- (ii) Sketch the black-body radiation curve for Bellatrix. Label the wavelength axis with a suitable scale.



(3)

- (c) Detailed analysis of the light from both stars reveals the presence of prominent absorption lines in the spectra.

- (i) To which spectral class does Bellatrix belong?

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(1)

- (ii) Prominent features in the Bellatrix spectrum are the Balmer absorption lines due to hydrogen. State the other element responsible for the prominent absorption lines in the spectrum of Bellatrix.

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(1)

(iii) Why does the spectrum of Betelgeuse not contain prominent Hydrogen Balmer absorption lines?

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(1)
(Total 10 marks)

Q4. (a) The table summarises the properties of five of the stars in the constellation of Cassiopeia.

name	absolute magnitude	apparent magnitude	spectral class
Achird	4.6	3.5	G
Chaph	1.9	2.3	F
Ruchbah	0.24	2.7	A
Segin	-2.4	3.4	B
Shedir	-0.9	2.2	K

Explaining your answer in each case, state which star

(i) is the hottest,

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(ii) is likely to appear orange in colour,

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(iii) appears the brightest from Earth,

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(iv) is less than 10 pc away from the Earth.

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(4)

(b) The constellation Cassiopeia contains another star with an apparent magnitude of 2.2, absolute magnitude of -4.6 and a surface temperature of 12 000 K. Calculate, for this star,

(i) its distance from the Earth,

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(ii) the peak wavelength in its black body radiation curve.

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(3)

(Total 7 marks)

Q5. **Figure 1** shows the black body radiation curves for three stars, labelled P, Q and R.

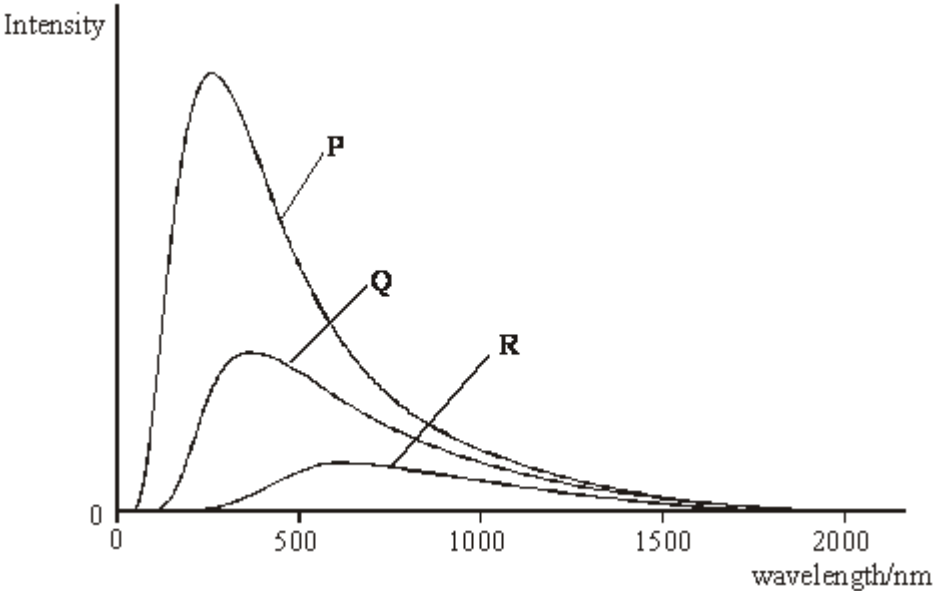


Figure 1

(a) (i) State and explain, without calculation, which one of the three stars is the hottest.

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(ii) Calculate the black body temperature of the hottest star.

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(3)

(b) More detailed analysis of the hottest star's spectrum revealed the presence of Hydrogen Balmer absorption lines.

(i) For which two spectral classes are these lines the prominent feature?

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(ii) Describe how these absorption lines are produced in the spectrum of a star.

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(4)
(Total 7 marks)