AQA A-LEVEL PHYSICS · 7408

PHYSICS



EXAM QUESTION PACK

3.9.2 CLASSIFICATION OF STARS

SCORE	PERCENTAGE
/103	%

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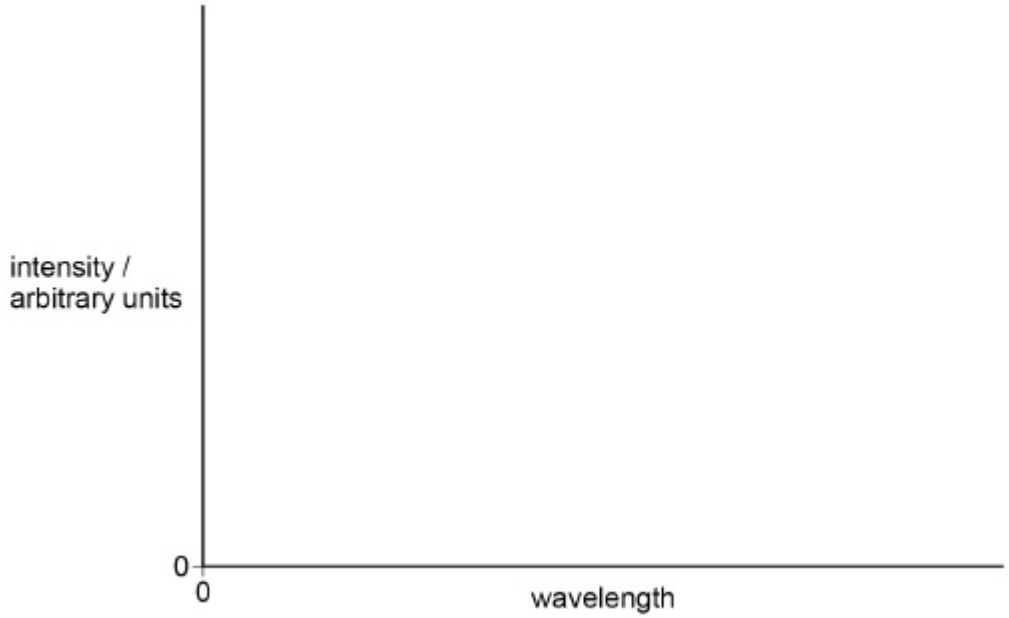
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Q1.

(a) Sketch, on the axes, the black-body radiation curve for a typical star.



(2)

(b) Explain, with reference to the SI units involved, how the curve you have drawn can be used to determine the black-body temperature of the star.

(3)

(c) Two stars, 61 Cygnus A and 61 Cygnus B, can be seen very close together in the constellation Cygnus. Early astronomers were unsure whether the two stars form a binary system, or simply appear in the same line of sight.

The table shows some of the properties of the two stars.

Temperature	Radius /	Apparent

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	/ K	km	magnitude
61 Cygnus A	4500	4.7×10^5	5.2
61 Cygnus B	4100	4.1×10^5	6.1

Evaluate whether the data support the suggestion that the two stars form a binary system.

In your answer you should

- compare the two stars as seen by an observer on Earth
- support your evaluation with suitable calculations.

(6)

(d) What is the spectral class of 61 Cygnus A?
Tick (✓) the correct box.

A ☐

F ☐

G ☐

K ☐

(1)
(Total 12 marks)

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Q2.

The table summarises some of the properties of four stars in the constellation Hercules.

Star	Distance/pc	Spectral class	Apparent magnitude
Kornephoros	43	G	2.8
Rasalgethi	110	M	3.0
Rutilicus	11	G	2.8
Sarin	23	A	3.1

(a) Define the parsec. You may use a diagram as part of your answer.

(2)

(b) Deduce which star is larger, Kornephoros or Rutilicus.

(3)

(c) One of the four stars has the peak in its black-body radiation curve at a wavelength of 1.0 μm.

Calculate the corresponding temperature for this curve.

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temperature = _____ K

(2)

(d) Explain which star produced the black-body radiation curve described in question (c).

_____

_____

_____

_____

(2)

(e) Which star has the brightest absolute magnitude?

Tick (✓) the correct box.

Kornephoros ☐

Rasalgethi ☐

Rutilicus ☐

Sarin ☐

(1)

(f) Determine the absolute magnitude of Sarin.

absolute magnitude = _____

(3)

(Total 13 marks)

Q3.

(a) Sketch, on the axes, the light curve for a typical type 1a supernova.
Label the axes with suitable scales.

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(3)

(b) Type 1a supernovae can be used as standard candles.

Explain what is meant by a standard candle.

(1)

(c) Measurements of type 1a supernovae in 1999 led to a controversy concerning the behaviour of the Universe.

Describe this controversy and how the measurements led to it.

(3)

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(Total 7 marks)

Q4.

(a) Draw a ray diagram for an astronomical refracting telescope in normal adjustment. Your diagram should show the paths of **three** non−axial rays through both lenses.

Label the principal foci of the two lenses.

(2)

(b) Most modern optical observatories make use of reflecting telescopes rather than refracting telescopes.

Discuss the principal optical advantages of reflecting telescopes.

(4)

(c) The Greek astronomer Hipparcos used naked-eye observations to develop a scale for comparing the apparent magnitude of stars.

Explain what is meant by apparent magnitude and describe the main features of the

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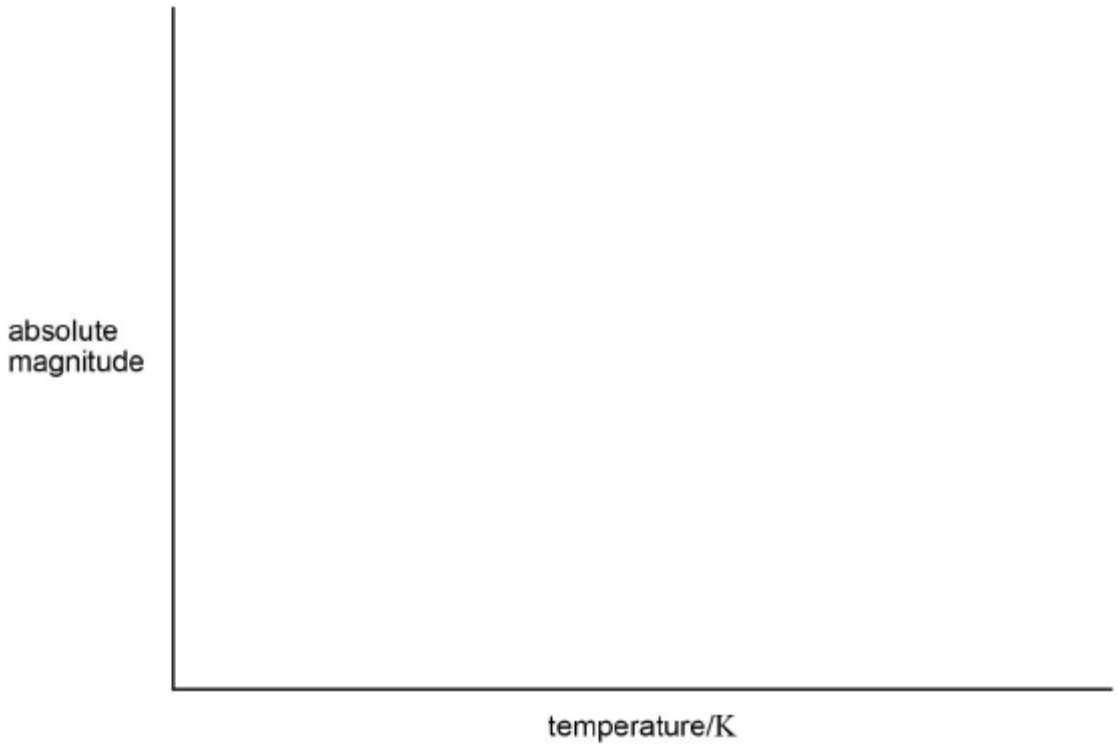
Hipparcos scale.

(6)
(Total 12 marks)

Q5.

(a) Sketch a Hertzsprung−Russell diagram on the axes on the graph below. Label the position of the main sequence, white dwarf and giant stars.

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(3)

(b) Label the minimum and maximum values on the scale of each axis.

(2)

(c) Some of the properties of three stars are shown in the table below.

	Rigel	**Omicron 2 Eridani**	**Regulus A**
distance/light year	860	16.5	79
apparent magnitude	0.13	9.5	1.3
temperature/K	12 000	16 500	12 500

Identify the spectral class to which all three stars belong.

Tick (✓) the correct answer in the right hand column.

	✓ if correct
A	
B	
F	
G	
K	
M	

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O	

(1)

(d) Explain your answer to part **(c)**.

(2)

(e) The three stars belong to different parts of the Hertzsprung−Russell diagram.

Deduce which star is a white dwarf.

(3)

(Total 11 marks)

Q6.

In 2013 a gamma-ray burst was detected from a region of space between the constellations of Leo and Ursa Major.

(a) State the event that was the likely cause of this gamma−ray burst.

(1)

(b) Measurements of the optical remnant of the event revealed an object with a red shift z of 0.34.

Calculate, ignoring relativistic effects, the distance to this object in light year. Give your answer to an appropriate number of significant figures.

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distance = _____ light year

(4)

(c) The total energy of the gamma−ray burst was estimated to be 10^{47} J. Many scientists are concerned that a gamma-ray burst in the direction of the Earth could cause major problems.

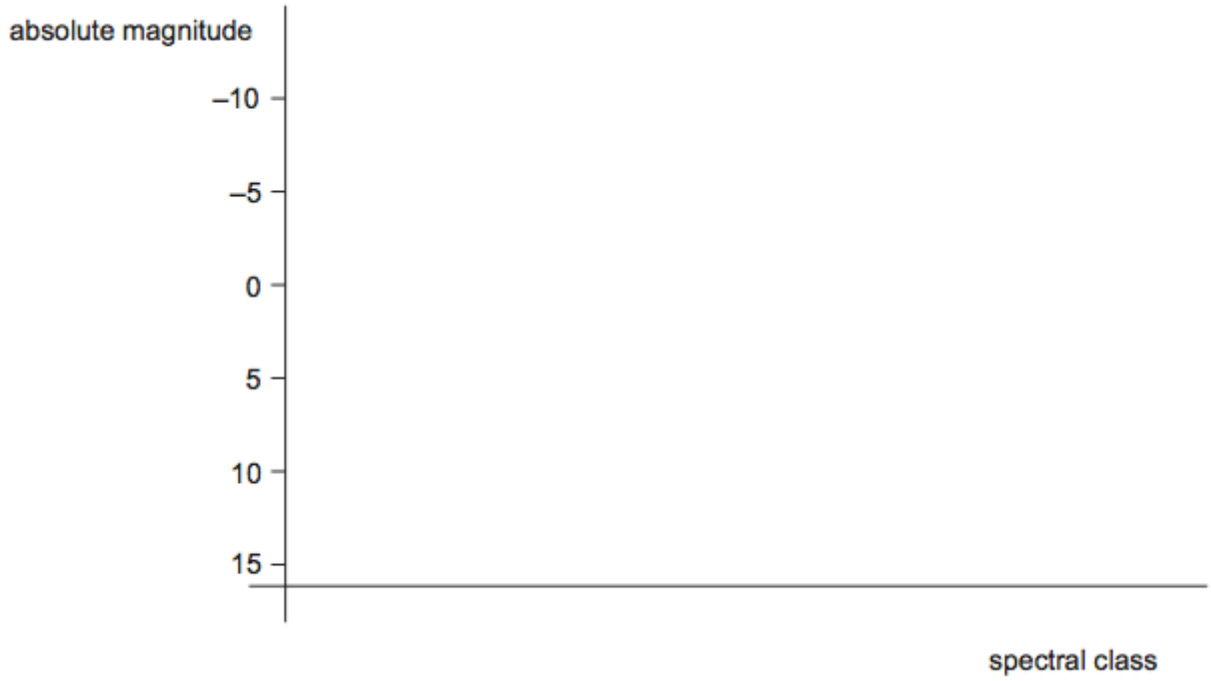
Show that this is similar to the energy that would be released if the mass of the Sun were all converted to energy.

(2)

(Total 7 marks)

Q8.

(a) The graph shows the axes of a Hertzsprung–Russell (H–R) diagram.



(i) Label the spectral class axis with a suitable scale.

(1)

(ii) Complete the H–R diagram by marking the positions of the main sequence, dwarf star and giant star regions.

(2)

(b) The table summarises some of the properties of three stars in the constellation Aries.

Star	Apparent magnitude	Temperature / K	Radius / m

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Hamal	2.0	4500	1.0×10^{10}
Sharatan	2.7	9000	1.8×10^{9}
41 Arietis	3.6	12000	9.6×10^{10}

(i) With reference to the data in the table, compare the three stars.
Your answer should include a discussion of:

- the appearance to the naked eye of the three stars as seen from Earth
- the spectrum of the three stars
- the region of the Hertzsprung–Russell diagram to which each star belongs.

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

(6)

(ii) Hamal is 66 light years from the Earth.
Calculate the absolute magnitude of Hamal.

absolute magnitude = _____

(3)

(iii) Identify which star is the greatest distance from Earth.
Explain your answer.

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_____

_____

_____

_____

_____

(3)

(Total 15 marks)

Q9.

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)

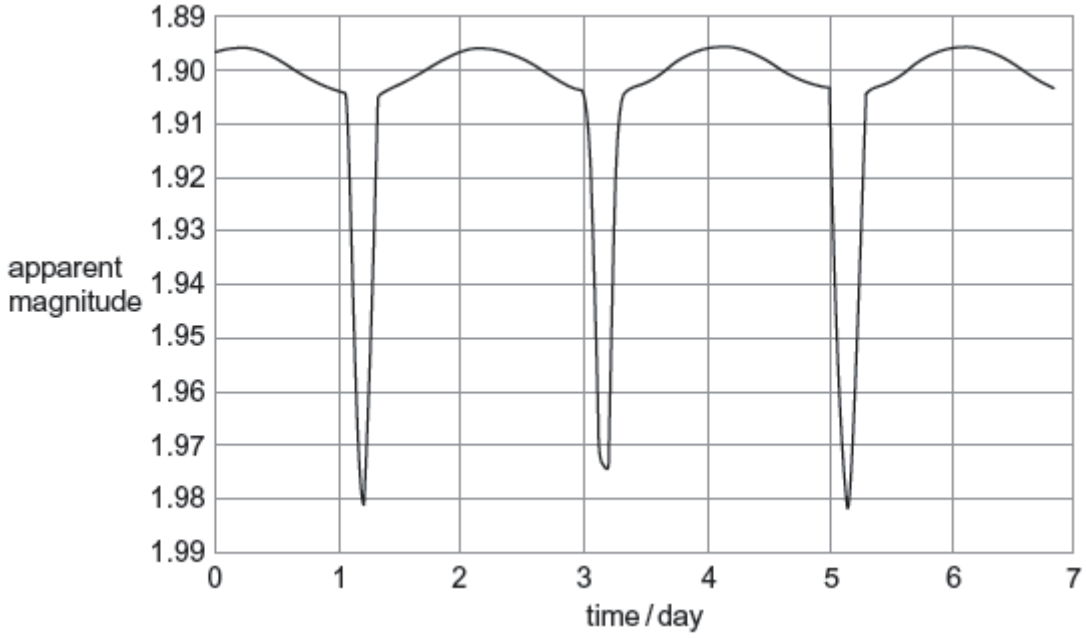
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Q10.

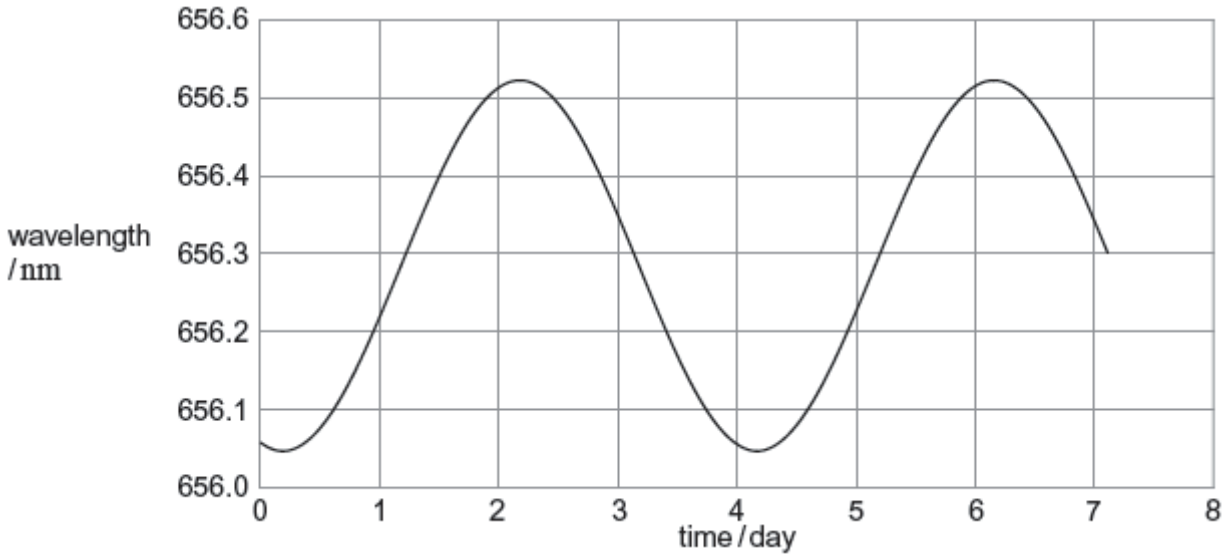
Menkalinan is an eclipsing binary star system in the constellation of Auriga. **Figure 1** shows the variation in apparent magnitude with time (light curve) for Menkalinan.

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.

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(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.

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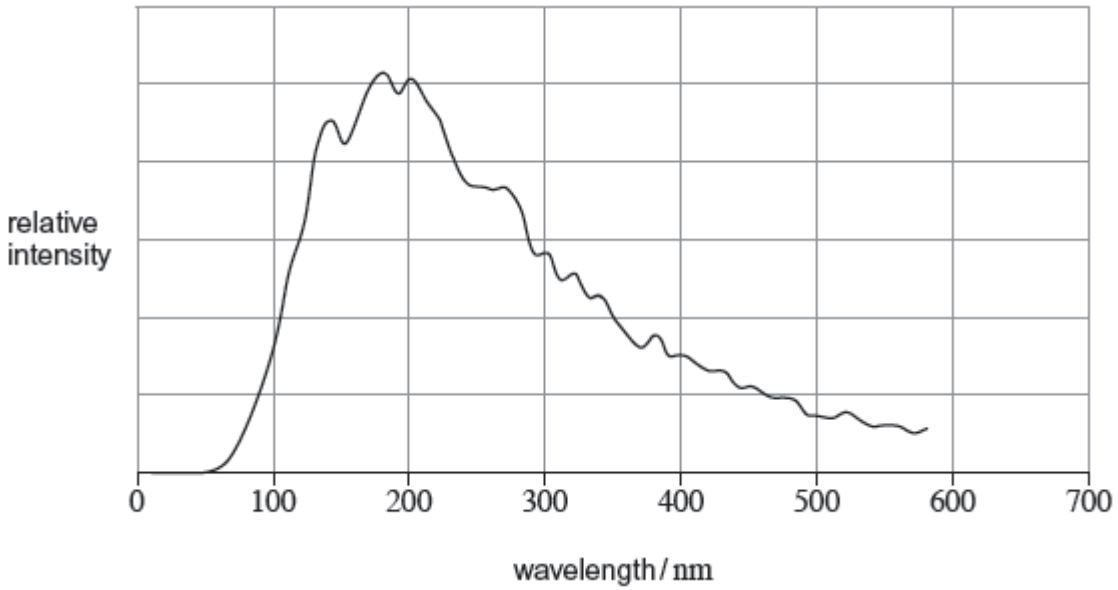
absolute magnitude = _____

(3)

(Total 11 marks)

Q11.

The graph shows the variation of intensity with wavelength for the star 40 Eridani B.



(a) (i) Calculate the black body temperature of 40 Eridani B.

State an appropriate unit for your answer.

temperature = _____ unit _____

(3)

(ii) 40 Eridani B has a total power output of 4.2×10^{24} W.

Calculate its radius.

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radius = _____ m

(2)

(b) (i) Which of the following regions of the Hertzsprung-Russell diagram does 40 Eridani B belong to?
Tick (✓) the correct answer.

main sequence	
dwarf star	
giant star	

(1)

(ii) Give reasons for your answer to part (i).

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

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