

Additional examination-style questions

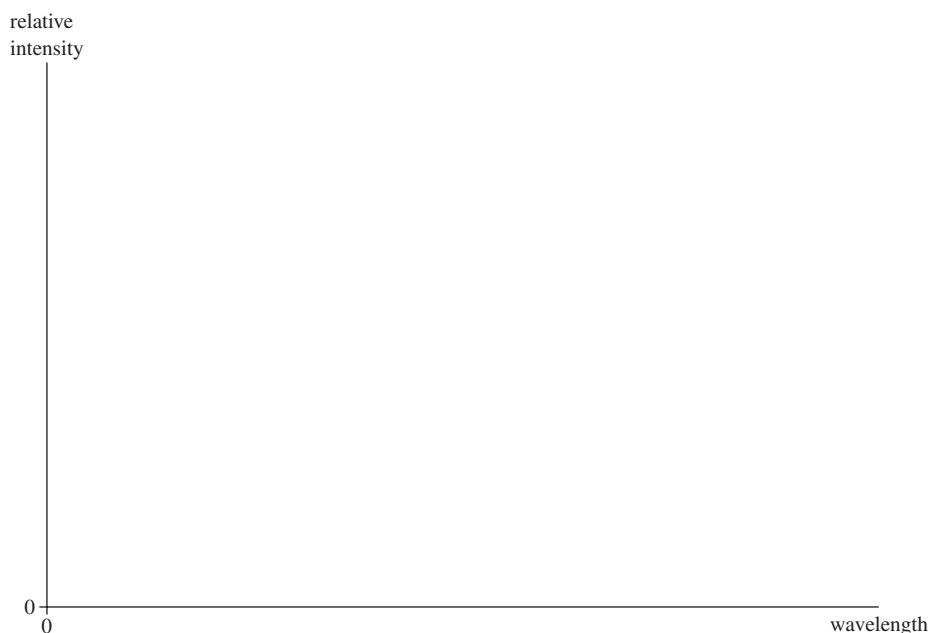
- 1 (a) A lens used by Galileo has a range of focal lengths from 0.98 m to 0.92 m, depending on the wavelength of the light passing through the lens.
- (i) Calculate the power of the lens for red light.
- (ii) Name the defect in the image which arises because a lens has different focal lengths for different wavelengths of light. (3 marks)
- (b) The telescope with which Galileo discovered Io, one of the satellites of Jupiter, had an angular magnification of 30. Calculate the maximum angular separation of the images of Io and Jupiter when viewed through this telescope.
- radius of the orbit of Io around Jupiter = 4.2×10^5 km
distance of Jupiter from the Earth = 6.0×10^8 km. (2 marks)
- (c) A lens of focal length 0.95 m is used as the objective of an astronomical telescope. In normal adjustment, the telescope has an angular magnification of 30. Calculate the distance between the objective and eyepiece lenses. (2 marks)
AQA, 2007
- 2 (a) Draw a ray diagram to show how a converging lens forms a diminished image of a real object. Label the principal foci, the object and the image on your diagram. (2 marks)
- (b) A converging lens of power 12.5 D is used to produce an image of a real object placed 0.35 m from the lens.
- (i) Calculate the image distance.
- (ii) State **three** properties of the image. (4 marks)
AQA 2008
- 3 (a) Draw a ray diagram to show the path of two rays, initially parallel to the axis, through a Cassegrain telescope, as far as the eyepiece. (3 marks)
- (b) The Bradford Robotic Telescope in Tenerife is a Cassegrain arrangement with an objective of diameter 356 mm.
- (i) Calculate the resolving power of this telescope when used with light of wavelength 570 nm.
- (ii) The images are collected using a CCD. What feature of the structure of a CCD can affect the resolution of the final image obtained?
- (iii) The *quantum efficiency* of a CCD is typically greater than 70%. What is meant by quantum efficiency? (3 marks)
AQA 2009
- 4 Stars of spectral classes A and B have strong hydrogen Balmer absorption lines in their spectra.
- (a) Describe how Balmer absorption lines are produced.
You may be awarded marks for the quality of written communication in your answer. (4 marks)
- (b) (i) Why do the spectra of stars in classes F and G not have strong Balmer absorption lines?
(ii) What is the prominent feature in the spectra of stars in classes F and G? (2 marks)
AQA 2007

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5 The data in the table gives some of the properties of the star Mu Cephei.

apparent magnitude	4.23
absolute magnitude	-6.81
surface temperature	3500 K

- (a) (i) Calculate the wavelength of the peak in the black body radiation curve for Mu Cephei.
 (ii) Sketch the black body radiation curve for Mu Cephei on the axes below. Label the wavelength axis with a suitable scale.



(3 marks)

(b) Calculate the distance to Mu Cephei in light years. (2 marks)

(c) Mu Cephei is possibly the largest star yet discovered. Its radius is 1.2×10^9 km, which is about the orbital radius of Saturn. Show that the power output of Mu Cephei is approximately 400 000 times that of the Sun.

surface temperature of the Sun = 5800 K
 radius of the Sun = 6.9×10^5 km

(2 marks)
 AQA 2007

6 Tonantzintla 202 is a *quasar* with a red shift, $\frac{\Delta f}{f}$, of 0.366. When it was discovered in 1957 it was wrongly assumed to be a *white dwarf*.

(a) Explain what is meant by

- (i) a white dwarf,
 (ii) a quasar.

(5 marks)

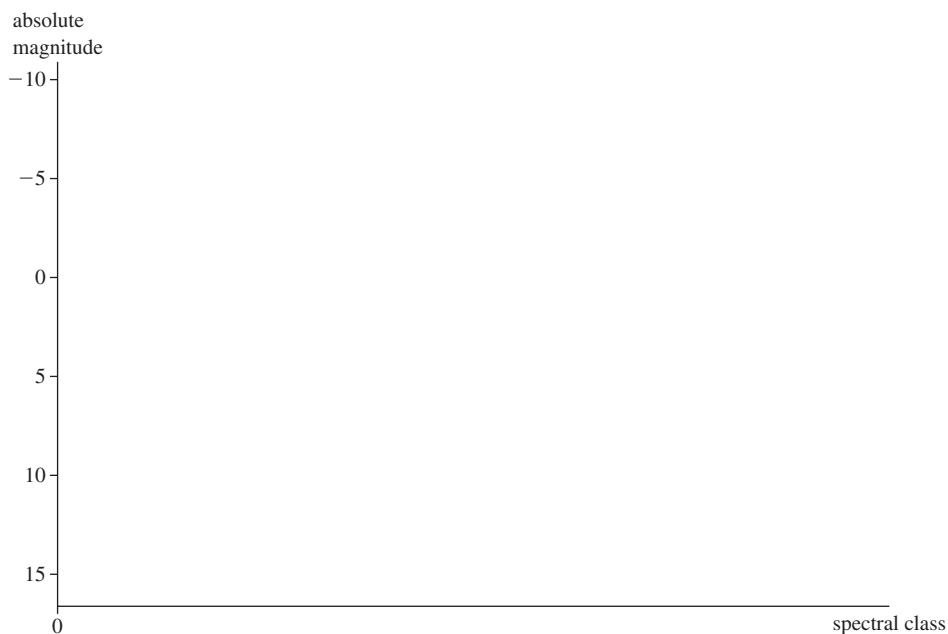
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- (b) Ignoring relativistic effects, calculate, for Tonantzintla 202
- (i) its recessional speed, relative to the Earth,
 - (ii) its distance from the Earth. (3 marks)
- AQA 2007

7 (a) Explain what is meant by the terms *Rayleigh criterion* and *Airy disc*.
 You may be awarded marks for the quality of written communication in your answer. (3 marks)

- (b) The Very Large Telescope (VLT) facility in the Atacama desert in Chile is a combination of four Cassegrain telescopes each of diameter 8.2 m. It is used to detect electromagnetic radiation of wavelengths in the range 200 nm to 20 μm .
- (i) Show that the combination has a similar light-collecting power to that of a single 16 m diameter telescope.
 - (ii) The VLT is capable of an angular resolution similar to that of a 100 m diameter telescope. Calculate the maximum angular resolution of the VLT.
 - (iii) The Atacama desert is possibly the driest place on Earth. What part of the electromagnetic spectrum is significantly absorbed by water vapour? (6 marks)
- AQA 2008

8 (a) Sketch a Hertzsprung-Russell (HR) diagram on the axes below. Label the position of the main sequence, dwarf and giant stars. Complete the spectral class axis by labelling the spectral classes.



- (b) Beta Hydri is a star with the same black body temperature as the Sun, but is approximately 3.5 times brighter.
- (i) Label with the letter X the position of Beta Hydri on the HR diagram.
 - (ii) State and explain which star is larger, the Sun or Beta Hydri. (5 marks)
- AQA 2008

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9 I Zw 1 is an active galaxy, containing a supermassive *black hole* which produces a *quasar* as it consumes its host galaxy.

(a) Explain what is meant by

- (i) a quasar,
- (ii) a black hole.

(3 marks)

(b) Analysis of radio waves from galaxy I Zw 1, suggest it is 800 million light years from Earth.

- (i) Calculate the recessional speed of the galaxy.
- (ii) The source of the radio waves is carbon monoxide molecules in the gas clouds of the galaxy. When measured from a lab-based source, the waves have a frequency of 108 GHz. What is the frequency of the waves detected from the galaxy?

(4 marks)

(c) The black hole at the centre of I Zw 1 could have a mass 100 million times greater than the Sun. Calculate the radius of the event horizon of a black hole of this mass.

(2 marks)

AQA 2008

10 The properties of some of the stars in Ursa Major are given in the table.

name	apparent magnitude	distance/ light year	spectral class
Dubhe	1.8	124	K
Merak	2.4	79	A
Megrez	3.3	81	A
Mizar	2.1	78	A
Alkaid	1.9	101	B

(a) (i) Which of these stars appears dimmest? Explain your answer.

(ii) Which star is the hottest? Explain your answer.

(2 marks)

(b) (i) Define absolute magnitude.

(ii) Which star has the brightest absolute magnitude? Explain your answer.

(2 marks)

(c) (i) Define the parsec.

(ii) Calculate the distance to Alkaid in parsecs.

(iii) Calculate the absolute magnitude of Alkaid.

(5 marks)

AQA 2009

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11 Eta Orionis is an eclipsing binary system. Analysis of the light from one of the stars shows that a particular spectral line varies in wavelength as shown in **Figure 1**.

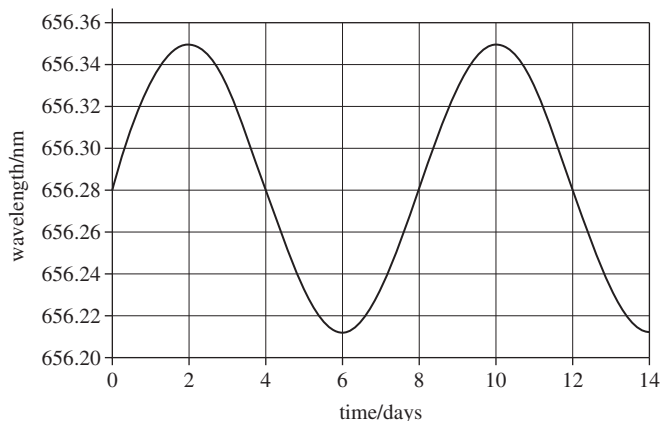


Figure 1

- (a) (i) Show that the star has an orbital velocity of approximately 30 km s^{-1} .
 (ii) Calculate the diameter of the orbit of the star. (4 marks)
- (b) The graph of apparent magnitude against time (light curve) for this binary system is shown in **Figure 2**.
 (i) Label the time axis with a suitable scale.

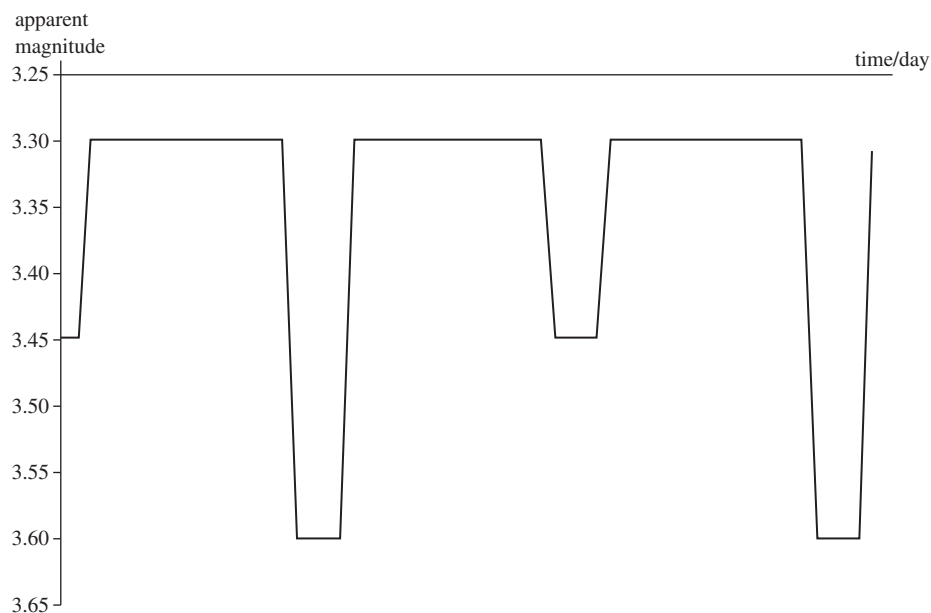


Figure 2

- (ii) Explain, in terms of the movement of the two stars, how this light curve is produced. (4 marks)