

A level Physics A
H556/03 Unified physics

Question Set 9

1 A binary star is a pair of stars which move in circular orbits around their common centre of mass.

In this question consider the stars to be point masses situated at their centres.

(a) Fig. 3.1 shows a binary star where the mass of each star is m . The stars move in the same circular orbit.

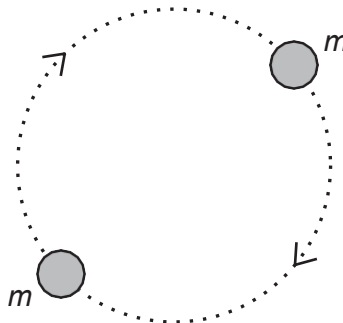


Fig. 3.1

(i) Explain why the stars of equal mass must always be diametrically opposite as they travel in the circular orbit.

[2]

(ii) The centres of the two stars are separated by a distance of $2R$ equal to 3.6×10^{10} m, where R is the radius of the orbit. The stars have an orbital period T of 20.5 days. The mass of each star is given by the equation

$$m = \frac{16\pi^2 R^3}{GT^2}$$

where G is the gravitational constant.

Calculate the mass m of each star in terms of the mass M_{\odot} of the Sun.

$$1 \text{ day} = 86400 \text{ s}$$

$$M_{\odot} = 2.0 \times 10^{30} \text{ kg}$$

$$m = \dots\dots\dots M_{\odot} \text{ [3]}$$

- (iii) The stars are viewed from Earth in the plane of rotation.
The stars are observed using light that has wavelength of 656 nm in the laboratory. The observed light from the stars is Doppler shifted.

Calculate the maximum change in the observed wavelength $\Delta\lambda$ of this light from the orbiting stars. Give your answer in nm.

$$\Delta\lambda = \dots\dots\dots \text{ nm [2]}$$

- (b) Fig. 3.2 shows a binary star where the masses of the stars are $4m$ and m .

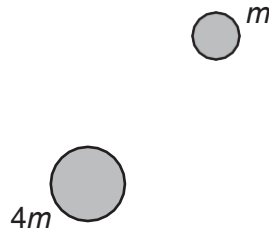


Fig. 3.2

- (i) The centre of mass of the binary star lies at the surface of the star of mass $4m$. Draw on **Fig. 3.2** two circles to represent the orbits of **both** stars. [1]
- (ii) Explain why the smaller mass star travels faster in its orbit than the larger mass star. [2]

Total Marks for Question Set 9: 10

OCR

Oxford Cambridge and RSA

Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact The OCR Copyright Team, The Triangle Building, Shaftesbury Road, Cambridge CB2 8EA.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge