4 Binary star systems, consisting of two stars orbiting around each other, are very common.

Fig. 4.1 shows two stars of mass *M* and 2*M* in circular orbits about point C.

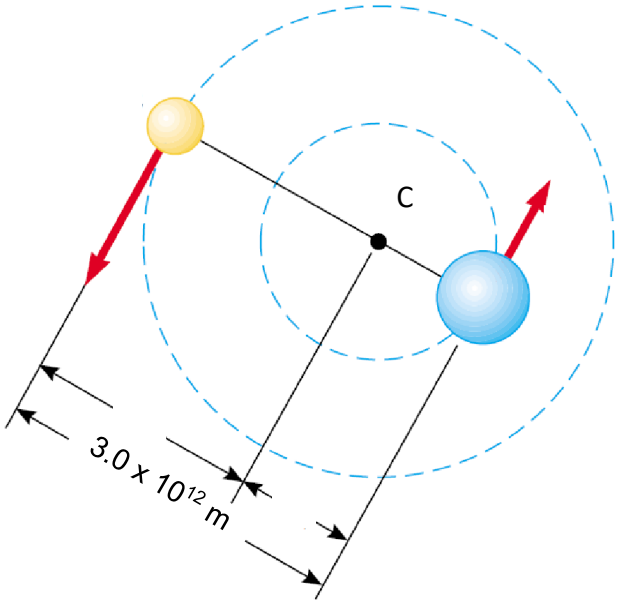

Fig. 4.1

The centre-to-centre separation between the two stars is 3.0×10^{12} m. Both stars have the same orbital period, and they are always located on opposite sides of C.

(a) Explain how the gravitational force acting on one star is equal to the gravitational force acting on the other star.

……

……[1]

(b) The orbital radius of M is r_1 and the orbital radius of 2*M* is r_2. By considering the magnitude of the centripetal forces acting on the two stars, show that

$$\frac{r_1}{r_2} = 2$$

[1]

[Turn over

(c) Hence, or otherwise, determine the value of r_1.

r_1 = ... m [2]

(d) M is 2.0×10^{30} kg.

Determine the orbital period T of the stars.

T = ... s [2]

[Total: 6]