2 A binary star system consists of two stars X and Y that orbit around their common centre of gravity C. The orbits are circular. Both stars can be considered as point masses.

The mass of star X is M and the mass of star Y is $2M$. The common centre of gravity is at a distance of D from star Y, and at a distance of $2D$ from star X, as shown in Fig. 2.1.

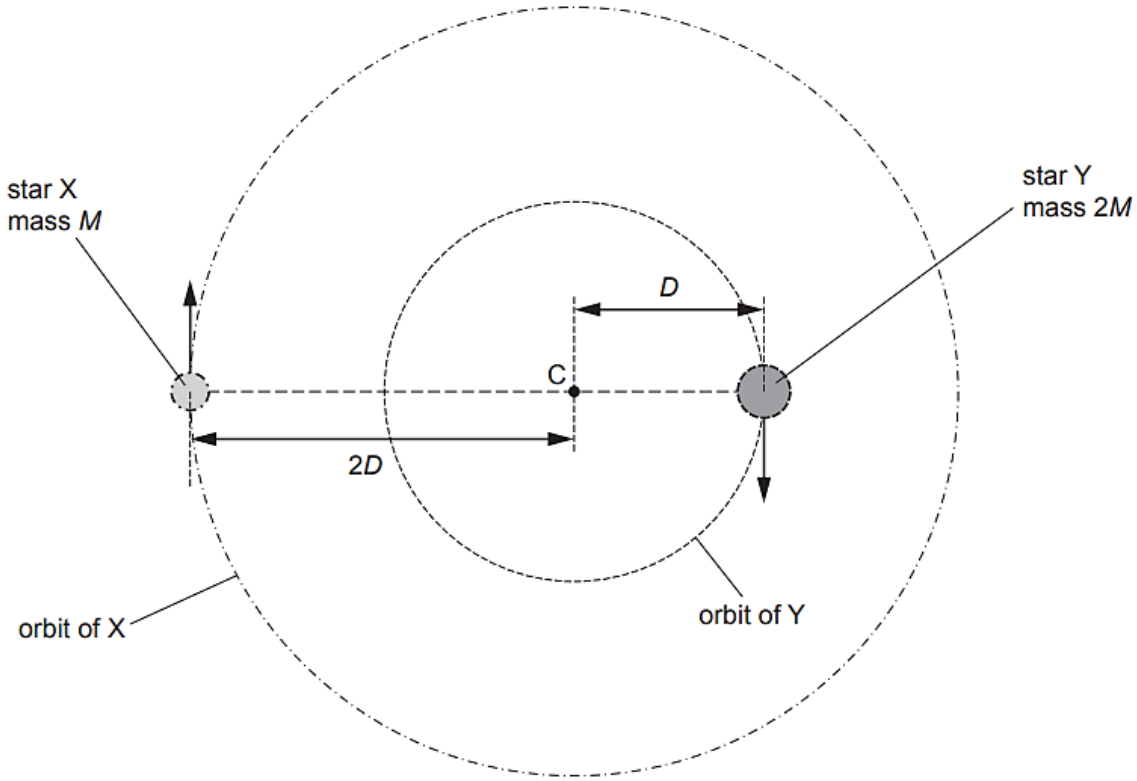

Fig. 2.1

(a) Star X orbits with angular velocity ω. Show that the angular velocity of the orbit of star Y is also ω.

[1]

(b) Deduce an expression, in terms of G, M and D, for the total energy E of the binary star system.

[4]

(c) The total energy E of the binary star system is negative.

Explain the physical significance of this negative value.

……..……..……..……..……

……..……..……..……..... [1]

(d) Explain whether two identical electric charges could form a system in which the charges orbit around a common centre.

……..……..……..……..……

……..……..……..……..... [1]