7 **(a)** Explain why an object moving at a constant speed in a circular path experiences a force towards the centre of the circle.

……..……...……

……..……...……

……...……..……..…

……..……..……. [2]

(b) A trinary star system consists of three stars A, B and C of equal mass *M*. The three stars are equidistant from one another and rotate at constant speed in a circular path of radius *R* about the centre X, as illustrated in Fig. 7.1.

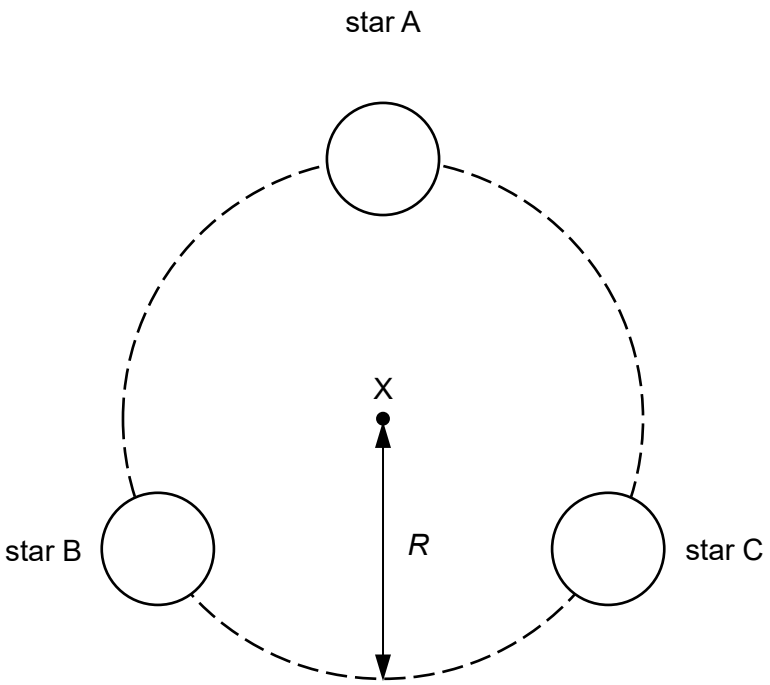

Fig. 7.1 (not to scale)

(i) Show that the centres of any two stars are separated by a distance 1.73R.

[1]

(ii) On Fig. 7.1, draw and label arrows to show the forces acting on star A. [2]

(iii) In terms of G, M and R,

1. determine the gravitational potential energy of the trinary star system.

gravitational potential energy = …… [2]

2. use **(b)(ii)** to determine the resultant force experienced by each star.

resultant force = …… [2]

3. hence determine the kinetic energy of the trinary star system.

kinetic energy = …… [2]

(iv) The speed of each of the three stars suddenly increased by the same magnitude.

State and explain the subsequent motion of the stars.

……

……

……

…… [2]

(c) A space probe travels in a circular orbit of radius *d* around the trinary star system, as illustrated in Fig. 7.2.

space probe

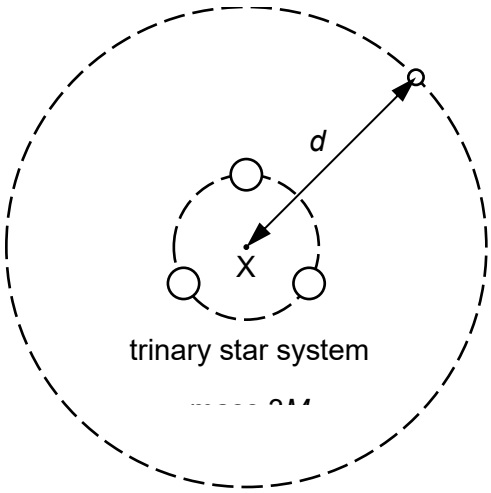

Fig. 7.2 (not to scale)

It can be assumed that the effective mass of the trinary star system is a point mass at its centre and is equal to 3*M*.

The mission of the space probe is to observe the trinary star system.

The orbital period of the trinary star system is *T*.

(i) Discuss the advantage

1. if the orbital period of the space probe is equal to *T*.

……..……..……...

……..……..……... [1]

2. if the orbital period of the space probe is smaller than *T*.

……..……..……...

……..……..……... [1]

3. if the space probe rotates about its own axis with the same period as its orbital period.

……..……..……...

……..……..……... [1]

(ii) A small component of the space probe was dislodged from the space probe when it is at the position shown in Fig. 7.2.

On Fig. 7.2, sketch the subsequent path of this component. [1]

(iii) Given that M is 1.39×10^{30} kg and d is 1.05×10^{11} m , determine the minimum velocity required for the space probe to escape the gravitational field of the trinary star system.

minimum velocity = …… m s^{-1} [3]