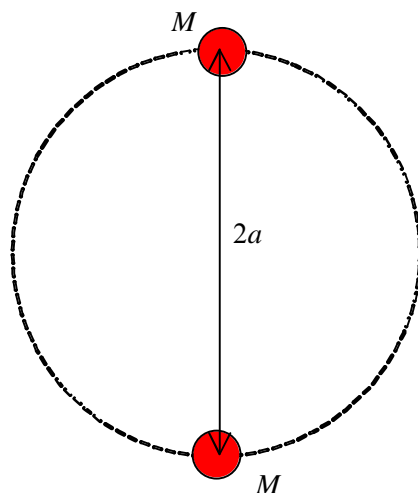


Extension Worksheet – Topic 2, Worksheet 7

- 1** Two stars each of mass M are separated by a distance $2a$. The stars revolve around a common centre as shown.



- a** Show that the speed of each of the masses is given by $v = \sqrt{\frac{GM}{4a}}$. [2]
 - b** Show that the period of revolution of each star is given by $T = 4\pi\sqrt{\frac{a^3}{GM}}$. [2]
 - c** Deduce that the total energy of the two stars is $E = -\frac{GM^2}{4a}$. [2]
 - d** The two stars radiate gravitational waves and so lose energy. State the effect this will have on (i) the separation of the stars, (ii) the speed of each star and (iii) the period of revolution of the stars. [3]
- 2** A sphere of radius 0.25 m is positively charged. A positive point charge $45 \mu\text{C}$ and mass 0.020 kg is launched with speed $v = 2.5 \times 10^2 \text{ m s}^{-1}$ from a point a distance of 0.85 m from the centre of the sphere towards the centre of the sphere. The point charge momentarily comes to rest on the surface of the sphere.
- a** Show that the charge on the sphere is approximately $550 \mu\text{C}$. [3]
 - b** Calculate the magnitude of the electric field on the surface of the sphere. [2]
 - c** Describe, qualitatively, the subsequent motion of the point charge. [2]
 - d** Determine the speed of the point charge when it is very far away from the sphere. [2]