Topic 23: Exercises on Motion in a Horizontal Circle
Level 2

1. A particle of mass 0.25 kg is attached to one end of a light inextensible string of length 0.5 m. The other end is fixed to a point A on a smooth horizontal table. The particle is set in motion in a circular path. If the speed of the particle is 8 ms^{-1}, find the tension in the string and the reaction with the table.

$32\text{ N}, \frac{1}{4}g\text{N}$

2. A particle of mass 0.5 *kg* is attached to one end of a light inextensible string of length 2 *m*. The other end is fixed to a point *A* on a smooth horizontal table. The particle is set in motion in a circular peth. If the string breaks when the tension in it exceeds 64 N, find the greatest speed at which the particle can travel.

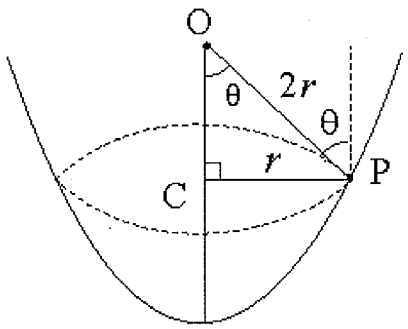
$16\ ms^{-1}$

3. A mass of 2 *kg* is revolving at the end of a string 2 *m* long on a smooth horizontal table with uniform angular speed. If the string would break under a tension equal to the weight of 20 *kg*, find the greatest positive speed of the mass.

$\sqrt{20g}\ ms^{-1}$

4. A particle moves with constant angular velocity ω in a horizontal circle of radius r on the inside of a fixed smooth hemispherical bowl of internal radius $2r$. Show that

$\omega^2 = \frac{g}{r\sqrt{3}}$.



5. A particle P of mass 0.2 kg moving on a smooth horizontal table with constant speed $v\ ms^{-1}$ describes a circle with centre O such that $OP = r\ m$. The particle is subject to two forces, one towards O with magnitude $8v$ N an one away from O with magnitude $\frac{k}{r^2}$ N, where k is a positive constant. If $r = 1$, find the set of possible values of k.

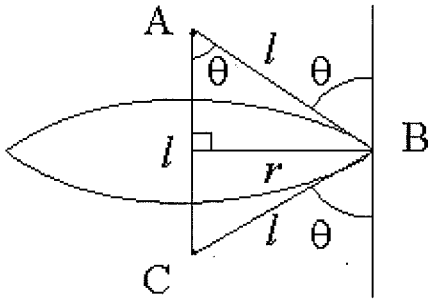
$0 \leq k \leq 80$

6. A particle of mass 0.1 kg moving on a smooth horizontal table with constant speed $v\ ms^{-1}$ describes a circle with centre O and radius $r\ m$. The particle is attracted towards O by a force of magnitude $4v$ N and repelled from O by a force of magnitude $\frac{k}{r}$ N, where k is a constant. Given that $k = 30$ and $r = 1$, find the possible values of v.

$10ms^{-1}$ or $30ms^{-1}$

7. Two light inextensible strings AB and BC each of length l are attached to a particle of mass m at B. The other ends A and C are fixed to two points in a vertical line such that A is a distance l above C. The particle describes a horizontal circle with constant angular velocity ω. Find

(a) the tension in the strings



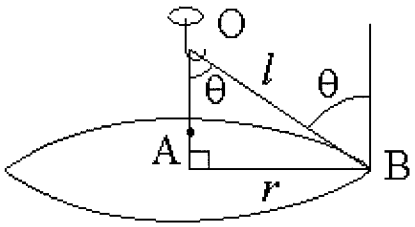
$$m\left(\frac{l\omega^2}{2}-g\right),\ m\left(\frac{l\omega^2}{2}+g\right)$$

(b) the least value of ω in order that strings are taut.

$$\left(\frac{2g}{l}\right)^{1/2}$$

8. Two particles A and Forces on engineof masses m and μ respectively are attached to the ends of a light inextensible string which passes over a smooth hook at O which is free to rotate. The particle A hangs at rest vertically below O while the particle B moves in a horizontal circle with constant speed v. Find expressions for

(a) the length OB and the angle AOB



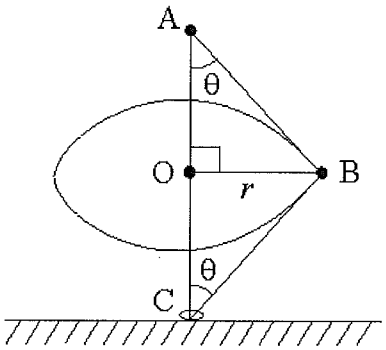
$$\frac{m\mu v^2}{g\left(m^2-\mu^2\right)},\ \cos^{-1}\left(\frac{\mu}{m}\right)$$

(b) the radius of the circle in which B moves.

$$\frac{\mu v^2}{g\sqrt{m^2-\mu^2}}$$

9. Two rigid light rods AB and BC, each of length 0.5 m, are smoothly jointed at B and the rod AB is smoothly jointed at A to a fixed smooth vertical rod. The joint at B has a particle of mass 2 kg attached. A small ring of mass 1 kg is smoothly jointed to BC at C and can slide on the vertical rod below A. The ring rests on a smooth horizontal ledge at a distance $\frac{\sqrt{3}}{2}$ m below A. The system rotates about the vertical rod with constant angular velocity 6 radians per second. Find

(a) the forces in the rod AB and BC



$18+\frac{20}{\sqrt{3}}\text{N}, 18-\frac{20}{\sqrt{3}}\text{N}$

(b) the force exerted by the ledge on the ring.

$20-9\sqrt{3}\text{N}$