Uniform Motion in a Circle

Question Paper 6

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Uniform Motion in a Circle
Sub Topic	
Booklet	Question Paper 6

Time Allowed: **52 minutes**

Score: **/43**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(i)**

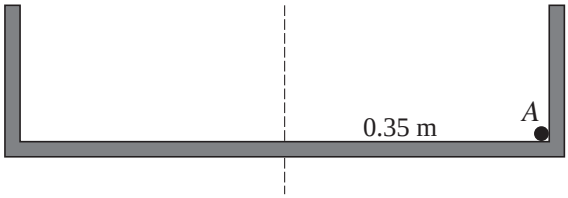


Fig. 1

A small sphere A of mass 0.15 kg is moving inside a fixed smooth hollow cylinder whose axis is vertical. A moves with constant speed 1.2 m s^{-1} in a horizontal circle of radius 0.35 m, and is continuously in contact with both the plane base and the curved surface of the cylinder. Fig. 1 shows a vertical cross-section of the cylinder through its axis. Find the magnitude of the force exerted on A by

(a) the base of the cylinder,

(b) the curved surface of the cylinder.

[3]

(ii)

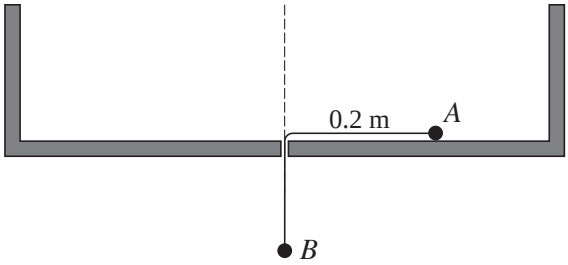
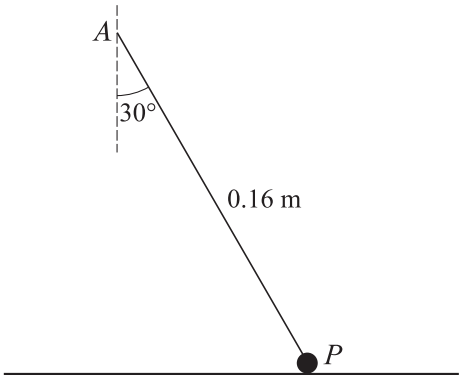


Fig. 2

Sphere A is now attached to one end of a light inextensible string. The string passes through a small smooth hole in the middle of the base of the cylinder. Another small sphere B, of mass 0.25 kg, is attached to the other end of the string. B hangs in equilibrium below the hole while A is moving in a horizontal circle of radius 0.2 m (see Fig. 2). Find the angular speed of A. [4]

2

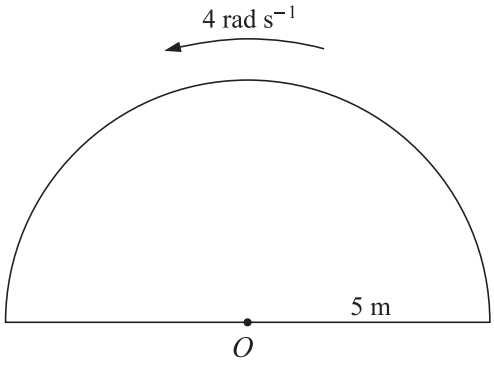


One end of a light inextensible string of length 0.16 m is attached to a fixed point A which is above a smooth horizontal table. A particle P of mass 0.4 kg is attached to the other end of the string. P moves on the table in a horizontal circle, with the string taut and making an angle of 30° with the downward vertical through A (see diagram). P moves with constant speed 0.6 m s^{-1}. Find

(i) the tension in the string, [3]

(ii) the force exerted by the table on P. [3]

3



A uniform semicircular lamina has radius 5 m. The lamina rotates in a horizontal plane about a vertical axis through O, the mid-point of its diameter. The angular speed of the lamina is 4 rad s^{-1} (see diagram). Find

(i) the distance of the centre of mass of the lamina from O, [2]

(ii) the speed with which the centre of mass of the lamina is moving. [2]

4

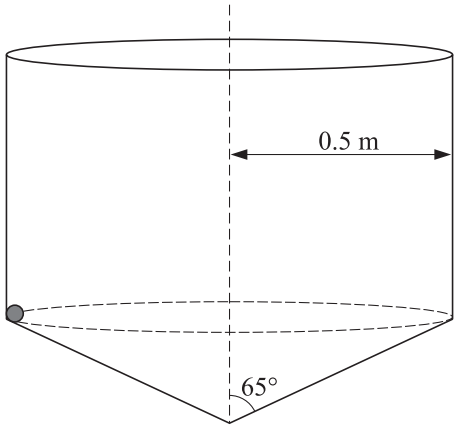


Fig. 1

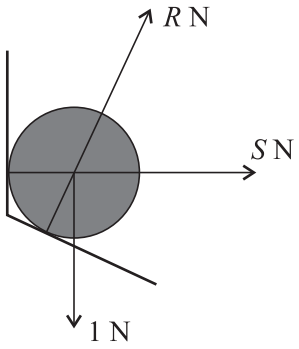


Fig. 2

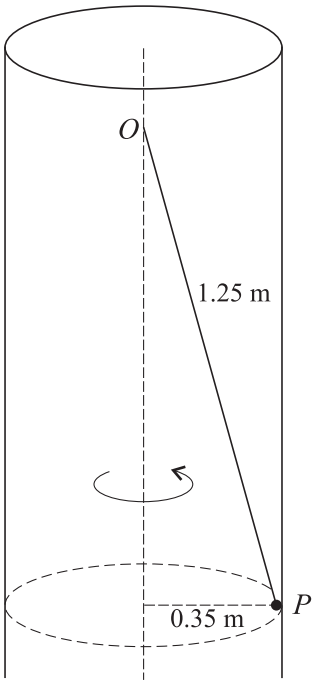
A hollow container consists of a smooth circular cylinder of radius 0.5 m, and a smooth hollow cone of semi-vertical angle 65° and radius 0.5 m. The container is fixed with its axis vertical and with the cone below the cylinder. A steel ball of weight 1 N moves with constant speed 2.5 m s^{-1} in a horizontal circle inside the container. The ball is in contact with both the cylinder and the cone (see Fig. 1). Fig. 2 shows the forces acting on the ball, i.e. its weight and the forces of magnitudes R N and S N exerted by the container at the points of contact. Given that the radius of the ball is negligible compared with the radius of the cylinder, find R and S. [6]

5 A horizontal turntable rotates with constant angular speed 3 rad s^{-1}. A particle of mass 0.06 kg is placed on the turntable at a point 0.25 m from its centre. The coefficient of friction between the particle and the turntable is μ. As the turntable rotates, the particle moves with the turntable and no sliding takes place.

(i) Find the vertical and horizontal components of the contact force exerted on the particle by the turntable. [3]

(ii) Show that $\mu \geqslant 0.225$. [1]

6

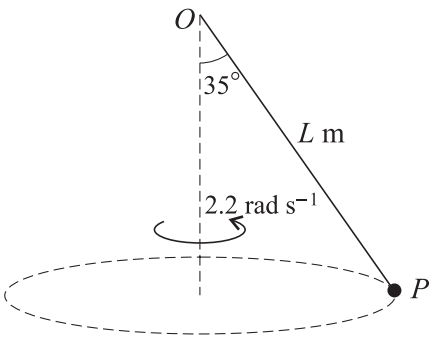


A hollow cylinder of radius 0.35 m has a smooth inner surface. The cylinder is fixed with its axis vertical. One end of a light inextensible string of length 1.25 m is attached to a fixed point O on the axis of the cylinder. A particle P of mass 0.24 kg is attached to the other end of the string. P moves with constant speed in a horizontal circle, in contact with the inner surface of the cylinder, and with the string taut (see diagram).

(i) Find the tension in the string. [2]

(ii) Given that the magnitude of the acceleration of P is $8\,\text{m}\,\text{s}^{-2}$, find the force exerted on P by the cylinder. [3]

7

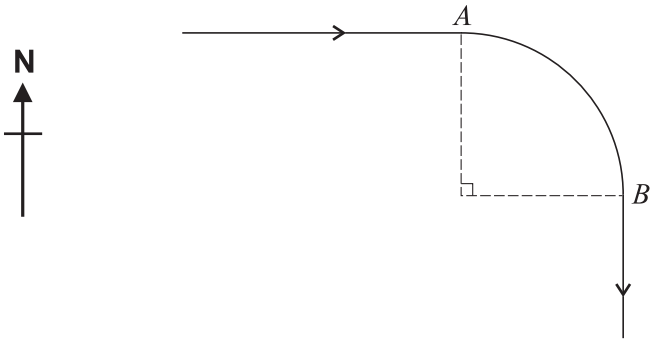


A particle P of mass m kg is attached to one end of a light inextensible string of length L m. The other end of the string is attached to a fixed point O. The particle P moves with constant speed in a horizontal circle, with the string taut and inclined at 35° to the vertical. OP rotates with angular speed $2.2\,\text{rad}\,\text{s}^{-1}$ about the vertical axis through O (see diagram). Find

(i) the value of L, [4]

(ii) the speed of P in $\text{m}\,\text{s}^{-1}$. [2]

8



An aircraft flies horizontally at a constant speed of $220\,\text{m}\,\text{s}^{-1}$. Initially it is flying due east. On reaching a point A it flies in a circular arc from A to B, taking 50 s. At B the aircraft is flying due south (see diagram).

(i) Show that the radius of the arc is approximately 7000 m. [3]

(ii) Find the magnitude of the acceleration of the aircraft while it is flying between A and B. [2]