Uniform Motion in a Circle

Question Paper 3

Level	International A Level
Subject	Maths
Exam Board	CIE
Topic	Uniform Motion in a Circle
Sub Topic	
Booklet	Question Paper 3

Time Allowed: **57 minutes**

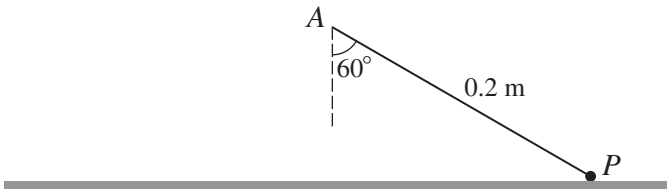
Score: **/47**

Percentage: **/100**

Grade Boundaries:

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

1



One end of a light inextensible string of length 0.2 m is attached to a fixed point A which is above a smooth horizontal table. A particle P of mass 0.3 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 60° with the downward vertical (see diagram).

(i) Calculate the tension in the string if the speed of P is $1.2\,\text{m s}^{-1}$. [3]

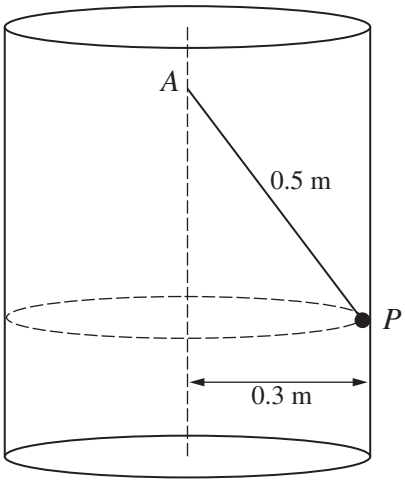
(ii) For the motion as described, show that the angular speed of P cannot exceed $10\,\text{rad s}^{-1}$, and hence find the greatest possible value for the kinetic energy of P. [6]

2 A small sphere of mass 0.4 kg moves with constant speed $1.5\,\text{m s}^{-1}$ in a horizontal circle inside a smooth fixed hollow cylinder of diameter 0.6 m. The axis of the cylinder is vertical, and the sphere is in contact with both the horizontal base and the vertical curved surface of the cylinder.

(i) Calculate the magnitude of the force exerted on the sphere by the vertical curved surface of the cylinder. [2]

(ii) Hence show that the magnitude of the total force exerted on the sphere by the cylinder is 5 N. [2]

3



A smooth hollow cylinder of internal radius 0.3 m is fixed with its axis vertical. One end of a light inextensible string of length 0.5 m is fixed to a point A on the axis. The other end of the string is attached to a particle P of mass 0.2 kg which moves in a horizontal circle on the surface of the cylinder (see diagram).

(i) Find the tension in the string. [3]

(ii) Find the least angular speed of P for which the motion is possible. [2]

(iii) Calculate the magnitude of the force exerted on P by the cylinder given that the speed of P is $1.8\,\text{m}\,\text{s}^{-1}$. [3]

4 ABC is a uniform semicircular arc with diameter $AC = 0.5$ m. The arc rotates about a fixed axis through A and C with angular speed $2.4\,\text{rad}\,\text{s}^{-1}$. Calculate the speed of the centre of mass of the arc. [3]

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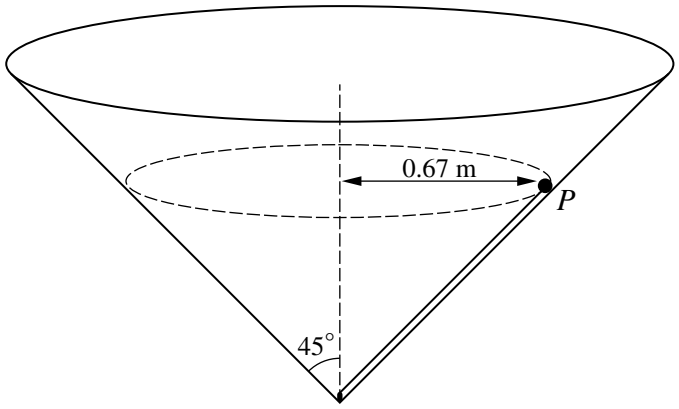
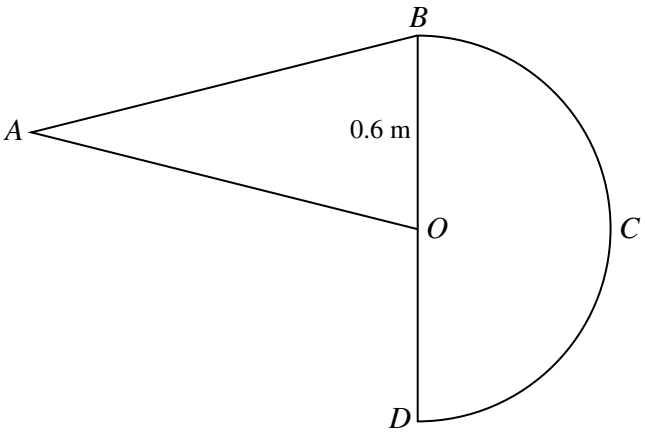


A particle P is moving inside a smooth hollow cone which has its vertex downwards and its axis vertical, and whose semi-vertical angle is 45°. A light inextensible string parallel to the surface of the cone connects P to the vertex. P moves with constant angular speed in a horizontal circle of radius 0.67 m (see diagram). The tension in the string is equal to the weight of P. Calculate the angular speed of P. [6]

6



A uniform lamina $OABCD$ consists of a semicircle BCD with centre O and radius 0.6 m and an isosceles triangle OAB, joined along OB (see diagram). The triangle has area 0.36 m^2 and $AB = AO$.

(i) Show that the centre of mass of the lamina lies on OB. [4]

(ii) Calculate the distance of the centre of mass of the lamina from O. [4]

7 The end A of a rod AB of length 1.2 m is freely pivoted at a fixed point. The rod rotates about A in a vertical plane. Calculate the angular speed of the rod at an instant when B has speed $0.6\,\text{m}\,\text{s}^{-1}$. [2]

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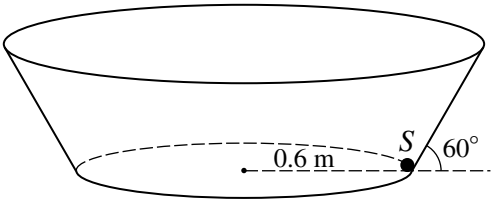

Fig. 1

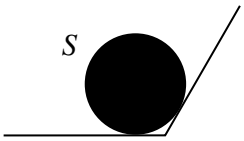

Fig. 2

A small sphere S of mass m kg is moving inside a smooth hollow bowl whose axis is vertical and whose sloping side is inclined at 60° to the horizontal. S moves with constant speed in a horizontal circle of radius 0.6 m (see Fig. 1). S is in contact with both the plane base and the sloping side of the bowl (see Fig. 2).

(i) Given that the magnitudes of the forces exerted on S by the base and sloping side of the bowl are equal, calculate the speed of S. [4]

(ii) Given instead that S is on the point of losing contact with one of the surfaces, find the angular speed of S. [3]