

2.

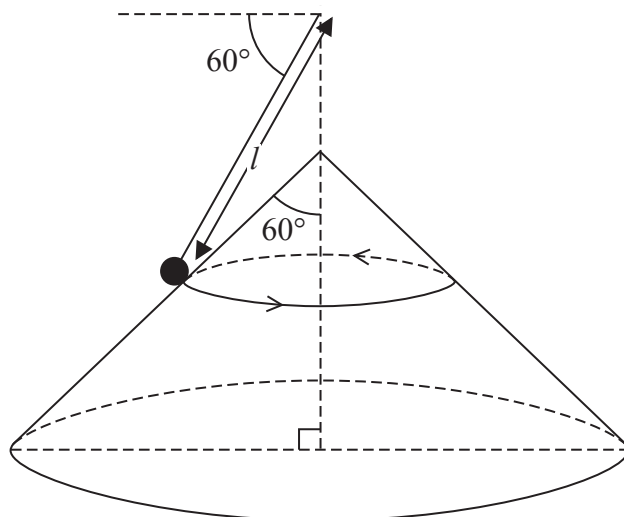


Figure 1

A cone of semi-vertical angle 60° is fixed with its axis vertical and vertex upwards. A particle of mass m is attached to one end of a light inextensible string of length l . The other end of the string is attached to a fixed point vertically above the vertex of the cone. The particle moves in a horizontal circle on the smooth outer surface of the cone with constant angular speed ω , with the string making a constant angle 60° with the horizontal, as shown in Figure 1.

- (a) Find the tension in the string, in terms of m , l , ω and g . (7)

The particle remains on the surface of the cone.

- (b) Show that the time for the particle to make one complete revolution is greater than

$$2\pi\sqrt{\frac{l\sqrt{3}}{2g}} \quad (6)$$



4.

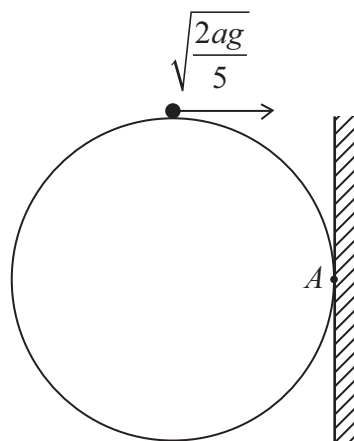


Figure 2

A smooth sphere of radius a is fixed with a point A of its surface in contact with a fixed vertical wall. A particle is placed on the highest point of the sphere and is projected towards the wall and perpendicular to the wall with horizontal speed $\sqrt{\frac{2ag}{5}}$, as shown in Figure 2.

The particle leaves the surface of the sphere with speed V .

(a) Show that $V = \sqrt{\frac{4ag}{5}}$ (7)

The particle strikes the wall at the point X .

(b) Find the distance AX . (9)



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Question 4 continued

Lined area for writing the answer to Question 4.

Q4

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(Total 16 marks)



5.

Diagram not to scale

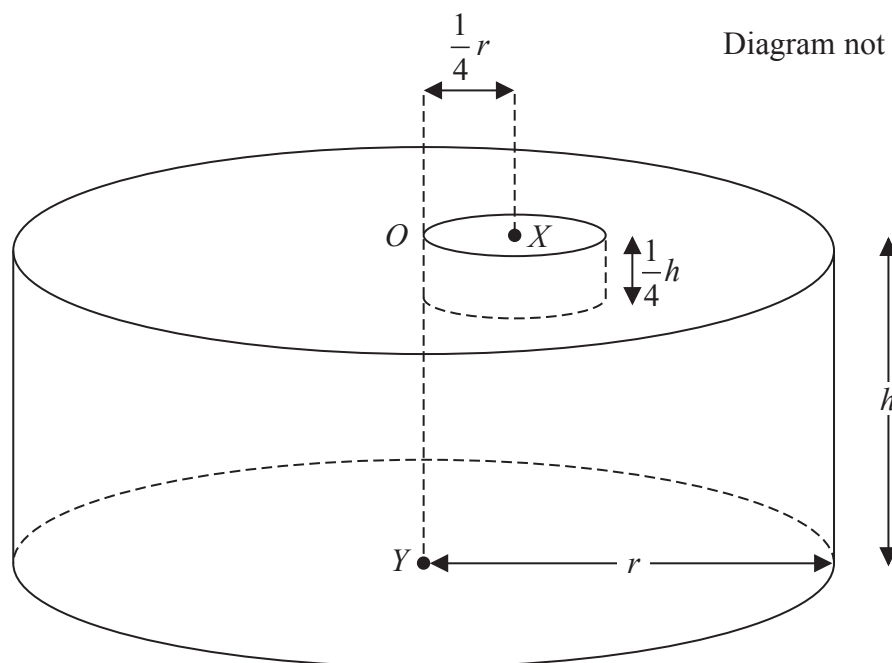


Figure 3

A uniform solid right circular cylinder has height h and radius r . The centre of one plane face is O and the centre of the other plane face is Y . A cylindrical hole is made by removing a solid cylinder of radius $\frac{1}{4}r$ and height $\frac{1}{4}h$ from the end with centre O . The axis of the cylinder removed is parallel to OY and meets the end with centre O at X , where $OX = \frac{1}{4}r$. One plane face of the cylinder removed coincides with the plane face through O of the original cylinder. The resulting solid S is shown in Figure 3.

- (a) Show that the centre of mass of S is at a distance $\frac{85h}{168}$ from the plane face containing O . (7)

The solid S is freely suspended from O . In equilibrium the line OY is inclined at an angle $\arctan(17)$ to the horizontal.

- (b) Find r in terms of h . (6)



Question 5 continued

Lined writing area for the answer to Question 5.



6. A light elastic string, of natural length l and modulus of elasticity $4mg$, has one end attached to a fixed point A . The other end is attached to a particle P of mass m . The particle hangs freely at rest in equilibrium at the point E . The distance of E below A is $(l + e)$.

(a) Find e in terms of l . **(2)**

At time $t = 0$, the particle is projected vertically downwards from E with speed \sqrt{gl} .

(b) Prove that, while the string is taut, P moves with simple harmonic motion. **(5)**

(c) Find the amplitude of the simple harmonic motion. **(3)**

(d) Find the time at which the string first goes slack. **(4)**



Question 6 continued

Handwriting practice area consisting of 30 horizontal lines.

Q6

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

END

