IYGB GCE

Mathematics FM2

Advanced Level

Practice Paper M

Difficulty Rating: 3.7333/1.7642

Time: 1 hour 30 minutes

Candidates may use any calculator allowed by the regulations of this examination.

Information for Candidates

This practice paper follows closely the Pearson Edexcel Syllabus, suitable for first assessment Summer 2018.

The standard booklet "Mathematical Formulae and Statistical Tables" may be used.
Full marks may be obtained for answers to ALL questions.
The marks for the parts of questions are shown in round brackets, e.g. **(2)**.
There are 7 questions in this question paper.
The total mark for this paper is 75.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.
You must show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.
Non exact answers should be given to an appropriate degree of accuracy.
The examiner may refuse to mark any parts of questions if deemed not to be legible.

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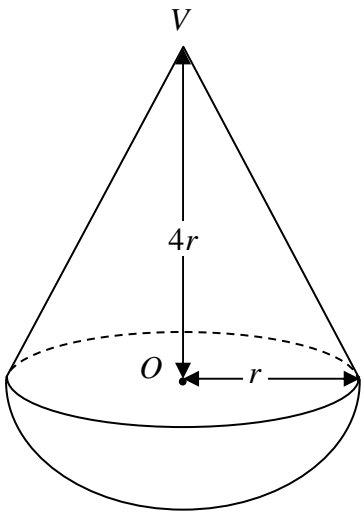
Question 1



A uniform solid S, consists of a hemisphere of radius r and mass M, and a right circular cone of radius r, height $4r$ and mass m. The centre of the plane face of the hemisphere is at O and this plane face coincides with the plane face at the base of the cone, as shown in the figure above. The point P lies on the circumference of the base of the cone. S is placed on a horizontal surface, so that VP is in contact with the surface, where VP is the vertex of the cone.

Given that S remains in equilibrium in that position, show that

$$m \leq 10M \ . \qquad (\mathbf{10})$$

Question 2

A boat moored at a harbour is moving up and down, taking 2.5 s to move from its highest point to its lowest point, where the vertical distance between these two points is 0.8 m. The boat is modelled as a particle moving with simple harmonic motion in a vertical direction.

The point A is 0.1 m below the highest point of the motion and the point B is 0.65 m below the highest point of the motion.

a) Determine the vertical speed of the boat as it passes through A. $(\mathbf{4})$

b) Calculate the least time taken by the boat to move from A to B. $(\mathbf{6})$

Question 3

A car is driven at constant speed v ms^{-1} round a bend of a race track. The track, round the bend is banked at $\arctan\frac{3}{4}$ to the horizontal and the coefficient of friction between the car tyres and the track is 0.625.

The car is modelled as a particle whose path round the bend is a horizontal circle of radius 25 m.

If the car tyres do not slip sideways as the car goes round the bend, determine the greatest value of v, correct to 2 decimal places. **(9)**

Question 4

A particle P, of mass m, is projected vertically upwards with speed U, from a point on the surface of the Earth, and moves in a straight line directly away from the centre of the Earth.

When P is at a distance x from the centre of the Earth, the gravitational force exerted by the Earth on P has magnitude $\frac{mk}{x^2}$, where k is a positive constant, and is directed towards the centre of the Earth.

At the surface of the Earth the acceleration due to gravity is g.

The Earth is modelled as a fixed sphere of radius R.

The kinetic energy of P at $x = 2R$ is half the kinetic energy when at $x = R$.

Ignoring air resistance, express k in terms of U and R. **(13)**

Question 5

A particle P is moving on the x axis, starting from rest at the origin O.

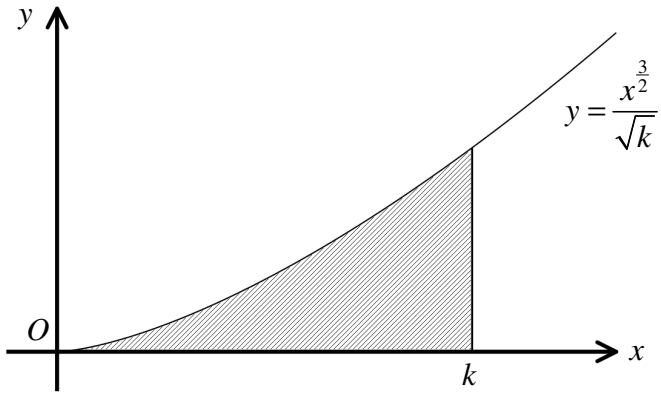
The acceleration of P is in the direction of x increasing and has magnitude

$$\frac{0.5}{v+3}\ \text{ms}^{-2},$$

where v is the subsequent velocity of the particle.

Find the distance P covers in the first 7 seconds of its motion. **(10)**

Question 6



The figure above shows the curve with equation

$$y=\frac{x^{\frac{3}{2}}}{\sqrt{k}},$$

where k is a positive constant

The finite region bounded by the curve, the coordinate axes and the straight line with equation $x=k$ region is revolved by 360° about the x axis, forming a solid of revolution. This solid is carefully placed with its plane face on a rough plane inclined at an angle θ to the horizontal and is at the point of toppling without any slipping.

Determine the value of $\tan\theta$. **(12)**

Question 7

A small bead, of mass m, is threaded on a smooth circular wire, with centre O and radius a, which is fixed in a vertical plane. You may further assume that the bead can freely access all parts of the vertically fixed wire.

A light inextensible string has one of its ends attached to the bead, passes through a smooth ring at O, and has its other end attached to a particle of mass M, which is hanging freely vertically below O.

The bead is projected from the lowest part of the wire with speed u and makes complete revolutions passing through the highest part of the wire with speed $\sqrt{12ag}$.

Determine an expression for u^2, in terms of a and g, and show that

$$11m \leq M \leq 17m . \qquad \textbf{(11)}$$