IYGB GCE

Mathematics FM2

Advanced Level

Practice Paper O

Difficulty Rating: 3.5000/1.600

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 8 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 particle of mass 2 kg is attached to one end of a light elastic string of natural length 3 m and the other end is attached to a fixed point A. The particle hangs in equilibrium at some point E, where $|AE| = 3.7$ m.

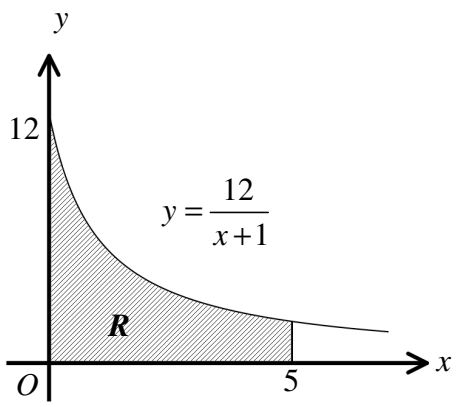
a) Find the modulus of elasticity of the string. **(2)**

The particle is pulled vertically downwards from the point E to the point B, where $|AB| = 4$ m, and it is released from rest.

b) Show that in the subsequent motion, the particle moves with simple harmonic motion and determine its amplitude and its period. **(6)**

c) Calculate the maximum speed of the particle during its motion. **(2)**

Question 2



The figure above shows the finite region R bounded by the coordinate axes, the curve with equation $y = \dfrac{12}{x+1}$ and the straight line with equation $x = 5$.

The centre of mass of a uniform lamina whose shape is that of R, is denoted by G.

Use integration to determine the exact coordinates of G. **(10)**

Question 3

A particle P, of mass $\frac{1}{6}$ kg, is moving on a straight horizontal line under the action of the force

$$F = \left(\frac{1}{t} - 1\right)\left(\frac{1}{t} + 1\right) \text{ N},$$

where t s is the time the particle is in motion, $t > 0$.

The motion of P is resisted by a constant force of magnitude 4 N.

It is further given that when the velocity of P is 18 ms^{-1} its acceleration is 24 ms^{-2}.

Determine the values of t when the velocity of P is 10 ms^{-1}. **(10)**

Question 4

A car is moving, with constant speed v, in a circular bend banked at an angle θ to the horizontal, so that the car is at the point of slipping down the banked road.

The motion of the car takes place in horizontal circle with centre O and radius r.

The coefficient of friction between the road and the car is μ.

Show with detail method that

$$v^2 = \frac{rg\left(\tan\theta - \mu\right)}{1 + \mu\tan\theta}.$$ **(9)**

Question 5

A particle is attached to one end of a light spring, whose other end is attached to a fixed point. The particle is hanging vertically in equilibrium.

The particle is then pulled downwards by a further 0.6 m and released from rest.

The motion of the particle satisfies the differential equation

$$\frac{d^2x}{dt^2} = -k^2x,$$

where x m is the additional extension of the spring from its equilibrium position, at time t s, and k is a constant. The motion has period of 2 s.

Find the first four positive values of t for which $x = 0.3$ m. **(7)**

Question 6

A particle P, of mass m, is fired vertically upwards 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 $\frac{\lambda}{x^2}$, where λ is a 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.

When P is at a height $\frac{1}{2}R$ above the surface of the Earth, the speed of P is $\sqrt{gR}$.

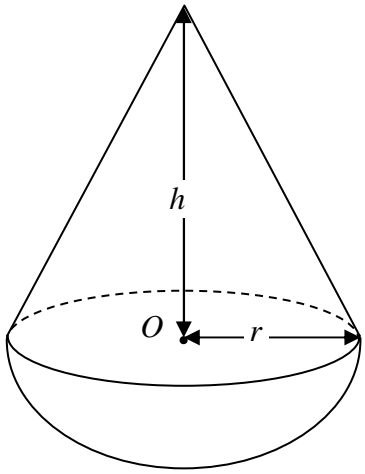
Given that air resistance can be ignored, find, in terms of R, the greatest distance from the centre of the Earth reached by P. **(9)**

Question 7

One end of a **light** rigid rod is freely jointed to a fixed point O and the other end is attached to a point mass. The loaded rod is describing full vertical circles so that the greatest speed of the point mass is three times its least speed.

Determine the cosine of the angle which the rod makes to the downward vertical through O, when the tension in the rod is zero. **(12)**

Question 8



A solid S, consists of a hemisphere of radius r and a right circular cone of radius r and height h. 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.

Both the cone and the hemisphere are of uniform density, but the density of the hemisphere is twice as large as that of the cone.

The centre of mass of S lies inside the cone, at a distance of $\frac{19h}{180}$ from O.

Express h in terms of r. **(8)**
