IYGB GCE

Mathematics FM1

Advanced Level

Practice Paper O

Difficulty Rating: 3.77/1.7391

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

Two particles A and B, of mass m kg and λm kg respectively, $\lambda > 0$, are moving on a smooth horizontal plane.

A and B have velocities $6\mathbf{i} - 2\mathbf{j}$ ms^{-1} and $-3\mathbf{i} + 3\mathbf{j}$ ms^{-1}, respectively.

A and B collide and coalesce to a single particle moving with velocity $k\mathbf{i} + k\mathbf{j}$ ms^{-1}.

Determine the value of λ and the value of k. **(7)**

Question 2

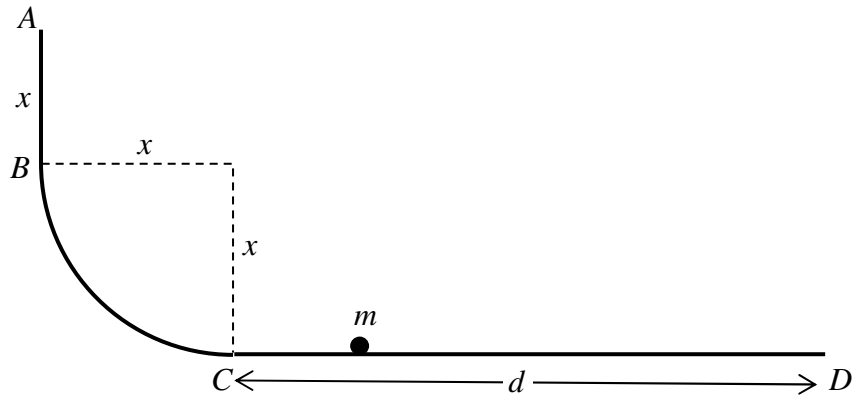
A car, which is modelled as a particle of mass 1500 kg, is travelling on a straight road inclined at an angle θ to the horizontal.

When the engine of the car is working at the constant rate of 96 kW, at an instant when the car is travelling **up** this road with speed 20 ms^{-1} the car is experiencing an acceleration of 0.2 ms^{-2}.

When the engine of the car is working at the constant rate of 60 kW, at an instant when the car is travelling **down** the same road with speed 20 ms^{-1} the car is experiencing an acceleration of 0.3 ms^{-2}.

If the resistance to the motion of the car R, due to non-gravitational forces, has constant magnitude, determine the value of R and the value of θ. **(10)**

Question 3



A particle of mass m travels along a path $ABCD$, whose cross section is shown in the figure above.

Section AB is vertical and of length x. Section BC is an arc of a quarter circle of radius x. Section CD is horizontal and of length d.

The particle is released from rest from A and comes to rest at D.

The particle experiences a constant frictional force only when travelling along the straight section CD.

Find the speed of the particle, in terms of g and x, when is at the midpoint of CD. **(8)**

Question 4

In this question $\mathbf{i}$ *and* $\mathbf{j}$ *are mutually perpendicular unit vectors.*

A small ball of mass 0.25 kg is moving on a smooth horizontal surface when it is struck by a bat. The bat exerts an impulse $(-8\mathbf{i}+4\mathbf{j})$ Ns on the ball.

Immediately after receiving the impulse the ball has velocity $(12\mathbf{i}+20\mathbf{j})$ ms^{-1}.

a) Find the speed of the ball immediately before the impact. **(4)**

b) Calculate the size of the angle through which the direction of motion of the ball is deflected by the impact. **(3)**

Question 5

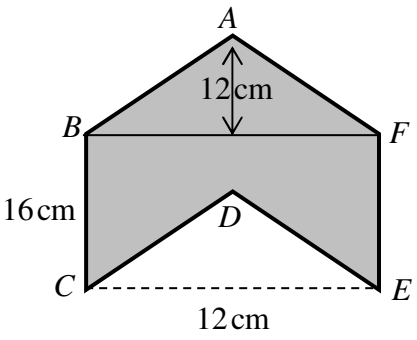


figure 1

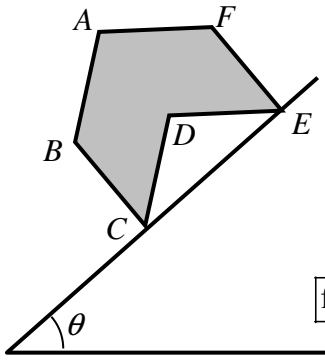


figure 2

From a rectangle $BCEF$, an isosceles triangle CDE is removed and attached to the rectangle so that the sides CE and BF coincide, and the point D is relabelled as A.

It is further given that $|CD| = |DE|$, $|BC| = 16\text{cm}$ and $|CE| = 12\text{cm}$. The height of the triangle ABF, measured from A, is 12 cm.

Figure 1 above, shows the composite which is modelled as a uniform lamina.

a) Show that the centre of mass of the lamina is located at a distance of 14 cm from CE. **(8)**

The lamina is next placed on plane inclined at an angle θ to the horizontal, as shown in figure 2. The plane is sufficiently rough to prevent the lamina from sliding.

b) Given that the lamina is at the point of toppling find the value of θ. **(3)**

Question 6

A bungee jumper of mass 75 kg is attached to one end of a light elastic string, of natural length 25 m, and modulus of elasticity 3675 N.

The other end of the string is securely tied to a fixed point P on a horizontal platform, which is sufficiently high enough above the ground.

The bungee jumper steps off the platform at P and when his vertical distance from P is x m his speed is v ms^{-1}.

The bungee jumper is modelled as a particle, falling without air resistance, with Hooke's law applying whilst the string is taut.

a) Show that for $x \geq 25$

$$25v^2 = -49x^2 + 2940x - 30625,$$

and hence calculate, correct to 2 decimal places, the greatest value of x. **(9)**

b) Determine the greatest value of x, during his jump. **(7)**

Question 7

A smooth sphere P of mass m is moving with speed u on a smooth horizontal plane. It collides directly with a smooth sphere Q of mass $4m$ which is initially at rest. The spheres are modelled as particles and the coefficient of restitution between P and Q is e, where $e > 0.25$.

a) Show that the **speed** of P after the collision is $\frac{1}{5}u(4e-1)$ and find a similar expression for the speed of Q. **(7)**

Three smooth spheres A, B and C lie in a straight line in that order on the same smooth horizontal plane. The masses of A and C are $4m$ each, while the mass of B is m. The three spheres are modelled as particles and the coefficient of restitution between any of these spheres is 0.75.

The spheres are initially at rest when B is projected towards C with speed u.

b) Show that after B and C collide, there will be another collision between A and B, and no more collisions between the spheres thereafter. **(9)**
