Paper Reference(s)

6682

Edexcel GCE

Mechanics M6

Advanced/Advanced Subsidiary

Monday 24 June 2002 – Afternoon

Time: 1 hour 30 minutes

Materials required for examination	Items included with question papers
Answer Book (AB16)	Nil
Mathematical Formulae (Lilac)	
Graph Paper (ASG2)	

Candidates may use any calculator EXCEPT those with the facility for symbolic algebra, differentiation and/or integration. Thus candidates may NOT use calculators such as the Texas Instruments TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G

Instructions to Candidates

In the boxes on the answer book, write the name of the examining body (Edexcel), your centre number, candidate number, the unit title (Mechanics M6), the paper reference (6682), your surname, other name and signature.
Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}.
When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae and Statistical Tables' is provided.
Full marks may be obtained for answers to ALL questions.
This paper has six questions.

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 gain no credit.

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1. A uniform rod AB, of mass m and length $2a$, lies at rest on a smooth horizontal table. The rod is given a horizontal impulse of magnitude I, in a direction perpendicular to the rod, at the point C of the rod, where $BC = \frac{1}{2}a$.

(a) Find, in terms of I and m, the speed of B immediately after the impulse has been applied.

(7)

Immediately after the impulse has been applied, the point O of the rod is at rest.

(b) Find the distance of O from the centre of the rod.

(3)

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2. A particle P of mass M kg moves in a horizontal plane. At time t seconds, the position vector of P is $(x\mathbf{i} + y\mathbf{j})$ m relative to a fixed origin O. The particle moves under the action of a resultant force $-4My\mathbf{i}$ newtons. At time $t = 0$, P is at O and is moving with velocity $(u\mathbf{i} + u\mathbf{j})$ m s^{-1}, where u is a positive constant.

Find the time at which P returns to the y-axis.

(10)

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3. A particle P moves in a plane. At time t, the polar coordinates of P are (r, θ) relative to a fixed pole O and an initial line in the plane. The particle P moves on the curve with equation $r = a \sec 3\theta$, where a is a positive constant and $-\frac{\pi}{6} < \theta < \frac{\pi}{6}$. The direction of the acceleration of P is always along the radius vector.

(a) Show that $r^2\dot{\theta} = h$, where h is a constant.

(2)

(b) Show that the magnitude of the acceleration of P is $\frac{k}{r^3}$ and express the constant k in terms of h.

(9)

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4. **Figure 1**

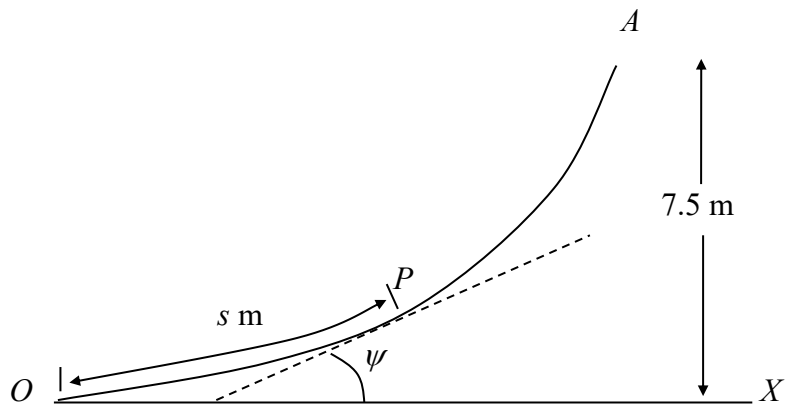

Figure 1 shows a curve OA modelling a vertical cross-section of an emergency escape chute used for evacuating passengers from an aircraft. Relative to a fixed point O and a fixed horizontal line OX, the intrinsic coordinates of a point P on the curve are (s, ψ), where s metres is the arc length OP. The intrinsic equation of the curve is $s = 20 \sin \psi$, $0 \leq \psi \leq \frac{\pi}{3}$. The point O is at ground level. The point A, where $\psi = \frac{\pi}{3}$, is 7.5 m above the ground. A man of mass 100 kg slides from rest down the chute. The man is modelled as a particle starting at A and the chute is modelled as being smooth. The speed of the man at P is v m s^{-1}.

(*a*) Show that $v^2 = 49(2 \cos 2\psi + 1)$.

(8)

(*b*) Find the magnitude of the normal reaction on the man as he reaches O.

(4)

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5. A uniform cylindrical container, closed at both ends, has radius a and height $4a$. The container is made of thin sheet metal and has mass M. The axis of the cylinder is l.

(*a*) Show that the moment of inertia of the container about l is $\frac{9}{10}Ma^2$.

(4)

The container is released from rest and rolls, without slipping, down a rough plane inclined at an angle α to the horizontal. The centre of mass of the container moves in a vertical plane through a line of greatest slope of the inclined plane.

(*b*) Find the angular speed of the container when its centre of mass has travelled a distance $5a$ down the plane.

(10)

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6. The point O is on smooth horizontal ground and is 4 m from the base of a smooth vertical wall. A ball is projected from O towards the wall at an angle θ to the ground, where $\tan\theta = \frac{3}{4}$ with speed 14 m s^{-1}. The ball moves in a vertical plane which is perpendicular to the wall. The coefficient of restitution between the ball and the wall and between the ball and the ground is $\frac{1}{2}$. The ball is modelled as a particle.

After rebounding from the wall, the ball strikes the ground for the first time at A.

(a) Find the time taken for the ball to reach A.

(4)

(b) Find the distance of A from the base of the wall.

(7)

The ball strikes the ground for the second time at B.

(c) Find the distance AB.

(7)

END