Paper Reference(s)

6682

Edexcel GCE

Mechanics M6

Advanced/Advanced Subsidiary

Thursday 1 July 2004 – Morning

Time: 1 hour 30 minutes

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

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 $g = 9.8 \text{ m s}^{-2}$.
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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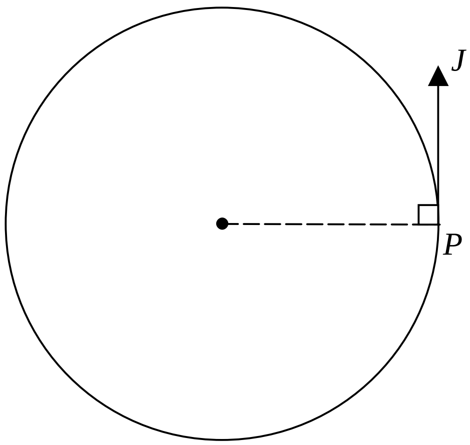
1. **Figure 1**



A uniform circular disc lies at rest with its centre O on a smooth horizontal plane. A horizontal impulse J is applied to the disc at a point P on the edge of the disc, in a direction which is tangential to the disc, as shown in Fig. 1.

Show that, immediately after the impulse, the speed of O is one third of the speed of P.

(6)

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2. A smooth wire is in the shape of a parabola with equation $y = \frac{3}{8}x^2$. The wire is fixed in a vertical plane with the positive y-axis vertically upwards. A small bead P of mass m is threaded on the wire and is released from rest at the point $(2, \frac{3}{2})$. The radius of curvature of the parabola at the point $A(1, \frac{3}{8})$ is $\frac{125}{48}$.

Find the magnitude of the force exerted on P by the wire as P passes A.

(10)

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3. A particle P moves in a plane and at time t seconds the polar coordinates of P are (r, θ), where r metres is the distance of P from the pole. It is given that $\frac{\mathrm{d}r}{\mathrm{d}t} = 4\cos\theta$ and $\frac{\mathrm{d}\theta}{\mathrm{d}t} = 3 - 2\sin\theta)^2$, and when $t = 0$, P has polar coordinates $(\frac{2}{3}, 0)$. Find

(*a*) the polar equation of the curve on which P moves,

(7)

(*b*) the magnitude of the radial component of the acceleration of P when $t = 0$.

(5)

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4. A uniform cylindrical tube of mass M has internal radius a and external radius b.

(*a*) Show that the moment of inertia of the tube about its axis is $\frac{1}{2}M(a^2 + b^2)$.

(4)

A gas pipe rolls without slipping, with its axis horizontal, down a rough slope which is inclined at an angle α to the horizontal. By modelling the pipe as the tube in part (*a*),

(*b*) show that T, the time taken for the pipe to roll a distance d down the slope from rest, is given by

$$gT^2 \sin\alpha = d\left(3 + \frac{a^2}{b^2}\right).$$

(9)

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5. A plane is inclined at an angle of 30° to the horizontal. The point O is above the plane and at a perpendicular distance $d\sqrt{3}$ from the plane. The foot of the perpendicular from O to the plane is N. A particle is projected from O with speed $2\sqrt{(gd)}$ at an angle of 60° above the horizontal, in a vertical plane through a line of greatest slope of the inclined plane. The particle strikes the plane at the point M, further up the plane than N.

(*a*) Show that $MN = 3d$.

(9)

Given that the coefficient of restitution between the particle and the plane is 1,

(*b*) show that the particle returns to O.

(5)

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6. Two particles P and Q, each of mass m, are attached to the ends of a light inextensible string. The string passes through a small smooth ring fixed at O, on a smooth horizontal table. The particles are at rest on the table, with the string straight and taut. Particle P is given a horizontal velocity V, perpendicular to the string, along the table. At time t, the polar coordinates of P, relative to O as pole and the initial line of the string, are (r, θ). When $t = 0$ the polar coordinates of P are $(a, 0)$.

For the motion before Q reaches O,

(*a*) show that $r^2 \dfrac{d\theta}{dt} = aV$,

(3)

(*b*) by considering P and Q separately, show that $2\dfrac{d^2r}{dt^2} = a^2\dfrac{V^2}{r^3}$,

(6)

(*c*) show that $\left(\dfrac{dr}{dt}\right)^2 = \dfrac{V^2}{2r^2}(r^2 - a^2)$.

(5)

When $t = T$, $OP = 2a$ and Q has not reached O.

(*d*) Find T, in terms of a and V.

(6)

END