Paper Reference(s)

6682

Edexcel GCE

Mechanics M6

Advanced/Advanced Subsidiary

Wednesday 25 June 2003 – 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 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 particle P of mass m moves with constant speed u along a curve with intrinsic equation $s = a \ln \sec \psi, 0 < \psi < \dfrac{\pi}{2}$, where a is a positive constant.

Find the magnitude of the resultant force acting on P at the point where $s = a \ln 2$.

(8)

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2. A uniform hollow cylinder, without ends, has mass m and radius a. A particle P of mass m is attached to the surface of the cylinder which is free to roll on a rough horizontal table. Initially the cylinder is at rest with P at its highest point. It is then displaced slightly and the cylinder rolls along the table without slipping. Using the principle of conservation of energy, or otherwise, find the speed of P when the cylinder has turned through one right angle.

(10)

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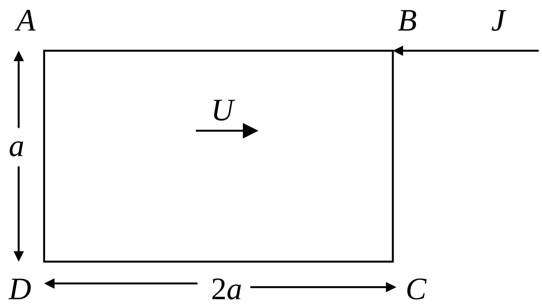
3. **Figure 1**



A car is moving in a straight line with speed U. The car is modelled as a uniform horizontal rectangular lamina $ABCD$ of mass M, where $CD = 2a$ and $AD = a$, moving on a horizontal plane in the direction AB. The car is involved in a collision which is modelled as an impulse of magnitude J acting on the lamina at the point B in the direction BA, as shown in Fig. 1.

(*a*) Show that the moment of inertia of the lamina $ABCD$ about a vertical axis through its centre is $\frac{5}{12}Ma^2$.

(3)

It is assumed that after the collision there are no forces acting horizontally on the car. Given that $J < MU$,

(*b*) show that, while it turns through one right angle, the car travels a distance $\dfrac{5\pi a(MU - J)}{12J}$.

(8)

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4. A particle P moves in a plane and at time t the polar coordinates of P, relative to a fixed pole O and a fixed initial line in the plane, are (r, θ). At time t the radial velocity component of P is $u \sin\theta$ and the transverse velocity component of P is $\frac{2ua}{r}$, where u and a are positive constants. When $t = 0$, P is on the initial line and $OP = a$.

(a) Show that the polar equation of the path of P is $r = \dfrac{2a}{(1+\cos\theta)}$.

(8)

(b) Find the speed of P when $OP = \frac{4}{3}a$.

(7)

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5. A particle P of mass m moves in a plane. At time t the polar coordinates of P are (r, θ), relative to a fixed pole O and a fixed initial line in the plane. The only force acting on P has constant magnitude km and is always directed towards O. When $t = 0$, P is at the point A, where $OA = a$, and is moving in a direction perpendicular to OA with speed U.

(a) Show that $\ddot{r} = \dfrac{a^2U^2}{r^3} - k$.

(8)

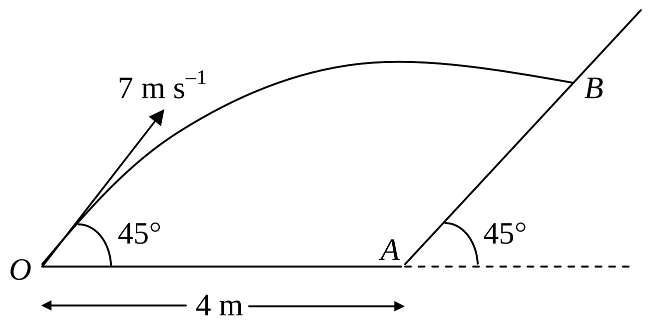
Given that $U = \frac{1}{2}\sqrt{(ak)}$,

(b) show that $\dot{r}^2 = \dfrac{k(a-r)(8r^2 - ar - a^2)}{4r^2}$.

(7)

6.

Figure 2



A small stone is projected with speed 7 m s^{-1} at an angle of 45° to the horizontal from a point *O* on horizontal ground. The point *O* is 4 m from the foot *A* of a sloping bank which is inclined at an angle of 45° to the horizontal. The stone moves in a vertical plane through a line of greatest slope of the bank and strikes the bank at the point *B*, as shown in Fig. 2. The stone is modelled as a particle moving freely under gravity. Find, to 2 significant figures,

(*a*) the distance *AB*,

(12)

(*b*) the speed of the stone as it strikes the bank.

(4)

END