Paper Reference(s)

6679/01R

Edexcel GCE

Mechanics M3 (R)

Advanced/Advanced Subsidiary

Monday 10 June 2013 – Morning

Time: 1 hour 30 minutes

Materials required for examination	**Items included with question papers**
Mathematical Formulae (Pink)	Nil

Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. Calculators must not have the facility for symbolic algebra manipulation or symbolic differentiation/integration, or have retrievable mathematical formulae stored in them.

This paper is strictly for students outside the UK.

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initials and signature.
Check that you have the correct question paper.
Answer ALL the questions.
You must write your answer for each question in the space following the question.
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.
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.
There are 28 pages in this question paper. Any blank pages are indicated.

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.

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1.

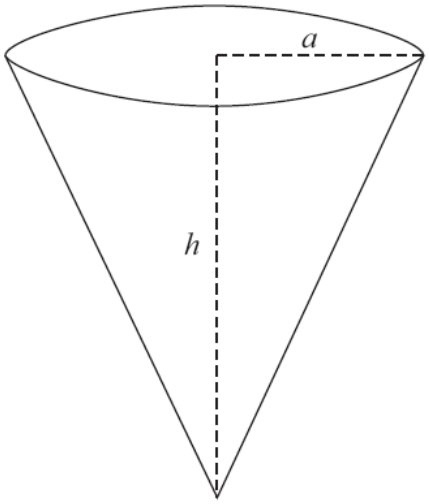

Figure 1

A hollow right circular cone, of base radius a and height h, is fixed with its axis vertical and vertex downwards, as shown in Figure 1. A particle moves with constant speed v in a horizontal circle of radius $\frac{1}{3}a$ on the smooth inner surface of the cone.

Show that $v = \sqrt{\left(\frac{1}{3}hg\right)}$.

(7)

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2. A particle of mass 4 kg is moving along the horizontal x-axis under the action of a single force which acts in the positive x-direction. At time t seconds the force has magnitude $\left(1+3t^{\frac{1}{2}}\right)$ N.

When $t = 0$ the particle has speed 2 m s^{-1} in the positive x-direction. Find the work done by the force in the interval $0 \leq t \leq 4$.

(7)

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3. A particle P of mass 0.5 kg is attached to one end of a light elastic spring, of natural length 2 m and modulus of elasticity 20 N. The other end of the spring is attached to a fixed point A. The particle P is held at rest at the point B, which is 1 m vertically below A, and then released.

(a) Find the acceleration of P immediately after it is released from rest.

(4)

The particle comes to instantaneous rest for the first time at the point C.

(b) Find the distance BC.

(6)

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4. A particle P is moving along the positive x-axis. At time t seconds, $t \geq 0$, P is x metres from the origin O and is moving away from O with velocity v m s^{-1}, where $v = \dfrac{4}{(x+2)}$.

When $t = 0$, P is at O. Find

(a) the distance of P from O when $t = 2$,

(5)

(b) the magnitude and direction of the acceleration of P when $t = 2$.

(5)

5.

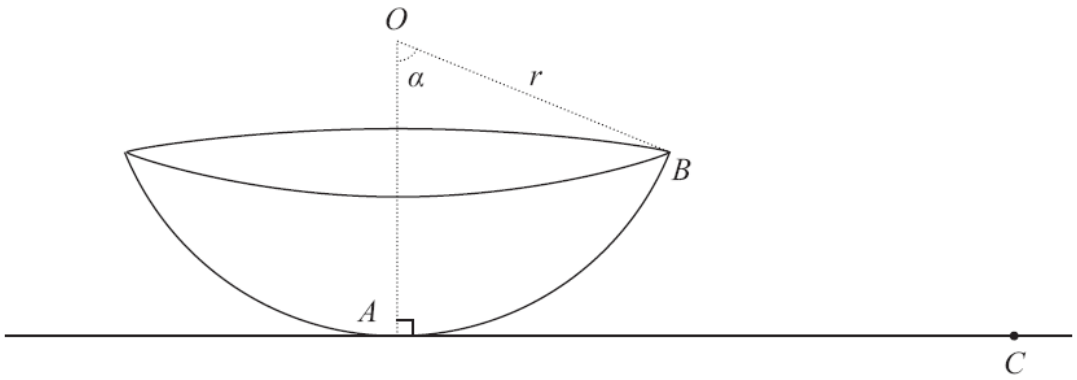

Figure 2

Part of a hollow spherical shell, centre O and radius r, forms a bowl with a plane circular rim. The bowl is fixed to a horizontal surface at A with the rim uppermost and horizontal. The point A is the lowest point of the bowl. The point B, where $\angle AOB = \alpha$ and $\tan \alpha = \frac{3}{4}$, is on the rim of the bowl, as shown in Figure 2. A small smooth marble M is placed inside the bowl at A, and given an initial horizontal speed $\sqrt{(gr)}$. The motion of M takes place in the vertical plane OAB.

(a) Show that the speed of M as it reaches B is $\sqrt{\left(\frac{3}{5}gr\right)}$.

(4)

After leaving the surface of the bowl at B, M moves freely under gravity and first strikes the horizontal surface at the point C. Given that $r = 0.4$m,

(b) find the distance AC.

(8)

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6. (*a*) A uniform lamina is in the shape of a quadrant of a circle of radius *a*. Show, by integration, that the centre of mass of the lamina is at a distance of $\frac{4a}{3\pi}$ from each of its straight edges.

(7)

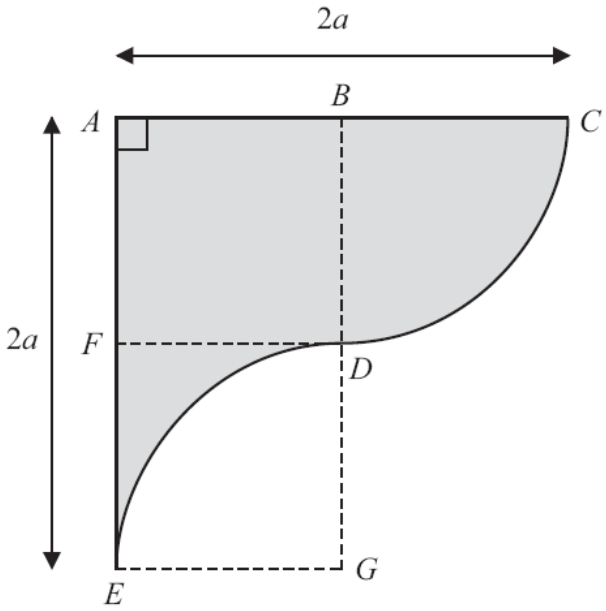

Figure 3

A second uniform lamina *ABCDEFA* is shown shaded in Figure 3. The straight sides *AC* and *AE* are perpendicular and $AC = AE = 2a$. In the figure, the midpoint of *AC* is *B*, the midpoint of *AE* is *F*, and *ABDF* and *DGEF* are squares of side *a*. *BCD* is a quadrant of a circle with centre *B*. *DGE* is a quadrant of a circle with centre *G*.

(*b*) Find the distance of the centre of mass of the lamina from the side *AE*.

(5)

The lamina is smoothly hinged to a horizontal axis which passes through *E* and is perpendicular to the plane of the lamina. The lamina has weight *W* newtons. The lamina is held in equilibrium in a vertical plane, with *A* vertically above *E*, by a horizontal force of magnitude *X* newtons applied at *C*.

(*c*) Find *X* in terms of *W*.

(3)

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7. Two points A and B are 4 m apart on a smooth horizontal surface. A light elastic string, of natural length 0.8 m and modulus of elasticity 15 N, has one end attached to the point A. A light elastic string, of natural length 0.8 m and modulus of elasticity 10 N, has one end attached to the point B. A particle P of mass 0.2 kg is attached to the free end of each string. The particle rests in equilibrium on the surface at the point C on the straight line between A and B.

(a) Show that the length of AC is 1.76 m.

(4)

The particle P is now held at the point D on the line AB such that AD = 2.16 m. The particle is then released from rest and in the subsequent motion both strings remain taut.

(b) Show that P moves with simple harmonic motion.

(4)

(c) Find the speed of P as it passes through the point C.

(2)

(d) Find the time from the instant when P is released from D until the instant when P is first moving with speed 2 m s^{-1}.

(4)

TOTAL FOR PAPER: 75 MARKS

END