Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	6	7	9	/	0	1	Signature	

Paper Reference(s)

6679/01

Edexcel GCE

Mechanics M3

Advanced/Advanced Subsidiary

Friday 28 January 2011 – Morning

Time: 1 hour 30 minutes

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
5	
6	
7	
Total	

Materials required for examination
Mathematical Formulae (Pink)

Items included with question papers
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, differentiation and integration, or have retrievable mathematical formulae stored in them.

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 to 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 individual questions and 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 should show sufficient working to make your methods clear to the Examiner.
Answers without working may not gain full credit.

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1. A particle P moves on the positive x-axis. When the distance of P from the origin O is x metres, the acceleration of P is $(7 - 2x)$ m s^{-2}, measured in the positive x-direction. When $t = 0$, P is at O and is moving in the positive x-direction with speed 6 m s^{-1}. Find the distance of P from O when P first comes to instantaneous rest.

(6)

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Question 1 continued

Q1

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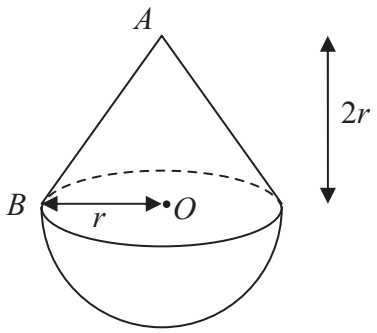

Figure 1

A toy is formed by joining a uniform solid hemisphere, of radius r and mass $4m$, to a uniform right circular solid cone of mass km. The cone has vertex A, base radius r and height $2r$. The plane face of the cone coincides with the plane face of the hemisphere. The centre of the plane face of the hemisphere is O and OB is a radius of its plane face as shown in Figure 1. The centre of mass of the toy is at O.

(a) Find the value of k.

(4)

A metal stud of mass λm is attached to the toy at A. The toy is now suspended by a light string attached to B and hangs freely at rest. The angle between OB and the vertical is 30°.

(b) Find the value of λ.

(4)

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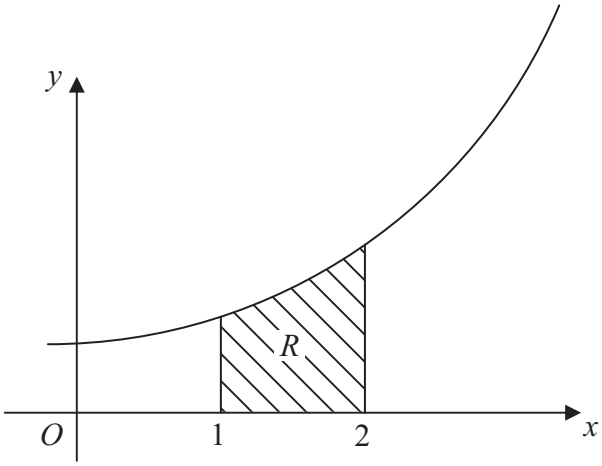

Figure 2

The region R is bounded by the curve with equation $y = e^x$, the line $x = 1$, the line $x = 2$ and the x-axis as shown in Figure 2. A uniform solid S is formed by rotating R through 2π about the x-axis.

(a) Show that the volume of S is $\frac{1}{2}\pi(e^4 - e^2)$.

(4)

(b) Find, to 3 significant figures, the x-coordinate of the centre of mass of S.

(6)

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4. A particle P moves along the x-axis. At time t seconds its displacement, x metres, from the origin O is given by $x = 5 \sin\left(\frac{1}{3}\pi t\right)$.

(a) Prove that P is moving with simple harmonic motion.

(3)

(b) Find the period and the amplitude of the motion.

(2)

(c) Find the maximum speed of P.

(2)

The points A and B on the positive x-axis are such that $OA = 2$ m and $OB = 3$ m.

(d) Find the time taken by P to travel directly from A to B.

(4)

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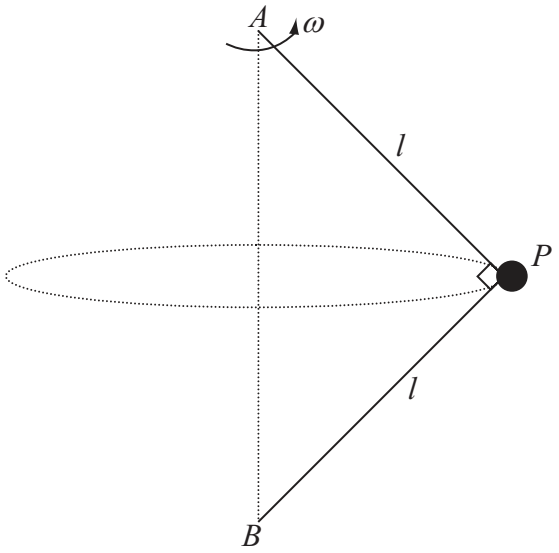

Figure 3

A small ball P of mass m is attached to the ends of two light inextensible strings of length l. The other ends of the strings are attached to fixed points A and B, where A is vertically above B. Both strings are taut and AP is perpendicular to BP as shown in Figure 3. The system rotates about the line AB with constant angular speed ω. The ball moves in a horizontal circle.

(a) Find, in terms of m, g, l and ω, the tension in AP and the tension in BP.

(8)

(b) Show that $\omega^2 > \dfrac{g\sqrt{2}}{l}$.

(2)

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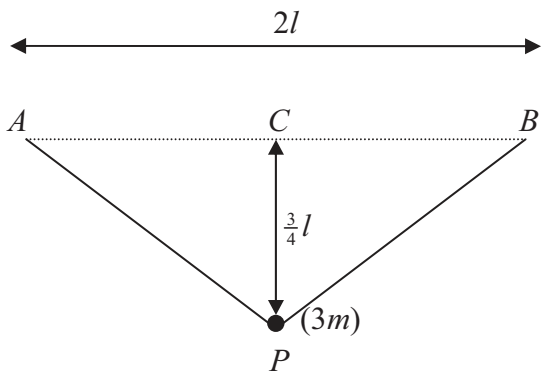

Figure 4

A small ball of mass $3m$ is attached to the ends of two light elastic strings AP and BP, each of natural length l and modulus of elasticity kmg. The ends A and B of the strings are attached to fixed points on the same horizontal level, with $AB = 2l$. The mid-point of AB is C. The ball hangs in equilibrium at a distance $\frac{3}{4}l$ vertically below C as shown in Figure 4.

(a) Show that $k = 10$

(7)

The ball is now pulled vertically downwards until it is at a distance $\frac{12}{5}l$ below C. The ball is released from rest.

(b) Find the speed of the ball as it reaches C.

(6)

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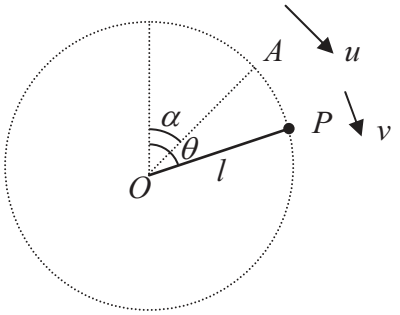

Figure 5

A particle P of mass m is attached to one end of a light rod of length l. The other end of the rod is attached to a fixed point O. The rod can turn freely in a vertical plane about O. The particle is projected with speed u from a point A, where OA makes an angle α with the upward vertical through O and $0 < \alpha < \frac{\pi}{2}$. When OP makes an angle θ with the upward vertical through O the speed of P is v as shown in Figure 5.

(a) Show that $v^2 = u^2 + 2gl(\cos\alpha - \cos\theta)$.

(4)

It is given that $\cos\alpha = \frac{3}{5}$ and that P moves in a complete vertical circle.

(b) Show that $u > 2\sqrt{\left(\frac{gl}{5}\right)}$.

(4)

As the rod rotates the least tension in the rod is T and the greatest tension is $5T$.

(c) Show that $u^2 = \frac{33}{10}gl$.

(9)

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TOTAL FOR PAPER: 75 MARKS

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