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 29 January 2010 – 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 or Green)

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 of mass 0.5 kg is moving along the positive x-axis. At time t seconds, P is moving under the action of a single force of magnitude $\left[4 + \cos(\pi t)\right]$ N, directed away from the origin. When $t = 1$, the particle P is moving away from the origin with speed $6\,\text{m}\,\text{s}^{-1}$.

Find the speed of P when $t = 1.5$, giving your answer to 3 significant figures.

(7)

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Question 1 continued

Q1

(Total 7 marks)

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2. A particle P moves in a straight line with simple harmonic motion of period 2.4 s about a fixed origin O. At time t seconds the speed of P is $v \text{ m s}^{-1}$. When $t = 0$, P is at O. When $t = 0.4$, $v = 4$. Find

(a) the greatest speed of P,

(7)

(b) the magnitude of the greatest acceleration of P.

(2)

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Question 2 continued

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Question 2 continued

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Question 2 continued

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Q2

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3.

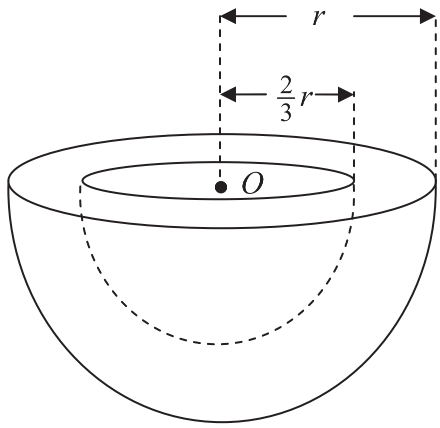

Figure 1

A bowl B consists of a uniform solid hemisphere, of radius r and centre O, from which is removed a solid hemisphere, of radius $\frac{2}{3}r$ and centre O, as shown in Figure 1.

(a) Show that the distance of the centre of mass of B from O is $\frac{65}{152}r$.

(5)

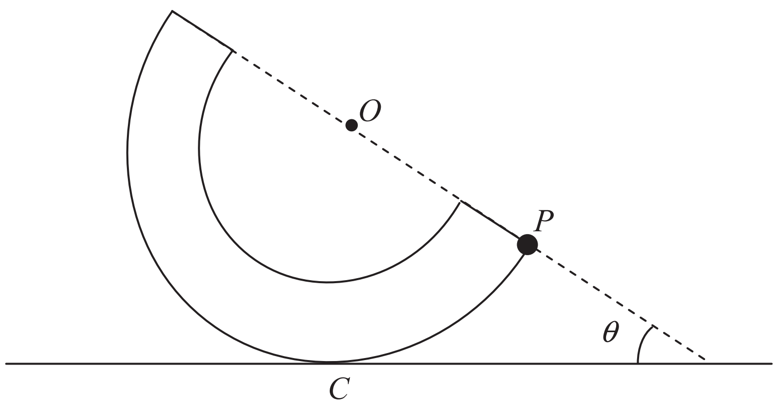

Figure 2

The bowl B has mass M. A particle of mass kM is attached to a point P on the outer rim of B. The system is placed with a point C on its outer curved surface in contact with a horizontal plane. The system is in equilibrium with P, O and C in the same vertical plane. The line OP makes an angle θ with the horizontal as shown in Figure 2. Given that

$\tan\theta = \frac{4}{5}$,

(b) find the exact value of k.

(5)

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Question 3 continued

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Question 3 continued

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Question 3 continued

Q3

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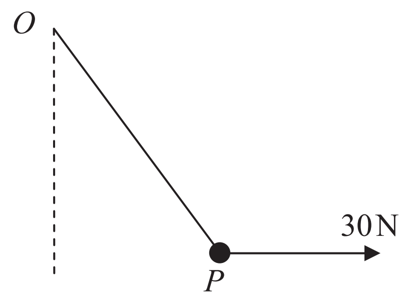

Figure 3

A particle P of weight 40 N is attached to one end of a light elastic string of natural length 0.5 m. The other end of the string is attached to a fixed point O. A horizontal force of magnitude 30 N is applied to P, as shown in Figure 3. The particle P is in equilibrium and the elastic energy stored in the string is 10 J.

Calculate the length OP.

(10)

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Question 4 continued

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Question 4 continued

Q4

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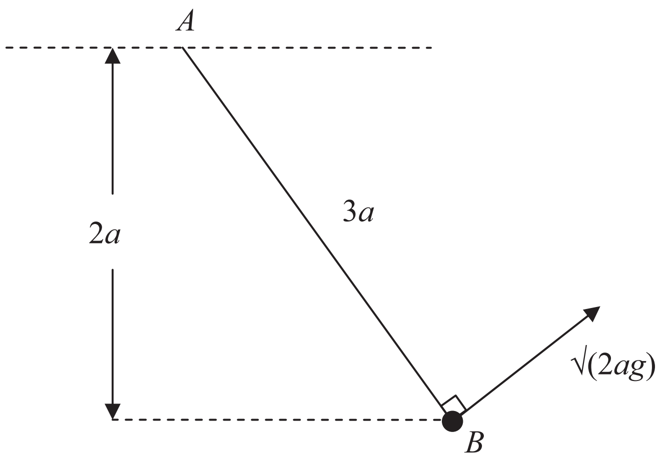

Figure 4

One end A of a light inextensible string of length $3a$ is attached to a fixed point. A particle of mass m is attached to the other end B of the string. The particle is held in equilibrium at a distance $2a$ below the horizontal through A, with the string taut. The particle is then projected with speed $\sqrt{(2ag)}$, in the direction perpendicular to AB, in the vertical plane containing A and B, as shown in Figure 4. In the subsequent motion the string remains taut. When AB is at an angle θ below the horizontal, the speed of the particle is v and the tension in the string is T.

(a) Show that $v^2 = 2ag(3\sin\theta - 1)$.

(5)

(b) Find the range of values of T.

(6)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

(Total 11 marks)

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6. A bend of a race track is modelled as an arc of a horizontal circle of radius 120 m. The track is not banked at the bend. The maximum speed at which a motorcycle can be ridden round the bend without slipping sideways is $28\,\text{m}\,\text{s}^{-1}$. The motorcycle and its rider are modelled as a particle and air resistance is assumed to be negligible.

(a) Show that the coefficient of friction between the motorcycle and the track is $\frac{2}{3}$.
(6)

The bend is now reconstructed so that the track is banked at an angle α to the horizontal. The maximum speed at which the motorcycle can now be ridden round the bend without slipping sideways is $35\,\text{m}\,\text{s}^{-1}$. The radius of the bend and the coefficient of friction between the motorcycle and the track are unchanged.

(b) Find the value of $\tan\alpha$.
(8)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total 14 marks)

Q6

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7. A light elastic string has natural length a and modulus of elasticity $\frac{3}{2}mg$. A particle P of mass m is attached to one end of the string. The other end of the string is attached to a fixed point A. The particle is released from rest at A and falls vertically. When P has fallen a distance $a + x$, where $x > 0$, the speed of P is v.

(a) Show that $v^2 = 2g(a + x) - \dfrac{3gx^2}{2a}$.
(4)

(b) Find the greatest speed attained by P as it falls.
(4)

After release, P next comes to instantaneous rest at a point D.

(c) Find the magnitude of the acceleration of P at D.
(6)

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Question 7 continued

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Question 7 continued

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Question 7 continued

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Question 7 continued

Q7

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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