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

Monday 19 May 2014 – 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 or symbolic differentiation/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}, and give your answer to either two significant figures or three significant figures.
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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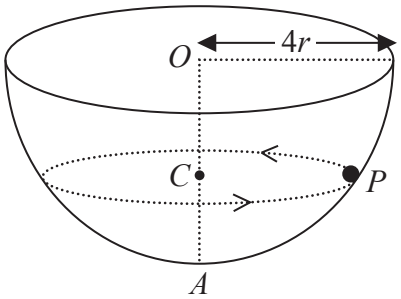

Figure 1

A hemispherical bowl of internal radius $4r$ is fixed with its circular rim horizontal. The centre of the circular rim is O and the point A on the surface of the bowl is vertically below O. A particle P moves in a horizontal circle, with centre C, on the smooth inner surface of the bowl. The particle moves with constant angular speed $\sqrt{\dfrac{3g}{8r}}$

The point C lies on OA, as shown in Figure 1.

Find, in terms of r, the distance OC.

(9)

P 4 3 1 7 5 A 0 2 2 8

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Question 1 continued

Q1

(Total 9 marks)

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2. A particle P of mass m is fired vertically upwards from a point on the surface of the Earth and initially moves in a straight line directly away from the centre of the Earth. When P is at a distance x from the centre of the Earth, the gravitational force exerted by the Earth on P is directed towards the centre of the Earth and has magnitude $\frac{k}{x^2}$, where k is a constant.

At the surface of the Earth the acceleration due to gravity is g. The Earth is modelled as a fixed sphere of radius R.

(a) Show that $k = mgR^2$.

(2)

When P is at a height $\frac{R}{4}$ above the surface of the Earth, the speed of P is $\sqrt{\frac{gR}{2}}$

Given that air resistance can be ignored,

(b) find, in terms of R, the greatest distance from the centre of the Earth reached by P.

(7)

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Question 2 continued

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Question 2 continued

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Question 2 continued

Q2

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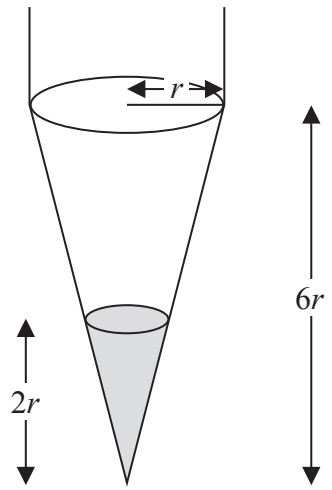

Figure 2

Figure 2 shows a container in the shape of a uniform right circular conical shell of height $6r$. The radius of the open circular face is r. The container is suspended by two vertical strings attached to two points at opposite ends of a diameter of the open circular face. It hangs with the open circular face uppermost and axis vertical. Molten wax is poured into the container. The wax solidifies and adheres to the container, forming a uniform solid right circular cone. The depth of the wax in the container is $2r$. The container together with the wax forms a solid S.

The mass of the container when empty is m and the mass of the wax in the container is $3m$.

(a) Find the distance of the centre of mass of the solid S from the vertex of the container.
(4)

One of the strings is now removed and the solid S hangs freely in equilibrium suspended by the remaining vertical string.

(b) Find the size of the angle between the axis of the container and the downward vertical.
(3)

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Q3

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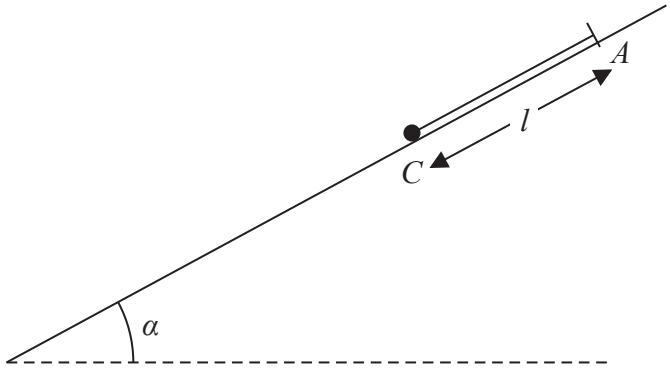

Figure 3

One end of a light elastic string, of natural length l and modulus of elasticity $3mg$, is fixed to a point A on a fixed plane inclined at an angle α to the horizontal, where $\sin \alpha = \frac{3}{5}$

A small ball of mass $2m$ is attached to the free end of the string. The ball is held at a point C on the plane, where C is below A and $AC = l$ as shown in Figure 3. The string is parallel to a line of greatest slope of the plane. The ball is released from rest. In an initial model the plane is assumed to be smooth.

(a) Find the distance that the ball moves before first coming to instantaneous rest.

(5)

In a refined model the plane is assumed to be rough. The coefficient of friction between the ball and the plane is μ. The ball first comes to instantaneous rest after moving a distance $\frac{2}{5}l$.

(b) Find the value of μ.

(6)

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Question 4 continued

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Question 4 continued

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Question 4 continued

Q4

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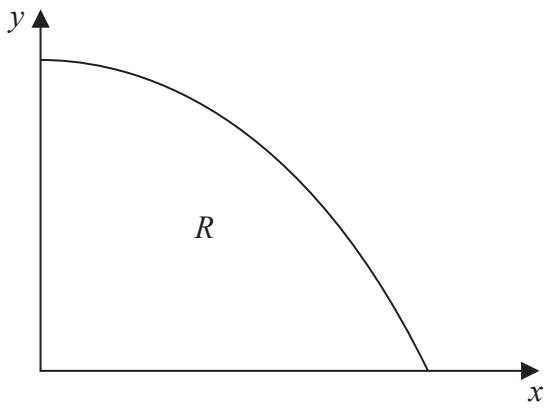

Figure 4

Figure 4 shows the region R bounded by part of the curve with equation $y = \cos x$, the x-axis and the y-axis. A uniform solid S is formed by rotating R through 2π radians about the x-axis.

(a) Show that the volume of S is $\dfrac{\pi^2}{4}$

(4)

(b) Find, using algebraic integration, the x coordinate of the centre of mass of S.

(7)

P 4 3 1 7 5 A 0 1 6 2 8

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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 particle P is attached to one end of a light inextensible string of length a. The other end of the string is attached to a fixed point. The particle is hanging freely at rest, with the string vertical, when it is projected horizontally with speed U. The particle moves in a complete vertical circle.

(a) Show that $U \geqslant \sqrt{5ag}$

(8)

As P moves in the circle the least tension in the string is T and the greatest tension is kT. Given that $U = 3\sqrt{ag}$

(b) find the value of k.

(5)

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

(Total 13 marks)

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7. A particle P of mass m is attached to one end of a light elastic spring of natural length l. The other end of the spring is attached to a fixed point A. The particle is hanging freely in equilibrium at the point B, where $AB = 1.5l$

(a) Show that the modulus of elasticity of the spring is $2mg$.

(3)

The particle is pulled vertically downwards from B to the point C, where $AC = 1.8l$, and released from rest.

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

(6)

(c) Find the greatest magnitude of the acceleration of P.

(2)

The midpoint of BC is D. The point E lies vertically below A and $AE = 1.2l$

(d) Find the time taken by P to move directly from D to E.

(4)

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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 15 marks)

TOTAL FOR PAPER: 75 MARKS

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P 4 3 1 7 5 A 0 2 8 2 8