Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M3

Advanced/Advanced Subsidiary

Sample Assessment Material
Time: 1 hour 30 minutes

Paper Reference
WME03/01

You must have:
Mathematical Formulae and Statistical Tables (Blue)

Total Marks

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

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B). Coloured pencils and highlighter pens must not be used.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- 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

- The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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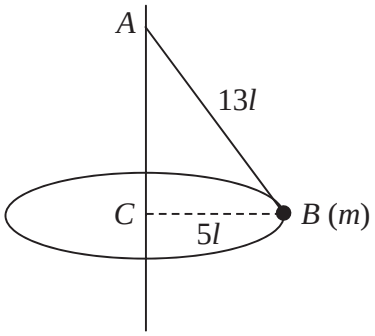

Figure 1

A garden game is played with a small ball B of mass m attached to one end of a light inextensible string of length $13l$. The other end of the string is fixed to a point A on a vertical pole as shown in Figure 1. The ball is hit and moves with constant speed in a horizontal circle of radius $5l$ and centre C, where C is vertically below A. Modelling the ball as a particle, find

(a) the tension in the string,

(3)

(b) the speed of the ball.

(4)

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Question 1 continued

Q1

(Total 7 marks)

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2. A particle P of mass m is above the surface of the Earth at distance x from the centre of the Earth. The Earth exerts a gravitational force on P. The magnitude of this force is inversely proportional to x^2.

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

(a) Prove that the magnitude of the gravitational force on P is $\frac{mgR^2}{x^2}$.

(3)

A particle is fired vertically upwards from the surface of the Earth with initial speed $3U$. At a height R above the surface of the Earth the speed of the particle is U.

(b) Find U in terms of g and R.

(7)

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Question 2 continued

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Question 2 continued

Q2

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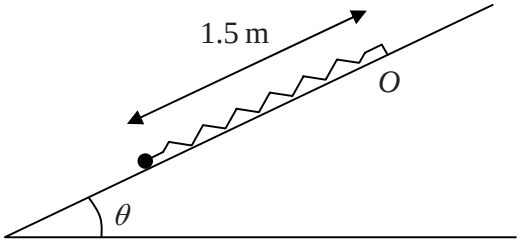

Figure 2

A particle of mass 0.5 kg is attached to one end of a light elastic spring of natural length 0.9 m and modulus of elasticity λ newtons. The other end of the spring is attached to a fixed point O on a rough plane which is inclined at an angle θ to the horizontal, where $\sin\theta = \frac{3}{5}$. The coefficient of friction between the particle and the plane is 0.15. The particle is held on the plane at a point which is 1.5 m down the line of greatest slope from O, as shown in Figure 2. The particle is released from rest and first comes to rest again after moving 0.7 m up the plane.

Find the value of λ.

(9)

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Question 3 continued

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Question 3 continued

Q3

(Total 9 marks)

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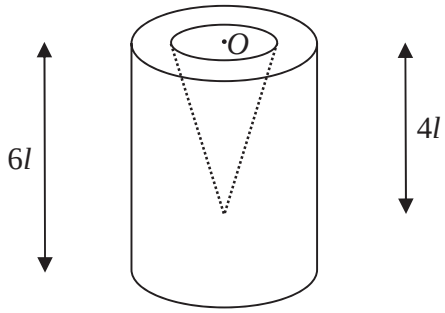

Figure 3

A container is formed by removing a right circular solid cone of height $4l$ from a uniform solid right circular cylinder of height $6l$. The centre O of the plane face of the cone coincides with the centre of a plane face of the cylinder and the axis of the cone coincides with the axis of the cylinder, as shown in Figure 3. The cylinder has radius $2l$ and the base of the cone has radius l.

(a) Find the distance of the centre of mass of the container from O.

(6)

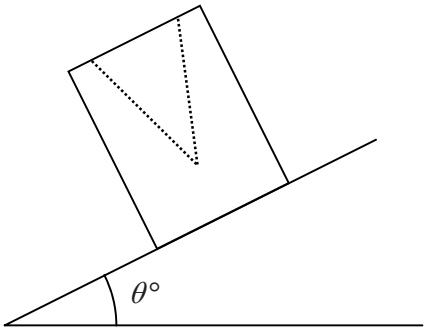

Figure 4

The container is placed on a plane which is inclined at an angle $\theta°$ to the horizontal. The open face is uppermost, as shown in Figure 4. The plane is sufficiently rough to prevent the container from sliding. The container is on the point of toppling.

(b) Find the value of θ.

(4)

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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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5.

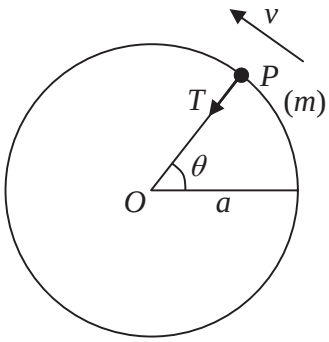

Figure 5

A particle P of mass m is attached to one end of a light inextensible string of length a. The other end of the string is fixed at the point O. The particle is initially held with OP horizontal and the string taut. It is then projected vertically upwards with speed u, where $u^2 = 5ag$. When OP has turned through an angle θ the speed of P is v and the tension in the string is T, as shown in Figure 5.

(a) Find, in terms of a, g and θ, an expression for v^2.

(3)

(b) Find, in terms of m, g and θ, an expression for T.

(4)

(c) Prove that P moves in a complete circle.

(3)

(d) Find the maximum speed of P.

(2)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Q5

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6. At time $t = 0$, a particle P is at the origin O moving with speed $2\ \text{m s}^{-1}$ along the x-axis in the positive x-direction. At time t seconds ($t > 0$), the acceleration of P has magnitude $\frac{3}{(t+1)^2}\ \text{m s}^{-2}$ and is directed towards O.

(a) Show that at time t seconds the velocity of P is $\left(\frac{3}{t+1} - 1\right)\ \text{m s}^{-1}$.

(5)

(b) Find, to 3 significant figures, the distance of P from O when P is instantaneously at rest.

(7)

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Question 6 continued

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Question 6 continued

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Question 6 continued

Q6

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7. A light elastic string, of natural length $3a$ and modulus of elasticity $6mg$, has one end attached to a fixed point A. A particle P of mass $2m$ is attached to the other end of the string and hangs in equilibrium at the point O, vertically below A.

(a) Find the distance AO.

(3)

The particle is now raised to point C vertically below A, where $AC > 3a$, and is released from rest.

(b) Show that P moves with simple harmonic motion of period $2\pi\sqrt{\left(\frac{a}{g}\right)}$.

(5)

It is given that $OC = \frac{1}{4}a$.

(c) Find the greatest speed of P during the motion.

(3)

The point D is vertically above O and $OD = \frac{1}{8}a$. The string is cut as P passes through D, moving upwards.

(d) Find the greatest height of P above O in the subsequent motion.

(4)

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Question 7 continued

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Question 7 continued

Q7

(Total 15 marks)

TOTAL FOR PAPER 75 MARKS

END

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