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Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Mechanics M3

Advanced/Advanced Subsidiary

Wednesday 10 January 2018 – Afternoon
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.

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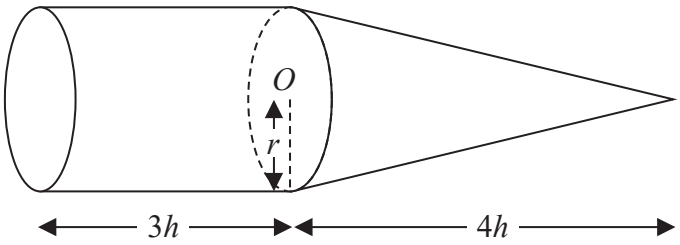

Figure 1

A uniform solid S consists of a right solid circular cone of base radius r and a right solid cylinder, also of radius r. The cone has height $4h$ and the centre of the plane face of the cone is O. The cylinder has height $3h$. The cone and cylinder are joined so that the plane face of the cone coincides with one of the plane faces of the cylinder, as shown in Figure 1.

Find the distance from O to the centre of mass of S.

(5)

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Question 1 continued

Q1

(Total 5 marks)

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2. A particle of mass 0.9 kg is attached to one end of a light elastic string, of natural length 1.2 m and modulus of elasticity 29.4 N. The other end of the string is attached to a fixed point A on a ceiling.

The particle is held at A and then released from rest. The particle first comes to instantaneous rest at the point B.

Find the distance AB.

(5)

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Question 2 continued

Q2

(Total 5 marks)

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3. A particle P of mass 0.4 kg moves along the x-axis in the positive direction. At time $t = 0$, P passes through the origin O with speed 10 m s^{-1}. At time t seconds P is x metres from O and the speed of P is v m s^{-1}. The resultant force acting on P has magnitude $\frac{8}{(t+4)^2}$ N and is directed towards O.

(a) Show that $v = \frac{20}{t+4} + 5$

(5)

When $v = 6$, $x = a + b\ln 5$, where a and b are integers.

(b) Using algebraic integration, find the value of a and the value of b.

(5)

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Question 3 continued

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Question 3 continued

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Question 3 continued

(Total 10 marks)

Q3

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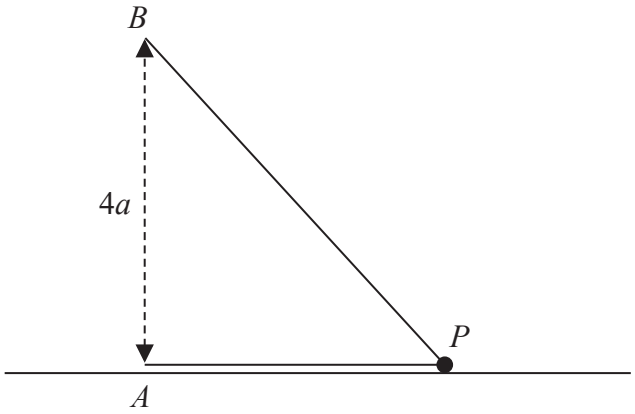

Figure 2

A small smooth bead P is threaded on a light inextensible string of length $8a$. One end of the string is attached to a fixed point A on a smooth horizontal table. The other end of the string is attached to the fixed point B, where B is vertically above A and $AB = 4a$, as shown in Figure 2. The bead moves with constant angular speed, in a horizontal circle, centre A, with AP horizontal. The bead remains in contact with the table and both parts of the string, AP and BP, are taut. The time for P to complete one revolution is S.

Show that $S \geqslant \pi\sqrt{\dfrac{6a}{g}}$

(12)

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Question 4 continued

Q4

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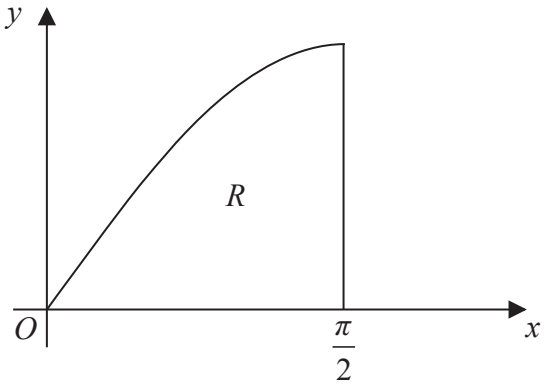

Figure 3

Figure 3 shows the finite region R which is bounded by part of the curve with equation $y = \sin x$, the x-axis and the line with equation $x = \frac{\pi}{2}$. A uniform solid S is formed by rotating R through 2π radians about the x-axis.

Using algebraic integration,

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

(4)

(b) find, in terms of π, the x coordinate of the centre of mass of S.

(7)

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Question 5 continued

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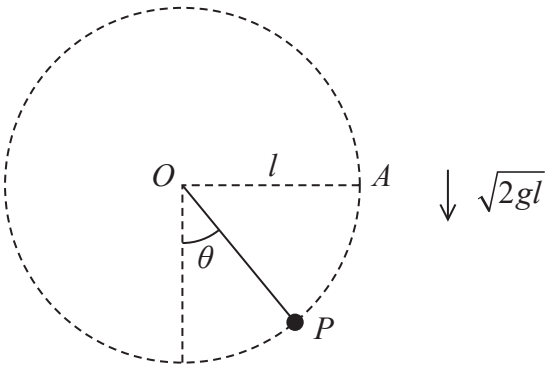

Figure 4

A particle P of mass m is attached to one end of a light inextensible string of length l. The other end of the string is attached to a fixed point O. The particle is held at the point A, where $OA = l$ and OA is horizontal. The particle is then projected vertically downwards from A with speed $\sqrt{2gl}$, as shown in Figure 4. When the string makes an angle θ with the downward vertical through O and the string is still taut, the tension in the string is T.

(a) Show that $T = mg(3\cos\theta + 2)$

(7)

At the instant when the particle reaches the point B, the string becomes slack.

(b) Find the speed of P at B.

(3)

(c) Find the greatest height above O reached by P in the subsequent motion.

(5)

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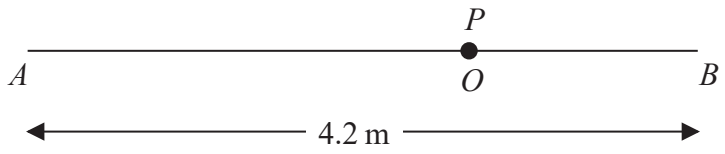

Figure 5

The fixed points A and B are 4.2 m apart on a smooth horizontal floor. One end of a light elastic spring, of natural length 1.8 m and modulus of elasticity 20 N, is attached to a particle P and the other end is attached to A. One end of another light elastic spring, of natural length 0.9 m and modulus of elasticity 15 N, is attached to P and the other end is attached to B. The particle P rests in equilibrium at the point O, where AOB is a straight line, as shown in Figure 5.

(a) Show that $AO = 2.7$ m.

(4)

The particle P now receives an impulse acting in the direction OB and moves away from O towards B. In the subsequent motion P does not reach B.

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

(5)

The mass of P is 10 kg and the magnitude of the impulse is J N s.

Given that P first comes to instantaneous rest at the point C where $AC = 2.9$ m,

(c) (i) find the value of J,

(ii) find the time taken by P to travel a total distance of 0.5 m from when it first leaves O.

(8)

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Question 7 continued

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Q7

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TOTAL FOR PAPER: 75 MARKS

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