Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 21 January 2026

Morning (Time: 1 hour 30 minutes)

Paper reference **WME03/01**

▲ △

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M3

You must have:
Mathematical Formulae and Statistical Tables (Yellow), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. 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).
- **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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, and give your answer to either two significant figures or three significant figures.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 8 questions in this question paper. 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ▶

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P 7 8 9 1 6 A 0 1 3 6

Pearson

1. A particle P is moving along the x-axis.
At time t seconds the displacement of P from the origin O is x metres, where
$x = 0.6\cos\left(kt + \frac{\pi}{4}\right)$ and k is a positive constant.

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

$$\ddot{x} = -k^2 x$$

(3)

(b) State the amplitude of the motion of P

(1)

(c) Find, in terms of k, the maximum speed of P

(1)

The period of the motion is 4 seconds.

(d) Find k in terms of π

(2)

The points A and B lie on the x-axis, on opposite sides of O, with $OA = OB = 0.2\,\text{m}$

(e) Find the time taken by P to move directly from A to B

(4)

Question 1 continued

Question 1 continued

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Question 1 continued

(Total for Question 1 is 11 marks)

2.

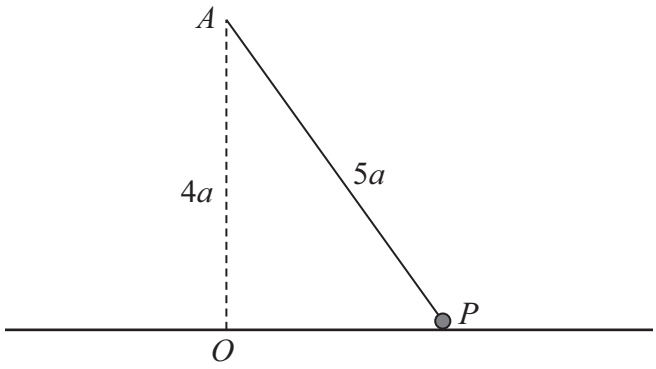

Figure 1

A particle P of mass m is attached to one end of a light inextensible string of length $5a$
The other end of the string is attached to a fixed point A above a smooth horizontal table.
The particle moves in a horizontal circle on the table with the string taut.
The centre O of the circle is vertically below A with $OA = 4a$, as shown in Figure 1.

The particle moves with constant angular speed ω and remains in contact with the table.

(a) Find, in terms of m and g, the magnitude of the normal reaction between P and the table when $\omega = \frac{1}{4}\sqrt{\frac{g}{a}}$

(6)

The angular speed ω is gradually increased and the particle remains in contact with the table.

(b) Show that $\omega < \frac{1}{2}\sqrt{\frac{g}{a}}$

(2)

Question 2 continued

Question 2 continued

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Question 2 continued

(Total for Question 2 is 8 marks)

3. **In this question you must show all stages of your working.**
Solutions relying entirely on calculator technology are not acceptable.

A particle P is moving along a straight line.
At time t seconds ($t \geqslant 0$), P is a distance x metres from a fixed point O on the line and is moving away from O with speed $\frac{8x}{3 + x^2}\,\text{m s}^{-1}$

(a) Find the magnitude of the acceleration of P when $x = 3$

(5)

Given that $x = 1$ when $t = 2$

(b) find the exact value of t when $x = 3$

(5)

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Question 3 continued

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Question 3 continued

(Total for Question 3 is 10 marks)

4.

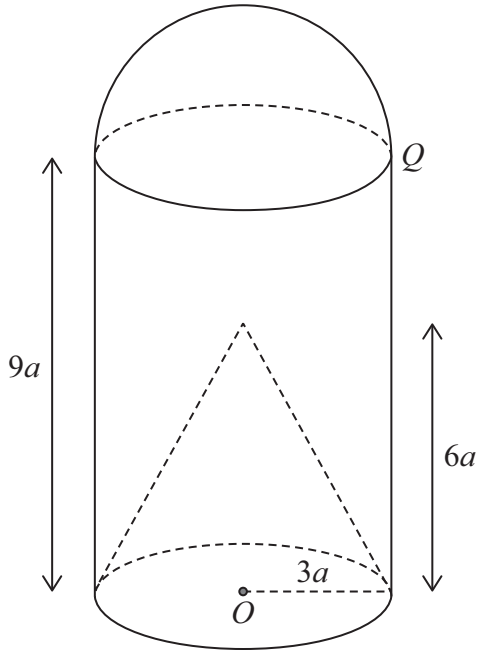

Figure 2

A uniform solid right circular cylinder has radius $3a$ and height $9a$

A uniform solid hemisphere of radius $3a$ is attached to the cylinder so that the plane face of the hemisphere coincides with one of the plane faces of the cylinder.

A solid right circular cone, of radius $3a$ and height $6a$, whose plane face is the other plane face of the cylinder, is now removed from the cylinder to form the uniform solid S
The point O is the centre of the circular base of S, as shown in Figure 2.

(a) Show that the distance from O to the centre of mass of S is $\frac{77}{12}a$

(5)

The solid S is placed with its circular base on a rough horizontal surface.
The point Q, shown in Figure 2, lies on the circumference of the top of the cylinder.

A horizontal force of magnitude H is applied to S at Q
The force acts towards the axis of symmetry of S
The horizontal surface is sufficiently rough to prevent S from sliding.

The solid S is on the point of tipping.

Given that the weight of S is W

(b) find H in terms of W

(2)

Question 4 continued

Question 4 continued

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Question 4 continued

(Total for Question 4 is 7 marks)

5.

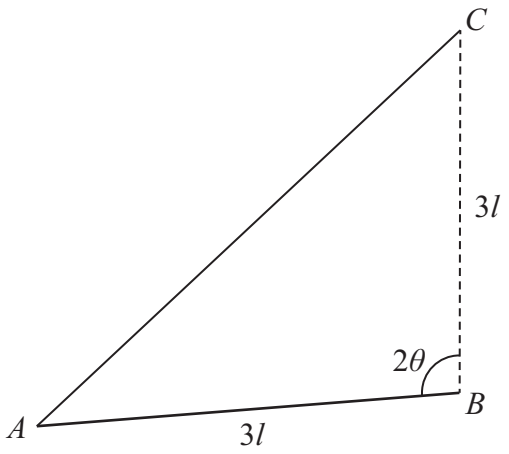

Figure 3

A uniform rod AB has mass M and length $3l$
The rod is free to move in a vertical plane about a fixed smooth horizontal axis through B

One end of a light elastic string, of natural length $2l$ and modulus of elasticity $\frac{5Mg}{8}$, is attached to the rod at A

The other end of the string is attached to the fixed point C, which is at a distance $3l$ vertically above B, as shown in Figure 3.

The rod is resting in equilibrium with angle $ABC = 2\theta$, where $0 < \theta < \frac{1}{2}\pi$

By taking moments about the horizontal axis through B, show that the extension of the string is $\frac{16}{7}l$

(7)

Question 5 continued

Question 5 continued

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Question 5 continued

(Total for Question 5 is 7 marks)

6.

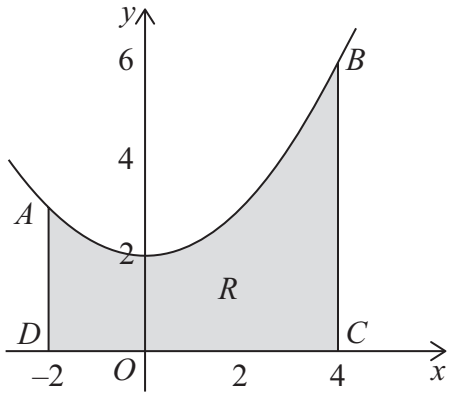

Figure 4

In this question you must show all stages of your working.
Solutions relying entirely on calculator technology are not acceptable.

A uniform lamina $ABCD$ is in the shape of the region R

The region R is bounded by the curve with equation $y = \frac{1}{4}(x^2 + 8)$, the line with equation $x = 4$, the x-axis and the line with equation $x = -2$, as shown shaded in Figure 4.

The area of R is 18

(a) Show that the x coordinate of the centre of mass of the lamina is $\frac{3}{2}$

(4)

(b) Show that the y coordinate of the centre of mass of the lamina is $\frac{17}{10}$

(4)

The lamina is freely suspended from B and hangs in equilibrium with BC at an angle θ to the downward vertical through B

(c) Find the exact value of $\tan\theta$

(2)

Question 6 continued

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Question 6 continued

(Total for Question 6 is 10 marks)

7. One end of a light elastic **spring** is attached to a fixed point A
A particle of mass M is attached to the other end of the spring.

The spring has natural length $3a$ and modulus of elasticity $\frac{18Mg}{5}$

The particle is held at rest at the point B, where B is a distance $5a$ vertically below A
The particle is released from rest.
Air resistance is assumed to be negligible.

Use the **principle of conservation of mechanical energy** to

(a) find, in terms of a and g, the speed of the particle at the instant when it is a distance $3a$ vertically below A

(4)

(b) find, in terms of a, the distance of the particle below A when it first comes to instantaneous rest.

(4)

Question 7 continued

Question 7 continued

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Question 7 continued

(Total for Question 7 is 8 marks)

8.

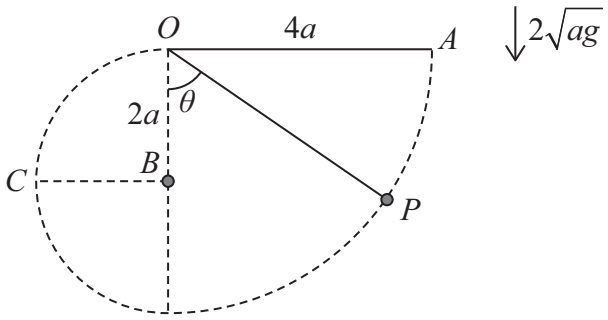

Figure 5

A particle P of mass m is attached to one end of a light inextensible string of length $4a$
The other end of the string is attached to a fixed point O
The particle is held at the point A, where $OA = 4a$, and OA is horizontal, as shown in Figure 5.

The particle is projected vertically downwards with speed $2\sqrt{ag}$

When the string makes an angle $\theta \left(0 \leqslant \theta \leqslant \frac{\pi}{2} \right)$ with the downward vertical through O and the string is still taut, the tension in the string is T

Air resistance is assumed to be negligible.

(a) Show that $T = mg(1 + 3\cos\theta)$

(6)

(b) Find, in terms of a and g, the speed of P at the lowest point of its path.

(2)

There is a fixed small horizontal peg at the point B, which is a distance $2a$ vertically below O. The peg is smooth and is perpendicular to the vertical plane of the motion of P and the string.

The string comes into contact with the peg and P continues to move clockwise in the same vertical plane. The point C is such that $CB = 2a$ and CB is horizontal, as shown in Figure 5.

When the particle passes through C, the string is still taut.

(c) Find, in terms of a and g, the exact speed of the particle at the instant when it passes through C

(3)

(d) Find, in terms of m and g, the tension in the string at the instant when P reaches O

(3)

Question 8 continued

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(Total for Question 8 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS