Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Time 1 hour 30 minutes

Paper reference **WME02/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M2

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 $g = 9.8\,\text{m s}^{-2}$, and give your answer to either 2 significant figures or 3 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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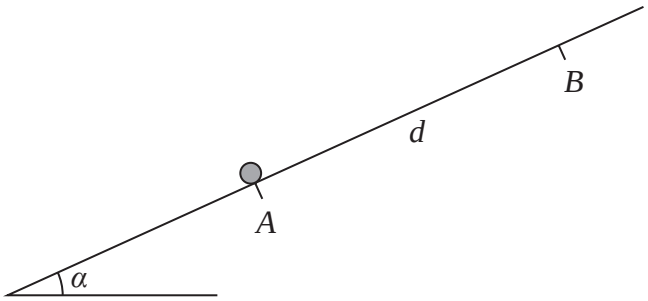

Figure 1

A particle of mass m is held at rest at a point A on a rough plane.

The plane is inclined at an angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$

The coefficient of friction between the particle and the plane is $\frac{1}{5}$

The points A and B lie on a line of greatest slope of the plane, with B above A, and $AB = d$, as shown in Figure 1.

The particle is pushed up the line of greatest slope from A to B.

(a) Show that the work done against friction as the particle moves from A to B is $\frac{12}{65}mgd$

(3)

The particle is then held at rest at B and released.

(b) Use the work-energy principle to find, in terms of g and d, the speed of the particle at the instant it reaches A.

(4)

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Question 1 continued

(Total 7 marks)

Q1

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2. A vehicle of mass 450 kg is moving on a straight road that is inclined at angle θ to the horizontal, where $\sin\theta = \frac{1}{15}$

At the instant when the vehicle is moving **down** the road at $12\,\text{m s}^{-1}$

- the engine of the vehicle is working at a rate of P watts
- the **acceleration** of the vehicle is $0.5\,\text{m s}^{-2}$
- the resistance to the motion of the vehicle is modelled as a constant force of magnitude R newtons

At the instant when the vehicle is moving **up** the road at $12\,\text{m s}^{-1}$

- the engine of the vehicle is working at a rate of $2P$ watts
- the **deceleration** of the vehicle is $0.5\,\text{m s}^{-2}$
- the resistance to the motion of the vehicle from non-gravitational forces is modelled as a constant force of magnitude R newtons

Find the value of P.

(8)

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Question 2 continued

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Question 2 continued

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Question 2 continued

(Total 8 marks)

Q2

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3. A particle P moves on the x-axis.

At time $t = 0$, P is instantaneously at rest at O.

At time t seconds, $t > 0$, the x coordinate of P is given by

$$x = 2t^{\frac{7}{2}} - 14t^{\frac{5}{2}} + \frac{56}{3}t^{\frac{3}{2}}$$

Find

(a) the non-zero values of t for which P is at instantaneous rest

(3)

(b) the total distance travelled by P in the interval $0 \leqslant t \leqslant 4$

(3)

(c) the acceleration of P when $t = 4$

(3)

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Question 3 continued

(Total 9 marks)

Q3

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4. A particle P of mass 0.75 kg is moving with velocity $4\mathbf{i}\,\text{m s}^{-1}$ when it receives an impulse $\mathbf{J}$ Ns. Immediately after P receives the impulse, the speed of P is $8\,\text{m s}^{-1}$

Given that $\mathbf{J} = c(-\mathbf{i} + 2\mathbf{j})$, where c is a constant, find the two possible values of c.

(6)

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Question 4 continued

Q4

(Total 6 marks)

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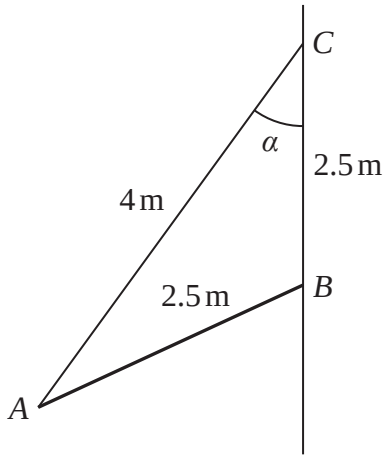

Figure 2

A pole AB has length 2.5 m and weight 70 N.
The pole rests with end B against a rough vertical wall. One end of a cable of length 4 m is attached to the pole at A. The other end of the cable is attached to the wall at the point C.
The point C is vertically above B and $BC = 2.5$ m.
The angle between the cable and the wall is α, as shown in Figure 2.
The pole is in a vertical plane perpendicular to the wall.
The cable is modelled as a light inextensible string and the pole is modelled as a uniform rod.

Given that $\tan\alpha = \frac{3}{4}$

(a) show that the tension in the cable is 56 N.

(4)

Given also that the pole is in limiting equilibrium,

(b) find the coefficient of friction between the pole and the wall.

(6)

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Question 5 continued

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Question 5 continued

(Total 10 marks)

Q5

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6. Two particles, A and B, are moving in opposite directions along the same straight line on a smooth horizontal surface when they collide directly.
The mass of A is $2m$ and the mass of B is $3m$.

Immediately **after** the collision, A and B are moving in opposite directions with the same speed v.
In the collision, A receives an impulse of magnitude $5mv$.

(a) Find the coefficient of restitution between A and B.

(6)

After the collision with A, particle B strikes a smooth fixed vertical wall and rebounds. The wall is perpendicular to the direction of motion of the particles.
The coefficient of restitution between B and the wall is f.

As a result of its collision with A and with the wall, the total kinetic energy lost by B is E.
As a result of its collision with B, the kinetic energy lost by A is $2E$.

(b) Find the value of f.

(4)

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Question 6 continued

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Question 6 continued

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Question 6 continued

(Total 10 marks)

Q6

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7. In this question you may use, without proof, the formula for the centre of mass of a uniform sector of a circle, as given in the formulae book.

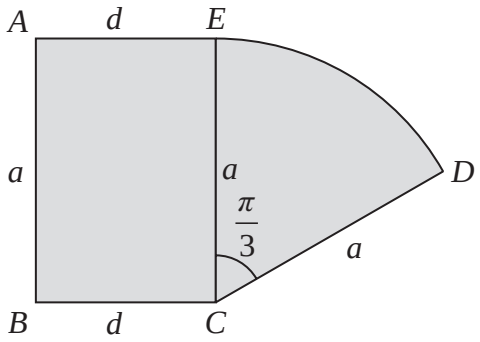

Figure 3

The uniform lamina *ABCDE*, shown shaded in Figure 3, is formed by joining a rectangle to a sector of a circle.

- The rectangle *ABCE* has $AB = EC = a$ and $AE = BC = d$
- The sector *CDE* has centre *C* and radius *a*
- Angle $ECD = \frac{\pi}{3}$ radians

The centre of mass of the lamina lies on *EC*.

(a) Show that $a = \sqrt{3}d$

(4)

The lamina is freely suspended from *B* and hangs in equilibrium with *BC* at an angle β radians to the downward vertical.

(b) Find the value of β

(7)

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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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Q7

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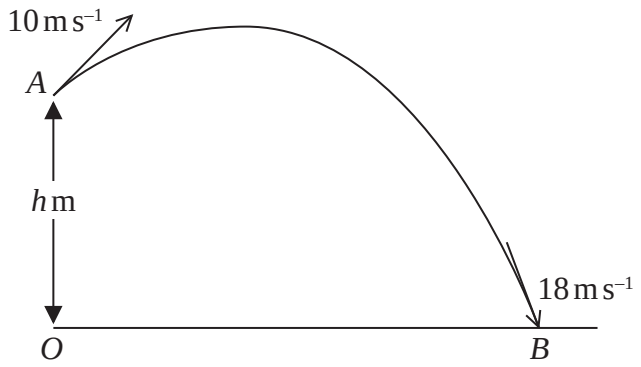

Figure 4

The fixed point A is h metres vertically above the point O that is on horizontal ground. At time $t = 0$, a particle P is projected from A with speed $10\,\text{m s}^{-1}$. The particle moves freely under gravity. At time $t = 2.5$ seconds, P strikes the ground at the point B. At the instant when P strikes the ground, the speed of P is $18\,\text{m s}^{-1}$, as shown in Figure 4.

(a) By considering energy, find the value of h.

(3)

(b) Find the distance OB.

(5)

As P moves from A to B, the speed of P is less than or equal to $8\,\text{m s}^{-1}$ for T seconds.

(c) Find the value of T

(6)

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Question 8 continued

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Question 8 continued

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Question 8 continued

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Question 8 continued

Q8

(Total 14 marks)

TOTAL FOR PAPER IS 75 MARKS

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