Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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Afternoon (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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, 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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1.

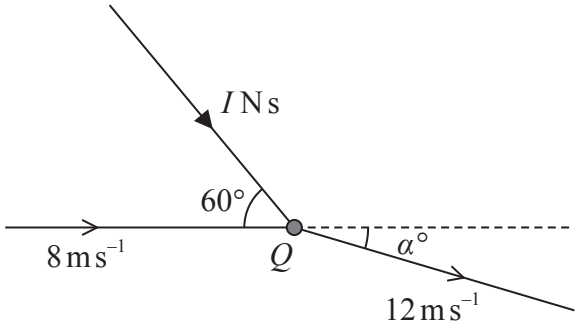

Figure 1

A particle Q of mass 0.25 kg is moving in a straight line on a smooth horizontal surface with speed $8\,\text{m s}^{-1}$ when it receives an impulse of magnitude I N s.

The impulse acts parallel to the horizontal surface and at 60° to the original direction of motion of Q.

Immediately after receiving the impulse, the speed of Q is $12\,\text{m s}^{-1}$

As a result of receiving the impulse, the direction of motion of Q is turned through $\alpha°$, as shown in Figure 1.

Find the value of I

(5)

Question 1 continued

(Total for Question 1 is 5 marks)

2. A particle P moves along the x-axis. At time t seconds, the acceleration of P is $a\,\text{m s}^{-2}$ in the positive x direction, where

$$a = 8 - 6t \quad t \geqslant 0$$

When $t = 0$, P is at the origin O and is moving with speed $3\,\text{m s}^{-1}$ in the positive x direction.

Find

(i) the distance of P from O at the instant when P is instantaneously at rest,

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

(8)

Question 2 continued

(Total for Question 2 is 8 marks)

3.

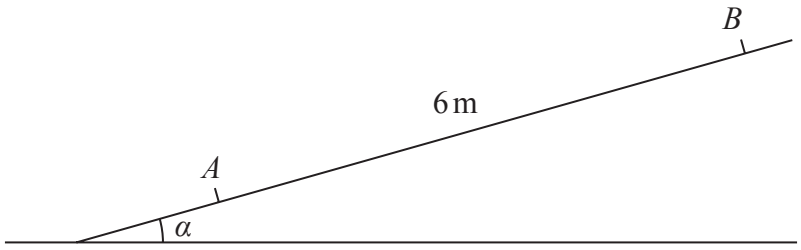

Figure 2

A rough ramp is fixed to horizontal ground.

The ramp is inclined to the horizontal at an angle α, where $\sin\alpha = \frac{3}{7}$

The line AB is a line of greatest slope of the ramp, with B above A and $AB = 6\,\text{m}$, as shown in Figure 2.

A block P of mass 2 kg is pushed, with constant speed, in a straight line up the slope from A to B. The force pushing P acts parallel to AB.

The coefficient of friction between P and the ramp is $\frac{1}{3}$

The block is modelled as a particle and air resistance is negligible.

(a) Use the model to find the **total** work done in pushing the block from A to B.

(5)

The block is now held at B and released from rest.

(b) Use the model and the work-energy principle to find the speed of the block at the instant it reaches A.

(4)

Question 3 continued

Question 3 continued

Question 3 continued

(Total for Question 3 is 9 marks)

4. At time t seconds ($0 \leqslant t < 5$), a particle P has velocity $\mathbf{v}\,\text{m s}^{-1}$, where

$$\mathbf{v} = \left(\sqrt{5 - t}\right)\mathbf{i} + \left(t^2 + 2t - 3\right)\mathbf{j}$$

When $t = \lambda$, particle P is moving in a direction parallel to the vector $\mathbf{i}$.

(a) Find the acceleration of P when $t = \lambda$

(5)

The position vector of P is measured relative to the fixed point O
When $t = 1$, the position vector of P is $(-2\mathbf{i} + \mathbf{j})$m.

Given that $1 \leqslant T < 5$

(b) find, in terms of T, the position vector of P when $t = T$

(5)

Question 4 continued

Question 4 continued

Question 4 continued

(Total for Question 4 is 10 marks)

5.

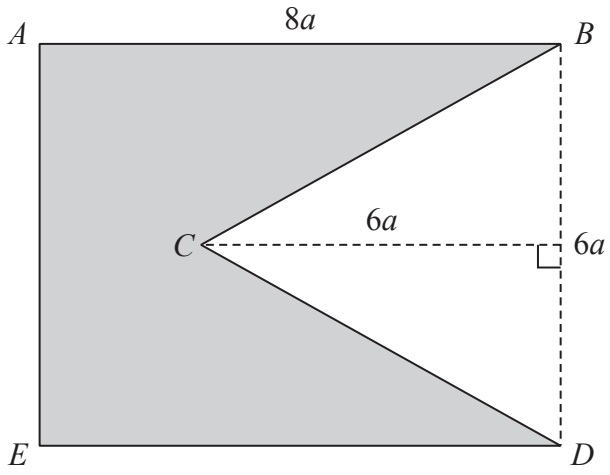

Figure 3

The uniform lamina $ABDE$ is in the shape of a rectangle with $AB = 8a$ and $BD = 6a$.
The triangle BCD is isosceles and has base $6a$ and perpendicular height $6a$.
The template $ABCDE$, shown shaded in Figure 3, is formed by removing the triangular lamina BCD from the lamina $ABDE$.

(a) Show that the centre of mass of the template is $\frac{14}{5}a$ from AE.

(5)

The template is freely suspended from A and hangs in equilibrium with AB at an angle of $\theta°$ to the downward vertical.

(b) Find the value of θ, giving your answer to the nearest whole number.

(3)

Question 5 continued

Question 5 continued

Question 5 continued

(Total for Question 5 is 8 marks)

6.

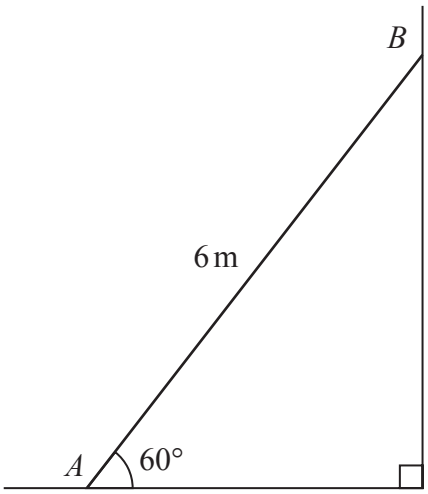

Figure 4

A ladder AB has length 6 m and mass 30 kg. The ladder rests in equilibrium at 60° to the horizontal with the end A on rough horizontal ground and the end B against a smooth vertical wall, as shown in Figure 4.

A man of mass 70 kg stands on the ladder at the point C, where $AC = 2$ m, and the ladder remains in equilibrium. The ladder is modelled as a uniform rod in a vertical plane perpendicular to the wall. The man is modelled as a particle.

(a) Find the magnitude of the force exerted on the ladder by the ground.

(6)

The man climbs further up the ladder. When he is at the point D on the ladder, the ladder is about to slip.

Given that the coefficient of friction between the ladder and the ground is 0.4

(b) find the distance AD.

(4)

(c) State how you have used the modelling assumption that the ladder is a rod.

(1)

Question 6 continued

Question 6 continued

Question 6 continued

(Total for Question 6 is 11 marks)

7. A particle P of mass m is moving in a straight line with speed v on a smooth horizontal surface. The particle P collides directly with a particle Q of mass km which is moving with speed w, $(w < v)$, along the same straight line and in the same direction as P. The direction of motion of P is unchanged by the collision and, immediately after the collision, the speed of P is w and the speed of Q is $2w$.

The coefficient of restitution between P and Q is $\frac{2}{3}$.

(a) Find the value of k.

(6)

When P and Q collide they are at the point A, which is a distance d from a smooth fixed vertical wall. The wall is perpendicular to the direction of motion of the particles. After the collision with P, particle Q hits the wall and rebounds towards P.

The coefficient of restitution between Q and the wall is $\frac{1}{3}$.

There is a second direct collision between P and Q at the point B.

(b) Find, in terms of d and w, the time taken for P to travel from A to B.

(5)

Question 7 continued

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Question 7 continued

(Total for Question 7 is 11 marks)

8.

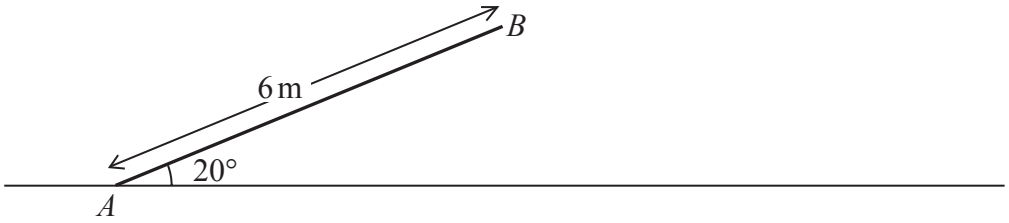

Figure 5

A rough ramp AB is fixed to horizontal ground at A. The ramp is inclined at 20° to the ground. The line AB is a line of greatest slope of the ramp and $AB = 6\,\text{m}$. The point B is at the top of the ramp, as shown in Figure 5. A particle P of mass 3 kg is projected with speed $15\,\text{m s}^{-1}$ from A towards B. At the instant P reaches the point B the speed of P is $10\,\text{m s}^{-1}$. The force due to friction is modelled as a constant force of magnitude F newtons.

(a) Use the work-energy principle to find the value of F.

(4)

After leaving the ramp at B, the particle P moves freely under gravity until it hits the horizontal ground at the point C. The speed of P as it hits the ground at C is $w\,\text{m s}^{-1}$.

Find

(b) (i) the value of w,

(ii) the direction of motion of P as it hits the ground at C,

(5)

(c) the greatest height of P above the ground as P moves from A to C.

(4)

Question 8 continued

Question 8 continued

(Total for Question 8 is 13 marks)

TOTAL FOR PAPER IS 75 MARKS

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