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 **WME01/01**

Mathematics

International Advanced Subsidiary/Advanced Level
Mechanics M1

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

1. A train travels along a straight horizontal track between two stations *A* and *B*.

The train starts from rest at station *A* and accelerates uniformly for *T* seconds until it reaches a speed of $20\,\text{m}\,\text{s}^{-1}$

The train then travels at a constant speed of $20\,\text{m}\,\text{s}^{-1}$ for 3 minutes before decelerating uniformly until it comes to rest at station *B*.

The magnitude of the acceleration of the train is twice the magnitude of the deceleration.

(a) On the axes below, sketch a speed–time graph to illustrate the motion of the train as it moves from station *A* to station *B*.

If you need to redraw your graph, use the axes on page 3

(3)

Stations *A* and *B* are 4.8 km apart.

(b) Find the value of *T*

(5)

(c) Find the acceleration of the train during the first *T* seconds of its motion.

(2)

Question 1 continued

Only use these axes if you need to redraw your graph.

(Total for Question 1 is 10 marks)

2. Two particles, A and B, are moving in a straight line in opposite directions towards each other on a smooth horizontal surface when they collide directly.

Particle A has mass $3m$ kg and particle B has mass m kg.

Immediately before the collision, both particles have a speed of $1.5\,\text{m s}^{-1}$

Immediately after the collision, the direction of motion of A is unchanged and the difference between the speed of A and speed of B is $1\,\text{m s}^{-1}$

(a) Find (i) the speed of A immediately after the collision,

(ii) the speed of B immediately after the collision.

(5)

(b) Find, in terms of m, the magnitude of the impulse exerted on B in the collision.

(3)

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Question 2 continued

(Total for Question 2 is 8 marks)

3. A particle P is moving with constant acceleration $(-4\mathbf{i} + \mathbf{j})\,\text{m s}^{-2}$

At time $t = 0$, P has velocity $(14\mathbf{i} - 5\mathbf{j})\,\text{m s}^{-1}$

(a) Find the speed of P at time $t = 2$ seconds.

(3)

(b) Find the size of the angle between the direction of $\mathbf{i}$ and the direction of motion of P at time $t = 2$ seconds.

(3)

At time $t = T$ seconds, P is moving in the direction of vector $(2\mathbf{i} - 3\mathbf{j})$

(c) Find the value of T

(4)

Question 3 continued

Question 3 continued

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Question 3 continued

(Total for Question 3 is 10 marks)

4.

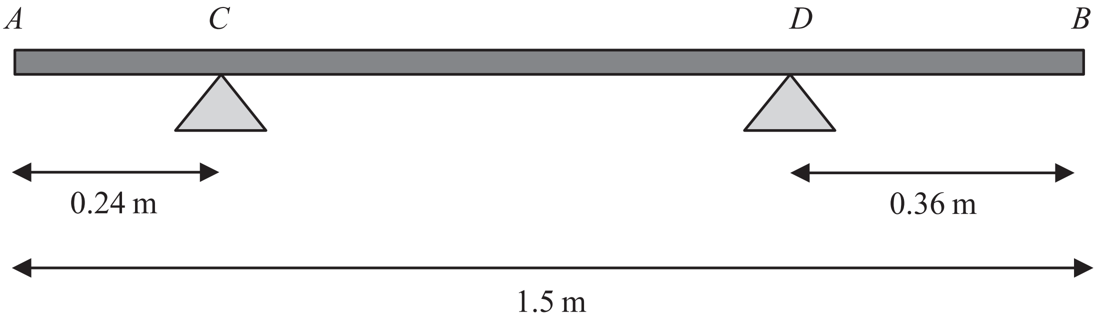

Figure 1

A branch AB, of length 1.5 m, rests horizontally in equilibrium on two supports.

The two supports are at the points C and D, where $AC = 0.24\,\text{m}$ and $DB = 0.36\,\text{m}$, as shown in Figure 1.

When a force of 150 N is applied vertically upwards at B, the branch is on the point of tilting about C.

When a force of 225 N is applied vertically downwards at B, the branch is on the point of tilting about D.

The branch is modelled as a non-uniform rod AB of weight W newtons.

The distance from the point C to the centre of mass of the rod is x metres.

Use the model to find

(i) the value of W

(ii) the value of x

(8)

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Question 4 continued

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Question 4 continued

(Total for Question 4 is 8 marks)

5.

Figure 2

Three points P, Q and R are on a horizontal road where PQR is a straight line.

The point Q is between P and R, with $PQ = 6x$ metres and $QR = 5x$ metres, as shown in Figure 2.

A vehicle moves along the road from P to Q with constant acceleration.

The vehicle is modelled as a particle.

At time $t = 0$, the vehicle passes P with speed $u \text{ m s}^{-1}$

At time $t = 12$ s, the vehicle passes Q with speed $2u \text{ m s}^{-1}$

Using the model,

(a) show that $x = 3u$

(2)

As the vehicle passes Q, the acceleration of the vehicle changes instantaneously to 1.5 m s^{-2}

The vehicle continues to move with a constant acceleration of 1.5 m s^{-2} and passes R with speed $3u \text{ m s}^{-1}$

Using the model,

(b) find the value of u,

(3)

(c) find the distance travelled by the vehicle during the first 14 seconds after passing P

(4)

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Question 5 continued

Question 5 continued

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Question 5 continued

(Total for Question 5 is 9 marks)

6.

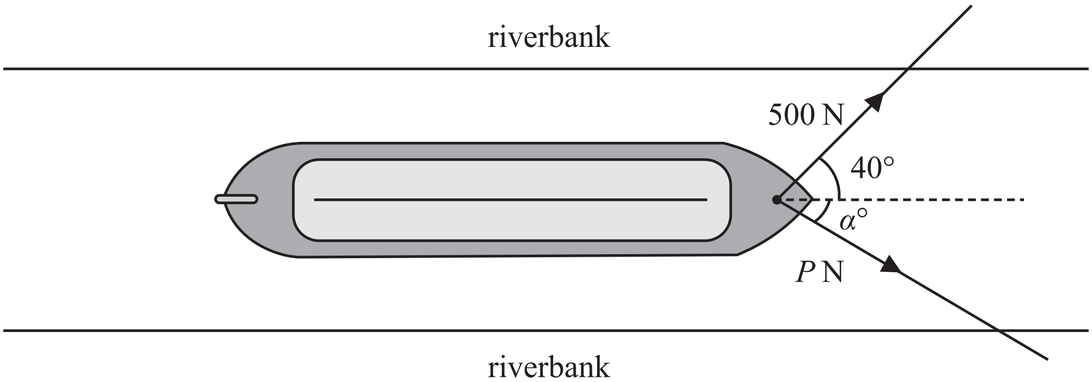

Figure 3

A boat is pulled along a river at a constant speed by two ropes.

The banks of the river are parallel and the boat travels horizontally in a straight line, parallel to the riverbanks.

- The tension in the first rope is 500 N acting at an angle of 40° to the direction of motion, as shown in Figure 3.
- The tension in the second rope is P newtons, acting at an angle of $\alpha°$ to the direction of motion, also shown in Figure 3.
- The resistance to motion of the boat as it moves through the water is a constant force of magnitude 900 N

The boat is modelled as a particle. The ropes are modelled as being light and lying in a horizontal plane.

Use the model to find

(i) the value of α

(ii) the value of P

(8)

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Question 6 continued

Question 6 continued

Question 6 continued

(Total for Question 6 is 8 marks)

7.

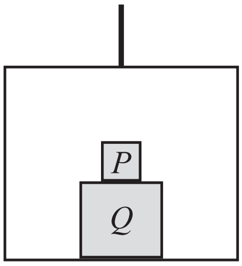

Figure 4

A simple lift operates by means of a vertical cable which is attached to the top of the lift.
The lift has mass m
A box Q is placed on the floor of the lift.
A box P is placed directly on top of box Q, as shown in Figure 4.

The cable is modelled as being light and inextensible and air resistance is modelled as being negligible.

The tension in the cable is $\frac{42mg}{5}$

The lift and its contents move vertically upwards with acceleration $\frac{2g}{5}$

Using the model,

(a) find, in terms of m, the combined mass of boxes P and Q

(4)

During the motion of the lift, the force exerted on box P by box Q is $\frac{14mg}{5}$

Using the model,

(b) find, in terms of m, the mass of box P

(3)

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Question 7 continued

(Total for Question 7 is 7 marks)

8.

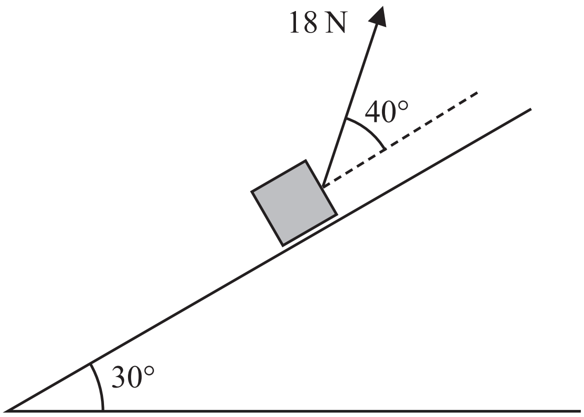

Figure 5

A parcel of mass 2 kg is pulled up a rough inclined plane by the action of a constant force.

The force has magnitude 18 N and acts at an angle of 40° to the plane.

The line of action of the force lies in a vertical plane containing a line of greatest slope of the inclined plane.

The plane is inclined at an angle of 30° to the horizontal, as shown in Figure 5.

The coefficient of friction between the plane and the parcel is 0.3

The parcel is modelled as a particle P

(a) Find the acceleration of P

(8)

The points A and B lie on a line of greatest slope of the plane, where $AB = 5\,\text{m}$ and B is above A. Particle P passes through A with speed $2\,\text{m}\,\text{s}^{-1}$ in the direction AB.

(b) Find the speed of P as it passes through B.

(3)

The force of 18 N is removed at the instant P passes through B. As a result, P comes to rest at the point C.

(c) Determine whether P will remain at rest at C. You must show all stages of your working clearly.

(4)

Question 8 continued

Question 8 continued

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Question 8 continued

Question 8 continued

(Total for Question 8 is 15 marks)

TOTAL FOR PAPER: 75 MARKS