Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
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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 $g = 9.8$ 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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Pearson

**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 $20\,\text{m s}^{-1}$

The train then travels at a constant speed of $20\,\text{m s}^{-1}$ 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)**

**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.**

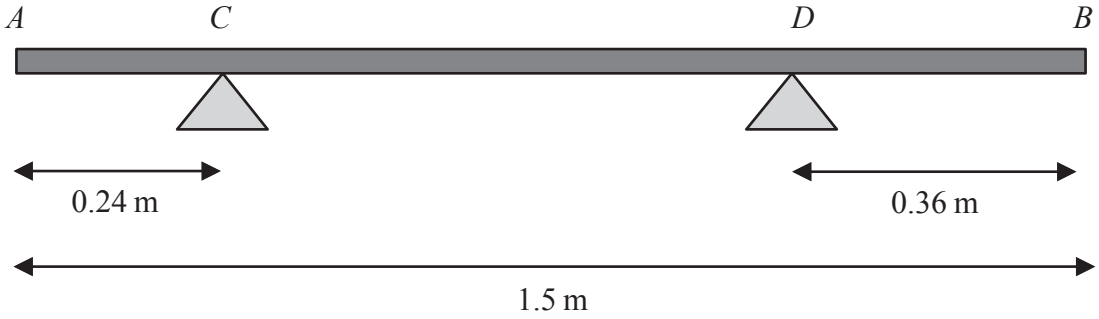


**Figure 1**

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)**

**Question 4 continued**

**Question 4 continued**

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**Question 4 continued**

**(Total for Question 4 is 8 marks)**

**5.**

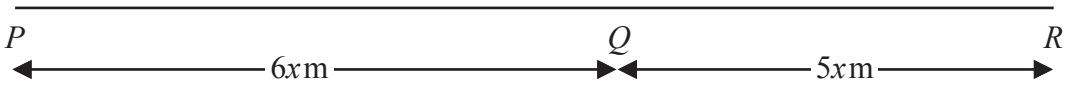


**Figure 2**

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 $1.5\,\text{m s}^{-2}$

The vehicle continues to move with a constant acceleration of $1.5\,\text{m s}^{-2}$ 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)**

**Question 5 continued**

**Question 5 continued**

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**Question 5 continued**

**(Total for Question 5 is 9 marks)**

**6.**

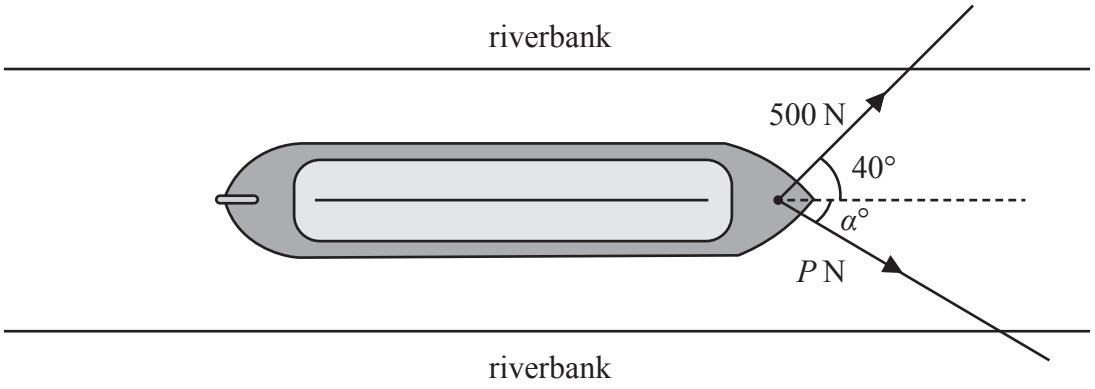


**Figure 3**

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 $\alpha$

(ii) the value of $P$

**(8)**

**Question 6 continued**

**Question 6 continued**

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**Question 6 continued**

**(Total for Question 6 is 8 marks)**

**7.**

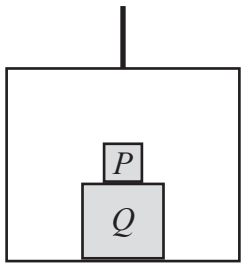


**Figure 4**

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)**

**Question 7 continued**

**(Total for Question 7 is 7 marks)**

**8.**

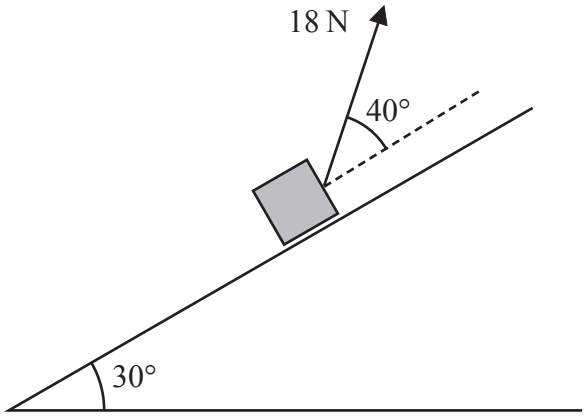


**Figure 5**

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 $2\,\text{m s}^{-1}$ 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**

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