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**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 ►

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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)

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**Question 1 continued****(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  $1.5 \text{ ms}^{-1}$

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  $1 \text{ ms}^{-1}$

- (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**

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**(Total for Question 2 is 8 marks)**



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

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

- (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)

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Question 3 continued

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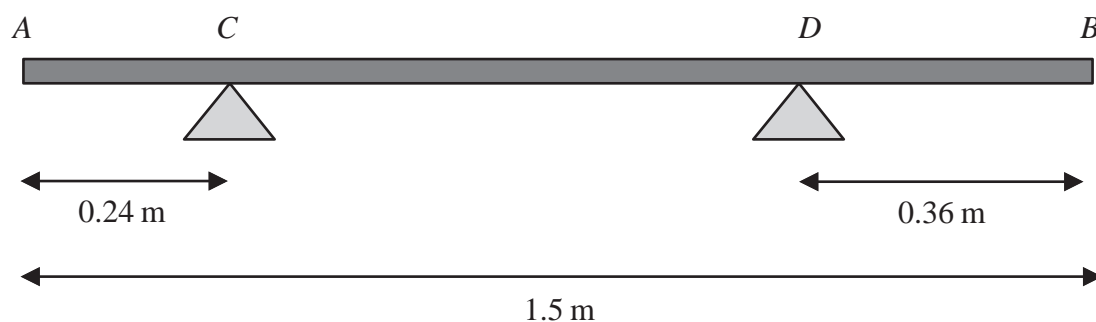
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**Question 3 continued**

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**(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  $AC = 0.24$  m and  $DB = 0.36$  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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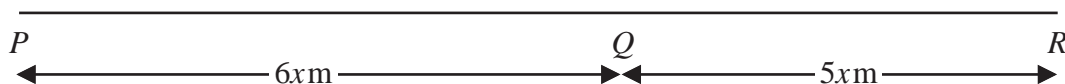
**Question 4 continued**

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**(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  $t = 12 \text{ s}$ , 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)

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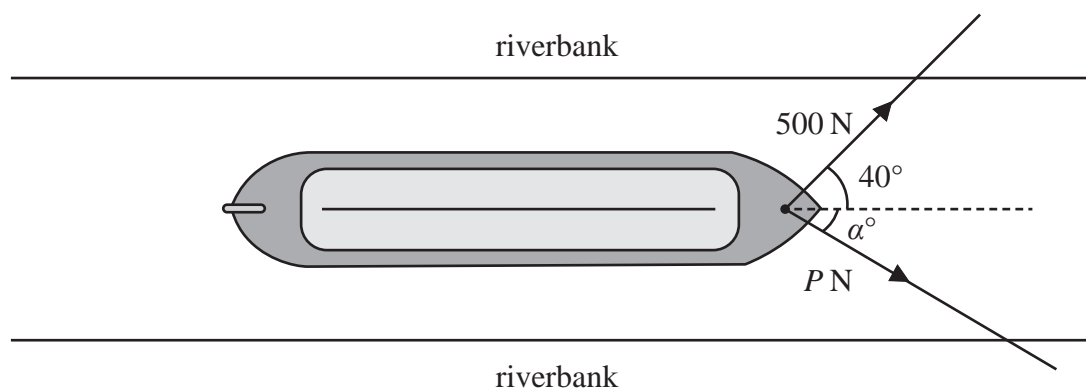
**Question 5 continued**

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**(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  $40^\circ$  to the direction of motion, as shown in Figure 3.
- The tension in the second rope is  $P$  newtons, acting at an angle of  $\alpha^\circ$  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

- the value of  $\alpha$
- the value of  $P$

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**Question 6 continued**

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



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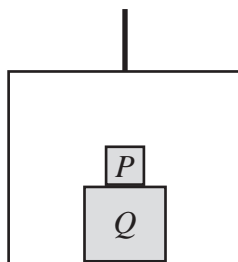


Figure 4

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**

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



8.

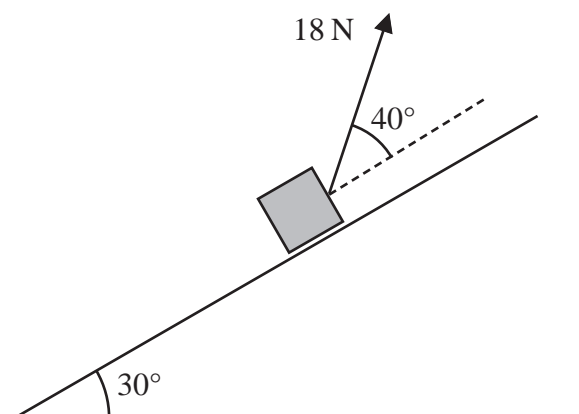


Figure 5

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  $40^\circ$  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  $30^\circ$  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  $AB = 5$  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)

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**Question 8 continued**

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**Question 8 continued**

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(Total for Question 8 is 15 marks)

**TOTAL FOR PAPER: 75 MARKS**

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