

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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**Pearson Edexcel International Advanced Level**

**Thursday 25 May 2023**

Morning (Time: 1 hour 30 minutes)

Paper  
reference

**WME02/01**

## 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.
- 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 7 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 particle  $P$  of mass  $0.3 \text{ kg}$  is moving with velocity  $5\mathbf{i} \text{ ms}^{-1}$

The particle receives an impulse  $\mathbf{I} \text{ N s}$ .

Immediately after receiving the impulse, the velocity of  $P$  is  $(7\mathbf{i} + 7\mathbf{j}) \text{ ms}^{-1}$

- (a) Find the magnitude of  $\mathbf{I}$  (4)
- (b) Find the angle between the direction of  $\mathbf{I}$  and the direction of motion of  $P$  immediately before receiving the impulse. (3)



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Question 1 continued

Handwriting practice area with horizontal lines.

(Total for Question 1 = 7 marks)



2. [In this question, the perpendicular unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are in a horizontal plane.]

**In this question you must show all stages of your working.  
Solutions relying on calculator technology are not acceptable.**

A particle  $P$  is moving on a smooth horizontal plane.

At time  $t$  seconds ( $t \geq 0$ ), the position vector of  $P$ , relative to a fixed point  $O$ , is  $\mathbf{r}$  metres and the velocity of  $P$  is  $\mathbf{v} \text{ ms}^{-1}$  where

$$\mathbf{v} = (4t^2 - 5t)\mathbf{i} + (-10t - 12)\mathbf{j}$$

When  $t = 0$ ,  $\mathbf{r} = 2\mathbf{i} + 6\mathbf{j}$

- (a) Find  $\mathbf{r}$  when  $t = 2$  (4)

When  $t = T$  particle  $P$  is moving in the direction of the vector  $\mathbf{i} - 2\mathbf{j}$

- (b) Find the value of  $T$  (3)

- (c) Find the exact magnitude of the acceleration of  $P$  when  $t = 2.5$  (3)



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Question 2 continued

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Question 2 continued

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Question 2 continued

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(Total for Question 2 = 10 marks)



3.

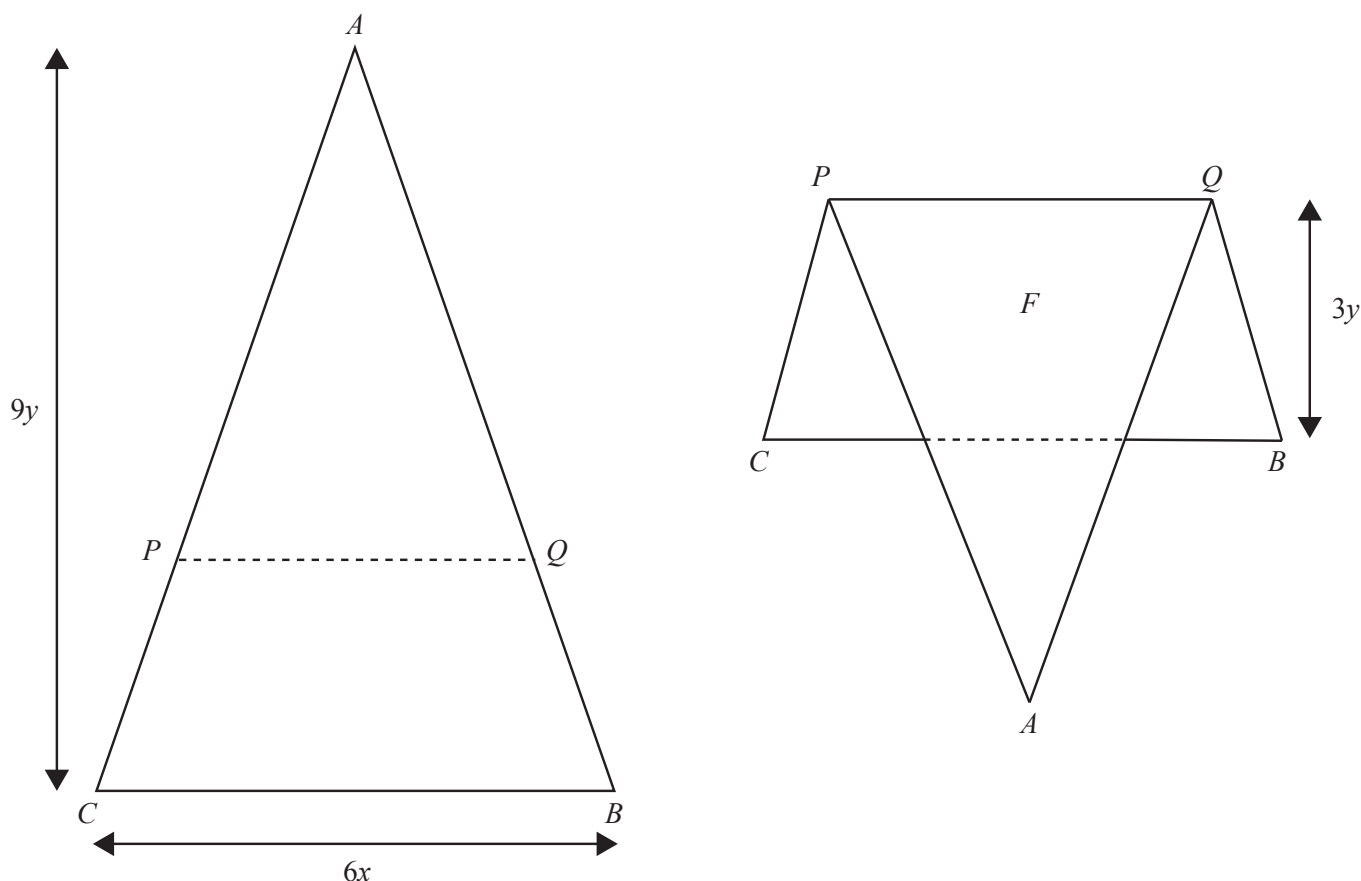


Figure 1

The uniform triangular lamina  $ABC$ , shown in Figure 1, has height  $9y$ , base  $BC = 6x$ , and  $AB = AC$

The points  $P$  and  $Q$  are such that  $AP : PC = AQ : QB = 2 : 1$

The lamina is folded along  $PQ$  to form the folded lamina  $F$

The distance of the centre of mass of  $F$  from  $PQ$  is  $d$

- (a) Show that  $d = \frac{16}{9}y$  (5)

The folded lamina is suspended from  $P$  and hangs freely in equilibrium with  $PQ$  at an angle  $\alpha$  to the downward vertical.

Given that  $\tan \alpha = \frac{64}{81}$

- (b) find  $x$  in terms of  $y$  (3)





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Question 3 continued

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Question 3 continued

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Question 3 continued

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(Total for Question 3 = 8 marks)





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Question 4 continued

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Question 4 continued

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Question 4 continued

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(Total for Question 4 = 12 marks)



5.

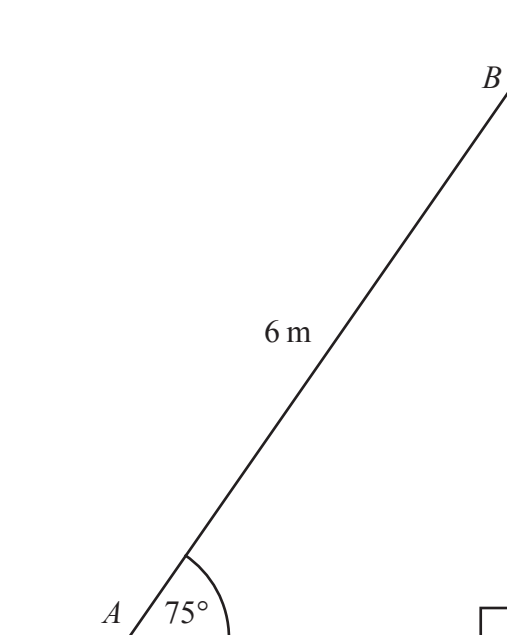


Figure 2

A uniform beam  $AB$ , of mass 15 kg and length 6 m, rests with end  $A$  on rough horizontal ground. The end  $B$  of the beam rests against a rough vertical wall.

The beam is inclined at  $75^\circ$  to the ground, as shown in Figure 2.

The coefficient of friction between the beam and the wall is 0.2

The coefficient of friction between the beam and the ground is  $\mu$

The beam is modelled as a uniform rod which lies in a vertical plane perpendicular to the wall.

The beam rests in limiting equilibrium.

(a) Find the magnitude of the normal reaction between the beam and the wall at  $B$ .

(5)

(b) Find the value of  $\mu$

(6)

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Question 5 continued

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Question 5 continued

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Question 5 continued

Lined area for writing answers.

(Total for Question 5 = 11 marks)



6. A van of mass 900 kg is moving along a straight horizontal road.

The resistance to the motion of the van is modelled as a constant force of magnitude 600 N.

The engine of the van is working at a constant rate of 24 kW.

At the instant when the speed of the van is  $V \text{ ms}^{-1}$ , the acceleration of the van is  $2 \text{ ms}^{-2}$

- (a) Find the value of  $V$

(4)

Later on, the van is towing a trailer of mass 700 kg up a straight road inclined at an angle  $\theta$  to the horizontal, where  $\sin \theta = \frac{1}{14}$

The trailer is attached to the van by a towbar, as shown in Figure 3.

The towbar is parallel to the direction of motion of the van and the trailer.

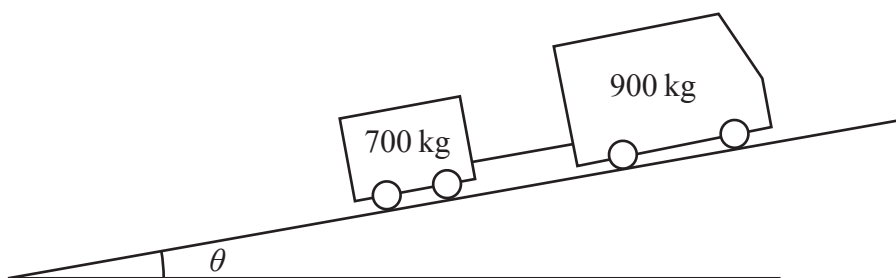


Figure 3

The resistance to the motion of the van from non-gravitational forces is modelled as a constant force of magnitude 600 N.

The resistance to the motion of the trailer from non-gravitational forces is modelled as a constant force of magnitude 550 N.

The towbar is modelled as a light rod.

The engine of the van is working at a constant rate of 24 kW.

- (b) Find the acceleration of the van at the instant when the van and the trailer are moving with speed  $8 \text{ ms}^{-1}$

(4)

At the instant when the van and the trailer are moving up the road at  $9 \text{ ms}^{-1}$ , the towbar breaks. The trailer continues to move in a straight line up the road until it comes to instantaneous rest.

The distance moved by the trailer as it slows from a speed of  $9 \text{ ms}^{-1}$  to instantaneous rest is  $d$  metres.

- (c) Use the work-energy principle to find the value of  $d$ .

(4)



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Question 6 continued

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Question 6 continued

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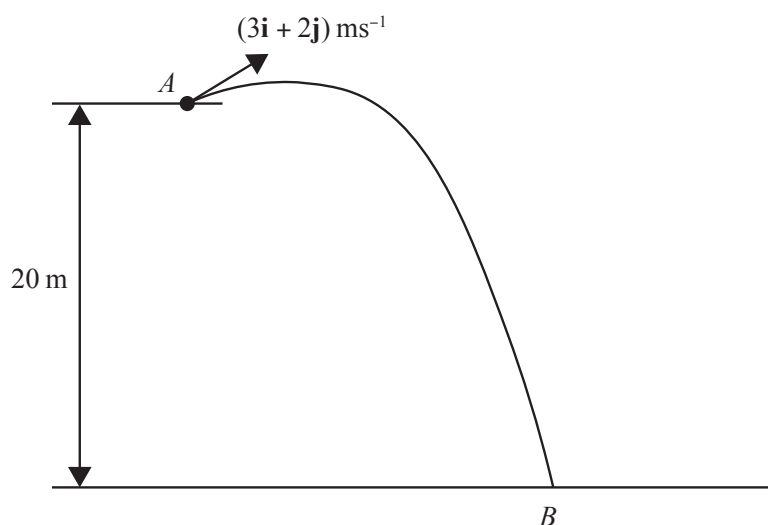
Question 6 continued

Lined area for writing answers.

(Total for Question 6 = 12 marks)



7. [In this question, the perpendicular unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are in a vertical plane with  $\mathbf{i}$  being horizontal and  $\mathbf{j}$  being vertically upwards.]



**Figure 4**

A small ball is projected with velocity  $(3\mathbf{i} + 2\mathbf{j}) \text{ ms}^{-1}$  from the fixed point  $A$ .

The point  $A$  is 20 m above horizontal ground.

The ball hits the ground at the point  $B$ , as shown in Figure 4.

The ball is modelled as a particle moving freely under gravity.

- By considering energy, find the speed of the ball at the instant immediately before it hits the ground. (3)
  - Find the direction of motion of the ball at the instant immediately before it hits the ground. (3)
  - Find the time taken for the ball to travel from  $A$  to  $B$ . (3)
- At the instant when the direction of motion of the ball is perpendicular to  $(3\mathbf{i} + 2\mathbf{j})$  the ball is  $h$  metres above the ground.
- Find the value of  $h$ . (6)

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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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**(Total for Question 7 = 15 marks)**

**TOTAL FOR PAPER IS 75 MARKS**

**END**

