

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

**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  $g = 9.8 \text{ m s}^{-2}$ , 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 ▶**

P69290A

©2021 Pearson Education Ltd.

E:1/1/1/1/

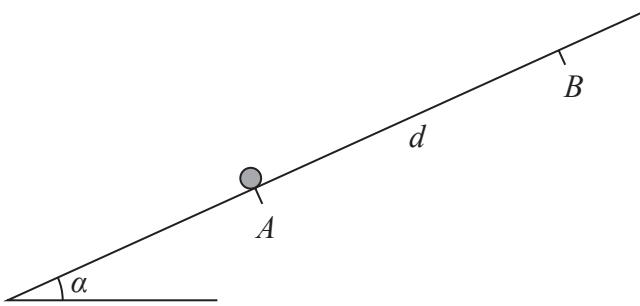


P 6 9 2 9 0 A 0 1 2 8



**Pearson**

1.

**Figure 1**

A particle of mass  $m$  is held at rest at a point  $A$  on a rough plane.

The plane is inclined at an angle  $\alpha$  to the horizontal, where  $\tan \alpha = \frac{5}{12}$

The coefficient of friction between the particle and the plane is  $\frac{1}{5}$

The points  $A$  and  $B$  lie on a line of greatest slope of the plane, with  $B$  above  $A$ , and  $AB = d$ , as shown in Figure 1.

The particle is pushed up the line of greatest slope from  $A$  to  $B$ .

- (a) Show that the work done against friction as the particle moves from  $A$  to  $B$  is  $\frac{12}{65}mgd$  (3)

The particle is then held at rest at  $B$  and released.

- (b) Use the work-energy principle to find, in terms of  $g$  and  $d$ , the speed of the particle at the instant it reaches  $A$ . (4)



**Question 1 continued**

Leave  
blank

**Q1**

**(Total 7 marks)**



P 6 9 2 9 0 A 0 3 2 8

2. A vehicle of mass 450kg is moving on a straight road that is inclined at angle  $\theta$  to the horizontal, where  $\sin \theta = \frac{1}{15}$

At the instant when the vehicle is moving **down** the road at  $12\text{ m s}^{-1}$

- the engine of the vehicle is working at a rate of  $P$  watts
  - the **acceleration** of the vehicle is  $0.5 \text{ m s}^{-2}$
  - the resistance to the motion of the vehicle is modelled as a constant force of magnitude  $R$  newtons

At the instant when the vehicle is moving **up** the road at  $12\text{ m s}^{-1}$

- the engine of the vehicle is working at a rate of  $2P$  watts
  - the **deceleration** of the vehicle is  $0.5 \text{ m s}^{-2}$
  - the resistance to the motion of the vehicle from non-gravitational forces is modelled as a constant force of magnitude  $R$  newtons

Find the value of  $P$ .

(8)



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 2 continued**

Leave  
blank



P 6 9 2 9 0 A 0 5 2 8

Leave  
blank

## **Question 2 continued**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**Question 2 continued**

Leave  
blank

**Q2**

**(Total 8 marks)**



P 6 9 2 9 0 A 0 7 2 8

3. A particle  $P$  moves on the  $x$ -axis.

At time  $t = 0$ ,  $P$  is instantaneously at rest at  $O$ .

At time  $t$  seconds,  $t > 0$ , the  $x$  coordinate of  $P$  is given by

$$x = 2t^{\frac{7}{2}} - 14t^{\frac{5}{2}} + \frac{56}{3}t^{\frac{3}{2}}$$

Find

- (a) the non-zero values of  $t$  for which  $P$  is at instantaneous rest (3)

(b) the total distance travelled by  $P$  in the interval  $0 \leq t \leq 4$  (3)

(c) the acceleration of  $P$  when  $t = 4$  (3)



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**Question 3 continued**

Leave  
blank

**Q3**

**(Total 9 marks)**



P 6 9 2 9 0 A 0 9 2 8

**9**

**Turn over ►**

4. A particle  $P$  of mass  $0.75\text{kg}$  is moving with velocity  $4\mathbf{i}\text{ms}^{-1}$  when it receives an impulse  $\mathbf{J}\text{Ns}$ . Immediately after  $P$  receives the impulse, the speed of  $P$  is  $8\text{ ms}^{-1}$

Given that  $\mathbf{J} = c(-\mathbf{i} + 2\mathbf{j})$ , where  $c$  is a constant, find the two possible values of  $c$ .

(6)

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**Question 4 continued**

Leave  
blank

**Q4**

**(Total 6 marks)**



P 6 9 2 9 0 A 0 1 1 2 8

5.

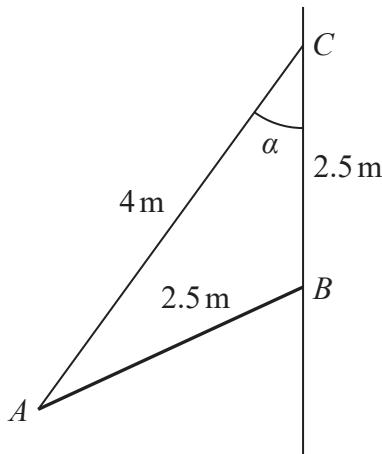


Figure 2

A pole  $AB$  has length 2.5 m and weight 70 N.

The pole rests with end  $B$  against a rough vertical wall. One end of a cable of length 4 m is attached to the pole at  $A$ . The other end of the cable is attached to the wall at the point  $C$ . The point  $C$  is vertically above  $B$  and  $BC = 2.5$  m.

The angle between the cable and the wall is  $\alpha$ , as shown in Figure 2.

The pole is in a vertical plane perpendicular to the wall.

The cable is modelled as a light inextensible string and the pole is modelled as a uniform rod.

Given that  $\tan \alpha = \frac{3}{4}$

- (a) show that the tension in the cable is 56 N.

(4)

Given also that the pole is in limiting equilibrium,

- (b) find the coefficient of friction between the pole and the wall.

(6)

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 5 continued**

Leave  
blank



P 6 9 2 9 0 A 0 1 3 2 8

Leave  
blank

**Question 5 continued**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**Question 5 continued**

Leave  
blank

**Q5**

**(Total 10 marks)**



P 6 9 2 9 0 A 0 1 5 2 8

**15**

**Turn over ►**

6. Two particles,  $A$  and  $B$ , are moving in opposite directions along the same straight line on a smooth horizontal surface when they collide directly. The mass of  $A$  is  $2m$  and the mass of  $B$  is  $3m$ .

Immediately **after** the collision,  $A$  and  $B$  are moving in opposite directions with the same speed  $v$ .

In the collision,  $A$  receives an impulse of magnitude  $5mv$ .

- (a) Find the coefficient of restitution between  $A$  and  $B$ .

(6)

After the collision with  $A$ , particle  $B$  strikes a smooth fixed vertical wall and rebounds. The wall is perpendicular to the direction of motion of the particles. The coefficient of restitution between  $B$  and the wall is  $f$ .

As a result of its collision with  $A$  and with the wall, the total kinetic energy lost by  $B$  is  $E$ . As a result of its collision with  $B$ , the kinetic energy lost by  $A$  is  $2E$ .

- (b) Find the value of  $f$ .

(4)



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 6 continued**

Leave  
blank



P 6 9 2 9 0 A 0 1 7 2 8

Leave  
blank

**Question 6 continued**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**Question 6 continued**

Leave  
blank

**Q6**

**(Total 10 marks)**



P 6 9 2 9 0 A 0 1 9 2 8

7. In this question you may use, without proof, the formula for the centre of mass of a uniform sector of a circle, as given in the formulae book.

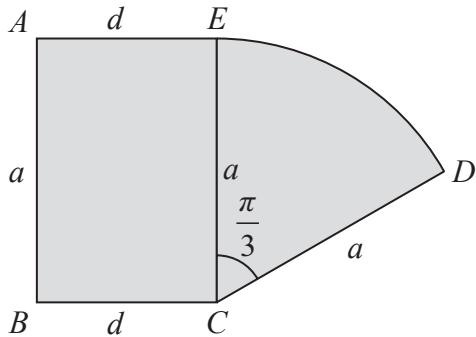


Figure 3

The uniform lamina  $ABCDE$ , shown shaded in Figure 3, is formed by joining a rectangle to a sector of a circle.

- The rectangle  $ABCE$  has  $AB = EC = a$  and  $AE = BC = d$
- The sector  $CDE$  has centre  $C$  and radius  $a$
- Angle  $ECD = \frac{\pi}{3}$  radians

The centre of mass of the lamina lies on  $EC$ .

- (a) Show that  $a = \sqrt{3}d$  (4)

The lamina is freely suspended from  $B$  and hangs in equilibrium with  $BC$  at an angle  $\beta$  radians to the downward vertical.

- (b) Find the value of  $\beta$  (7)



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 7 continued**

Leave  
blank



P 6 9 2 9 0 A 0 2 1 2 8

Leave  
blank

### **Question 7 continued**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**Question 7 continued**

Leave  
blank

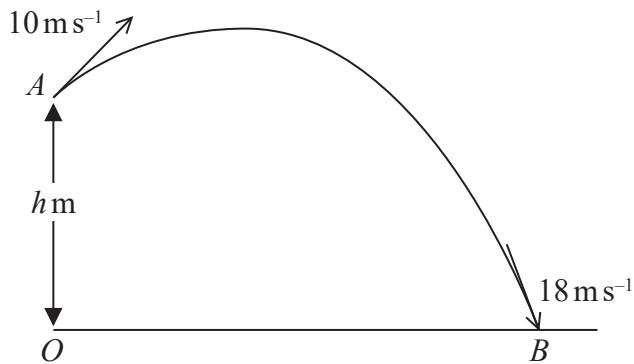
**Q7**

**(Total 11 marks)**



P 6 9 2 9 0 A 0 2 3 2 8

8.



**Figure 4**

The fixed point  $A$  is  $h$  metres vertically above the point  $O$  that is on horizontal ground. At time  $t = 0$ , a particle  $P$  is projected from  $A$  with speed  $10 \text{ m s}^{-1}$ . The particle moves freely under gravity. At time  $t = 2.5$  seconds,  $P$  strikes the ground at the point  $B$ . At the instant when  $P$  strikes the ground, the speed of  $P$  is  $18 \text{ m s}^{-1}$ , as shown in Figure 4.

- (a) By considering energy, find the value of  $h$ . (3)

(b) Find the distance  $OB$ . (5)

As  $P$  moves from  $A$  to  $B$ , the speed of  $P$  is less than or equal to  $8 \text{ m s}^{-1}$  for  $T$  seconds.

- (c) Find the value of  $T$  (6)



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 8 continued**

Leave  
blank



P 6 9 2 9 0 A 0 2 5 2 8

Leave  
blank

**Question 8 continued**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**



**DO NOT WRITE IN THIS AREA**

**DO NOT WRITE IN THIS AREA**

## **Question 8 continued**

Leave  
blank



P 6 9 2 9 0 A 0 2 7 2 8

Leave  
blank

## **Question 8 continued**

**DO NOT WRITE IN THIS AREA**

WRITE IN THIS AREA

**DO NOT WRITE IN THIS AREA**

Q8

**(Total 14 marks)**

END

**TOTAL FOR PAPER IS 75 MARKS**

