

Please check the examination details below before entering your candidate information

Candidate surname

Other names

**Pearson Edexcel  
International  
Advanced Level**

Centre Number

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Candidate Number

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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.
- Good luck with your examination.

**Turn over ▶**

P65794A

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**Pearson**

1. A motorcyclist and his motorcycle have a combined mass of 480 kg.

The motorcyclist drives down a straight road that is inclined at an angle  $\theta$  to the horizontal, where  $\sin \theta = \frac{1}{12}$ , with the engine of the motorcycle working at 3.5 kW. The motorcyclist is moving at a constant speed of  $V \text{ m s}^{-1}$ . The resistance to the motion of the motorcycle is modelled as a constant force with magnitude  $20V$  newtons.

Find the value of  $V$ .

(5)

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Q1

(Total 5 marks)



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2. A particle  $P$  of mass 1.5 kg moves under the action of a single force  $\mathbf{F}$  newtons

At time  $t$  seconds,  $t \geq 0$ ,  $P$  has velocity  $\mathbf{v} \text{ m s}^{-1}$ , where

$$\mathbf{v} = (5t^2 - t^3)\mathbf{i} + (2t^3 - 8t)\mathbf{j}$$

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

(4)

At time  $t = 0$ ,  $P$  is at the origin  $O$ .

- (b) Find the position vector of  $P$  relative to  $O$  at the instant when  $P$  is moving in the direction of the vector  $\mathbf{j}$

(4)



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Q2

(Total 8 marks)

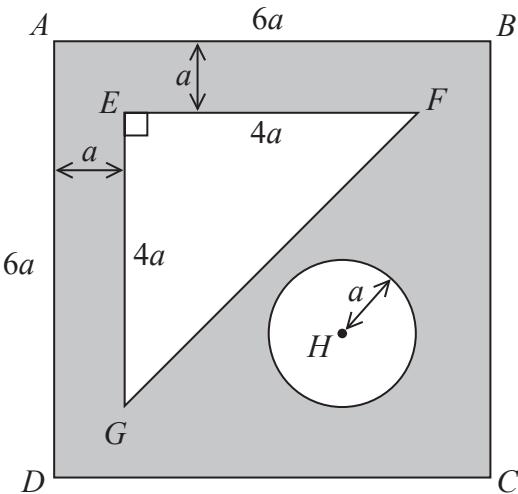
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P 6 5 7 9 4 A 0 5 2 8

3.

**Figure 1**

The uniform lamina  $ABCD$  is a square of side  $6a$ . The template  $T$ , shown shaded in Figure 1, is formed by removing the right-angled triangle  $EFG$  and the circle, centre  $H$  and radius  $a$ , from the square lamina.

Triangle  $EFG$  has  $EF = EG = 4a$ , with  $EF$  parallel to  $AB$  and  $EG$  parallel to  $AD$ . The distance between  $AB$  and  $EF$  is  $a$  and the distance between  $AD$  and  $EG$  is  $a$ .

The point  $H$  lies on  $AC$  and the distance of  $H$  from  $BC$  is  $2a$ .

- (a) Show that the centre of mass of  $T$  is a distance  $\frac{4(67 - 3\pi)}{3(28 - \pi)}a$  from  $AD$ . (5)

The template  $T$  is suspended from the ceiling by two light inextensible vertical strings. One string is attached to  $T$  at  $A$  and the other string is attached to  $T$  at  $B$  so that  $T$  hangs in equilibrium with  $AB$  horizontal.

The weight of  $T$  is  $W$ . The tension in the string attached to  $T$  at  $B$  is  $kW$ , where  $k$  is a constant.

- (b) Find the value of  $k$ , giving your answer to 2 decimal places. (3)



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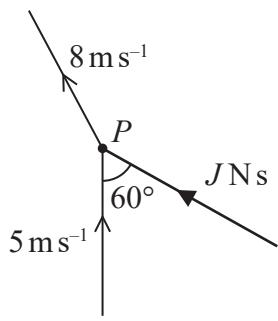
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4.

**Figure 2**

A particle  $P$  of mass  $0.3 \text{ kg}$  is moving with speed  $5 \text{ m s}^{-1}$  along a straight line on a smooth horizontal plane. The particle receives a horizontal impulse of magnitude  $J \text{ N s}$ . The speed of  $P$  immediately after receiving the impulse is  $8 \text{ m s}^{-1}$ . The angle between the direction of motion of  $P$  before it receives the impulse and the direction of the impulse is  $60^\circ$ , as shown in Figure 2.

Find the value of  $J$ .

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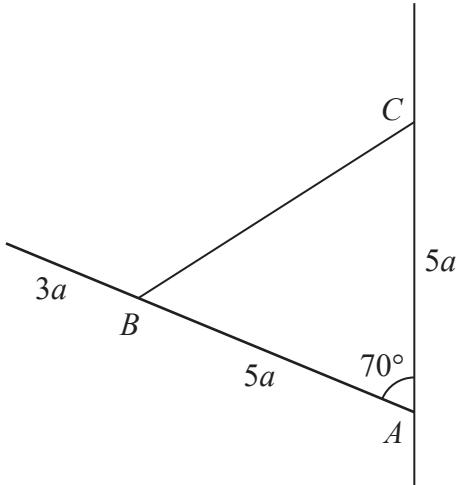
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Q4

(Total 6 marks)



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**Figure 3**

A uniform rod, of length  $8a$  and mass  $M$ , has one end freely hinged to a fixed point  $A$  on a vertical wall. One end of a light inextensible string is attached to the rod at the point  $B$ , where  $AB = 5a$ . The other end of the string is attached to the wall at the point  $C$ , where  $AC = 5a$  and  $C$  is vertically above  $A$ . The rod rests in equilibrium in a vertical plane perpendicular to the wall with angle  $BAC = 70^\circ$ , as shown in Figure 3.

- (a) Find, in terms of  $M$  and  $g$ , the tension in the string.

(3)

The magnitude of the force acting on the rod at  $A$  is  $\lambda Mg$ , where  $\lambda$  is a constant.

- (b) Find, to 2 significant figures, the value of  $\lambda$ .

(6)

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**Q5**

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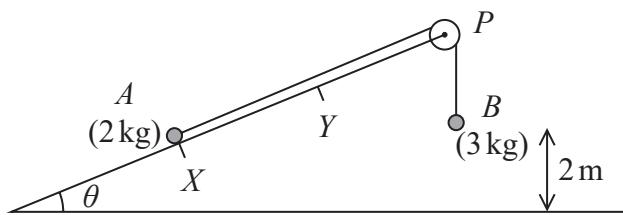


Figure 4

Two particles, A and B, of mass 2 kg and 3 kg respectively, are connected by a light inextensible string. Particle A is held at rest at the point X on a fixed rough ramp that is inclined at an angle  $\theta$  to the horizontal, where  $\tan \theta = \frac{5}{12}$ . The string passes over a small smooth pulley P that is fixed at the top of the ramp. Particle B hangs vertically below P, 2 m above the ground, as shown in Figure 4.

The particles are released from rest with the string taut so that A moves up the ramp and the section of the string from A to P is parallel to a line of greatest slope of the ramp.

The coefficient of friction between A and the ramp is  $\frac{3}{8}$

Air resistance is ignored.

- (a) Find the potential energy lost by the system as A moves 2 m up the ramp.

(3)

- (b) Find the work done against friction as A moves 2 m up the ramp.

(4)

When B hits the ground, B is brought to rest by the impact and does not rebound and A continues to move up the ramp.

- (c) Use the work-energy principle to find the speed of B at the instant before it hits the ground.

(4)

Particle A comes to instantaneous rest at the point Y on the ramp, where XY = (2 + d) m.

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

(4)



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**Q6**

**(Total 15 marks)**



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

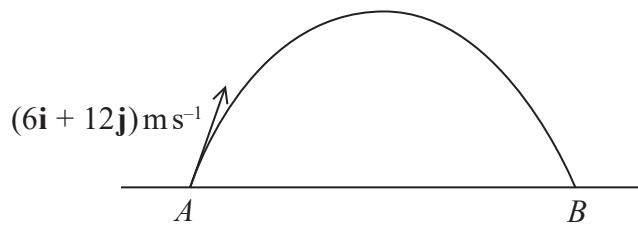


Figure 5

A small ball is projected with velocity  $(6\mathbf{i} + 12\mathbf{j}) \text{ m s}^{-1}$  from a fixed point  $A$  on horizontal ground. The ball hits the ground at the point  $B$ , as shown in Figure 5. The motion of the ball is modelled as a particle moving freely under gravity.

- (a) Find the distance  $AB$ .

(4)

When the height of the ball above the ground is more than  $h$  metres, the speed of the ball is less than  $10 \text{ m s}^{-1}$

- (b) Find the smallest possible value of  $h$ .

(4)

When the ball is at the point  $C$  on its path, the direction of motion of the ball is perpendicular to the direction of motion of the ball at the instant before it hits the ground at  $B$ .

- (c) Find, in terms of  $\mathbf{i}$  and  $\mathbf{j}$ , the velocity of the ball when it is at  $C$ .

(3)

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Q7

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8. Particles  $A$ ,  $B$  and  $C$ , of masses  $2m$ ,  $m$  and  $3m$  respectively, lie at rest in a straight line on a smooth horizontal plane with  $B$  between  $A$  and  $C$ . Particle  $A$  is projected towards particle  $B$  with speed  $2u$  and collides directly with  $B$ .

The coefficient of restitution between each pair of particles is  $e$ .

(a) (i) Show that the speed of  $B$  immediately after the collision with  $A$  is  $\frac{4}{3}u(1+e)$

(ii) Find the speed of  $A$  immediately after the collision with  $B$ .

(7)

At the instant when  $A$  collides with  $B$ , particle  $C$  is projected with speed  $u$  towards  $B$  so that  $B$  and  $C$  collide directly.

(b) Show that there will be a second collision between  $A$  and  $B$ .

(6)

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**Q8**

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**TOTAL FOR PAPER: 75 MARKS**

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