Please check the examination det	ails below	before enteri	ing your candidate information
Candidate surname			Other names
Pearson Edexcel International Advanced Level	Centr	e Number	Candidate Number
Wednesday 2	22 J	anua	ary 2020
Morning (Time: 1 hour 30 minut	es)	Paper Re	ference WME02/01
Mathematics			
International Advance Mechanics M2	ed Suk	osidiary	/Advanced Level
You must have: Mathematical Formulae and Sta	itistical ⁻	Tables (Blue	e), calculator

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 $g = 9.8 \,\mathrm{m \, s^{-2}}$, 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 ▶







A cyclist and his bicycle have a total mass of 75 kg. The cyclist is moving down a straight 1. road that is inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{15}$

The cyclist is working at a constant rate of 56 W. The magnitude of the resistance to motion is modelled as a constant force of magnitude 40 N. At the instant when the speed of the cyclist is $V \text{m s}^{-1}$, his acceleration is $\frac{1}{3} \text{m s}^{-2}$

(5)

Find the value of V .	(5
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Question 1 continued	
	Q1
(Total 5 marks)	
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2.

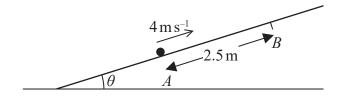


Figure 1

A rough straight ramp is fixed to horizontal ground. The ramp is inclined at an angle θ to the horizontal, where $\sin \theta = \frac{1}{7}$. The points A and B are on a line of greatest slope of the ramp with AB = 2.5 m and B above A, as shown in Figure 1. A package of mass 2 kg is projected up the ramp from A with speed 4 m s⁻¹ and first comes to instantaneous rest at B. The coefficient of friction between the package and the ramp is μ . The package is modelled as a particle.

Use the work-energy principle to find the value of μ .	

Question 2 continued	blank
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(Total 6 marks)	



(7)

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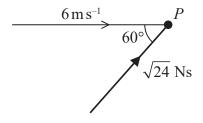


Figure 2

A particle P of mass $0.75\,\mathrm{kg}$ is moving along a straight line on a horizontal surface. At the instant when the speed of P is $6\,\mathrm{m\,s^{-1}}$, it receives an impulse of magnitude $\sqrt{24}\,\mathrm{Ns}$. The impulse acts in the plane of the horizontal surface. At the instant when P receives the impulse, the line of action of the impulse makes an angle of 60° with the direction of motion of P, as shown in Figure 2.

Find

- (i) the speed of P immediately after receiving the impulse,
- (ii) the size of the angle between the direction of motion of P immediately before receiving the impulse and the direction of motion of P immediately after receiving the impulse.

Question 3 continued	blank
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(6)

4. [The centre of mass of a uniform semicircular lamina of radius r is $\frac{4r}{3\pi}$ from the centre.]

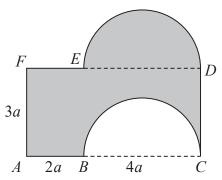


Figure 3

The uniform rectangular lamina ABCDEF has sides AC = FD = 6a and AF = CD = 3a. The point B lies on AC with AB = 2a and the point E lies on E with E is an E-calculated and E-calculated are E-calculated as E-calculated as

The template, T, shown shaded in Figure 3, is formed by removing the semicircular lamina with diameter BC from the rectangular lamina and then fixing this semicircular lamina to the opposite side, FD, of the rectangular lamina. The diameter of the semicircular lamina coincides with ED and the semicircular arc ED is outside the rectangle ABCDEF. All points of T lie in the same plane.

(a) Show that the centre of mass of
$$T$$
 is a distance $\left(\frac{9+2\pi}{6}\right)a$ from AC .

The mass of T is M. A particle of mass kM is attached to T at C. The loaded template is freely suspended from A and hangs in equilibrium with AF at angle ϕ to the downward vertical through A.

Given that $\tan \phi = \frac{3}{2}$

(b) find the value of k.

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Question 4 continued	



Question 4 continued		

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Question 4 continued	
	Q4
	V4
(Total 10 marks)	



5. At time t seconds $(t \ge 0)$, a particle P has velocity $\mathbf{v} \mathbf{m} \mathbf{s}^{-1}$, where

$$\mathbf{v} = (3t^2 - 4)\mathbf{i} + (2t - 4)\mathbf{j}$$

When t = 0, P is at the fixed point O.

(a) Find the acceleration of P at the instant when t = 0

(2)

(b) Find the exact speed of P at the instant when P is moving in the direction of the vector $(11\mathbf{i} + \mathbf{j})$ for the second time.

(4)

(c) Show that *P* never returns to *O*.

(4)

Question 5 continued	_
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(5)

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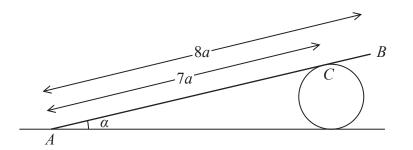


Figure 4

A uniform rod, AB, of weight W and length 8a, rests in equilibrium with the end A on rough horizontal ground. The rod rests on a smooth cylinder. The cylinder is fixed to the ground with its axis horizontal. The point of contact between the rod and the cylinder is C, where AC = 7a, as shown in Figure 4. The rod is resting in a vertical plane that is perpendicular to the axis of the cylinder. The rod makes an angle α with the horizontal.

(a) Show that the normal reaction of the ground on the rod at A has

magnitude
$$W\left(1 - \frac{4}{7}\cos^2\alpha\right)$$
 (6)

Given that the coefficient of friction between the rod and the ground is μ and that $\cos \alpha = \frac{3}{\sqrt{10}}$

(b) find the range of possible values of μ .

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7.

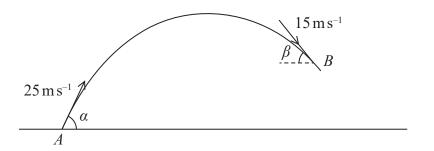


Figure 5

At time t = 0 a particle P is projected from a fixed point A on horizontal ground. The particle is projected with speed $25 \,\mathrm{m\,s^{-1}}$ at an angle α to the ground. The particle moves freely under gravity. At time t = 3 seconds, P is passing through the point B with speed $15 \,\mathrm{m\,s^{-1}}$ and is moving downwards at an angle β to the horizontal, as shown in Figure 5.

(a) By considering energy, find the height of B above the ground.

(3)

(b) Find the size of angle α .

(3)

(c) Find the size of angle β .

(3)

(d) Find the least speed of P as P travels from A to B.

(2)

As P travels from A to B, the speed, $v \text{ m s}^{-1}$, of P is such that $v \leq 15$ for an interval of T seconds.

(e) Find the value of T.

(3)



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(12)

8. A particle *A* has mass 4*m* and a particle *B* has mass 3*m*. The particles are moving along the same straight line on a smooth horizontal plane. They are moving in opposite directions towards each other and collide directly.

Immediately before the collision the speed of A is 2u and the speed of B is 3u.

The direction of motion of each particle is reversed by the collision.

The total kinetic energy lost in the collision is $\frac{473}{24}$ mu²

Find

- (i) the coefficient of restitution between A and B,
- (ii) the magnitude of the impulse received by A in the collision.



uestion 8 continued	



Question 8 continued

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