

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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I declare this is my own work.

INTERNATIONAL A-LEVEL FURTHER MATHEMATICS

(9665/FM05) Unit FM2 Mechanics

Time allowed: 1 hour 30 minutes

Materials

- For this paper you must have the Oxford International AQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphic calculator.

Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to two significant figures, unless stated otherwise.
- Unless stated otherwise, the acceleration due to gravity, g , should be taken as 9.8 m s^{-2}

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

For Examiner's Use	
Question	Mark
1	
2	
3	
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6	
7	
8	
9	
TOTAL	



J U N 2 2 F M 0 5 0 1

1B/G/Jun22/E7

FM05

Answer **all** questions in the spaces provided.

- 1** Two particles, A and B , are moving on a smooth horizontal surface when they collide and coalesce to form a single particle.

The mass of A is 2 kg and before the collision it has velocity $\mathbf{v} \text{ m s}^{-1}$

The mass of B is 3 kg and before the collision it has velocity $\mathbf{w} \text{ m s}^{-1}$

During the collision the impulse on B is $(-5\mathbf{i} - 4\mathbf{j}) \text{ N s}$

After the collision the single particle moves with velocity $(2\mathbf{i} - 3\mathbf{j}) \text{ m s}^{-1}$

- 1 (a)** Find $\mathbf{w}$

[3 marks]

Answer _____

- 1 (b)** Find $\mathbf{v}$

[3 marks]

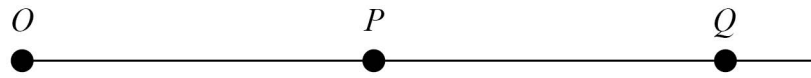
Answer _____



- 2** A force, F newtons, is the only force that acts on a body of mass 6 kg moving on a straight line.

The points O , P and Q lie on this line, as shown below.

Not to scale



The force acts in the direction OQ

When the displacement of the body is x metres from O , F is given by $F = 5\sqrt{x}$

At P , $x = 4$ and the body is moving towards Q with speed 4 m s^{-1}

At Q , $x = 9$

- 2 (a)** Find the work done by the force on the body as it moves from P to Q

[3 marks]

Answer _____

- 2 (b)** Find the speed of the body at Q giving your answer to three significant figures.

[3 marks]

Answer _____



When the particle is 0.2 metres from the equilibrium position, it has a speed of $\sqrt{21} \text{ m s}^{-1}$

[4 marks]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Answer _____



3 (b) Find the period of the motion.

[3 marks]

Answer _____

3 (c) Calculate the maximum speed of the particle.

[1 mark]

Answer _____

8

Turn over ►



At time t seconds the bead has velocity $v \text{ m s}^{-1}$

The velocity of the bead is always positive.

A resistance force of magnitude kv^2 newtons acts on the bead as it moves.

$$v = \frac{mU}{m + ktU}$$

[5 marks]

[illegible]

- 4 (b)** Find, in terms of m , k and U the time that it takes for the velocity of the bead to reduce to 90% of its initial value.

[3 marks]

Answer _____

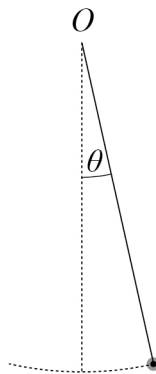
8

Turn over for the next question

Turn over ►



At time t seconds, the string makes an angle θ radians with the vertical through O as shown in the diagram.



[4 marks]

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5 (b) Find the period of the motion.

[2 marks]

Answer _____

5 (c) Find the time that it takes for θ to decrease from $\frac{\pi}{24}$ to $\frac{\pi}{36}$

[4 marks]

Answer _____

10

Turn over ►



The line OA is a line of greatest slope of the plane.

[4 marks]

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Answer



[7 marks]

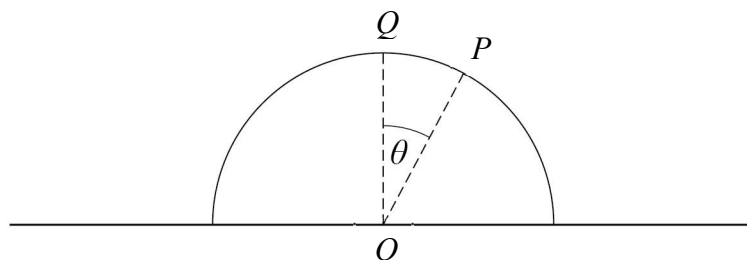
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11

A particle P is initially at the highest point Q of a smooth upturned hemisphere of radius r metres and centre O

The particle is set into motion with an initial horizontal velocity of magnitude $U \text{ m s}^{-1}$

As the particle moves on the hemisphere, the angle between OQ and OP is θ as shown in the diagram.



[8 marks]

[illegible]

Answer _____

- 7 (b) State, with a reason, whether or not your answer to **part (a)** would change if the mass of the particle was decreased.

[2 marks]

- 7 (c) State, with a reason, whether or not your answer to **part (a)** would change if the radius of the hemisphere was decreased.

[2 marks]



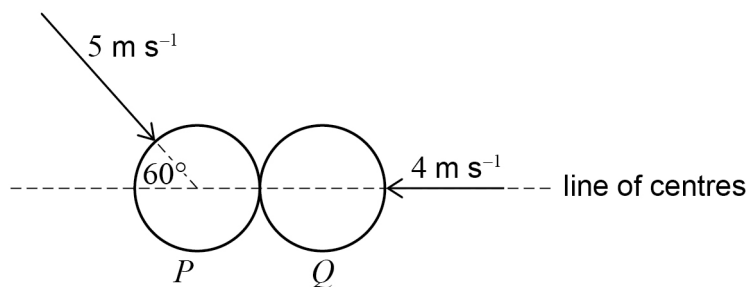
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outside the
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8 Two smooth spheres P and Q have the same radius and move on a horizontal surface and collide.

The mass of P is 3 kg and the mass of Q is 2 kg

Before the collision the speed of P is 5 m s^{-1} and the speed of Q is 4 m s^{-1}

The diagram shows the directions of the velocities of the spheres before the collision.



The coefficient of restitution between the spheres is $\frac{2}{5}$

Find the speeds of the spheres after the collision, giving your answer to three significant figures.

[10 marks]

[illegible]

[illegible]

Speed of P = _____ Speed of Q = _____

10



[illegible]

9



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ANSWER IN THE SPACES PROVIDED**



[illegible]

Question number	Additional page, if required. Write the question numbers in the left-hand margin.
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