

Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	



General Certificate of Education
Advanced Level Examination
June 2010

Mathematics

MM2B

Unit Mechanics 2B

Friday 18 June 2010 1.30 pm to 3.00 pm

For this paper you must have:

- the blue AQA booklet of formulae and statistical tables.
- You may use a graphics calculator.

Time allowed

- 1 hour 30 minutes

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.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer the questions in the spaces provided. Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.
- Take $g = 9.8 \text{ m s}^{-2}$, unless stated otherwise.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

Advice

- Unless stated otherwise, you may quote formulae, without proof, from the booklet.



J U N 1 0 M M 2 B 0 1

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

- 1** A particle moves along a straight line through the origin. At time t , the displacement, s , of the particle from the origin is given by

$$s = 5t^2 + 3 \cos 4t$$

Find the velocity of the particle at time t . (3 marks)

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QUESTION
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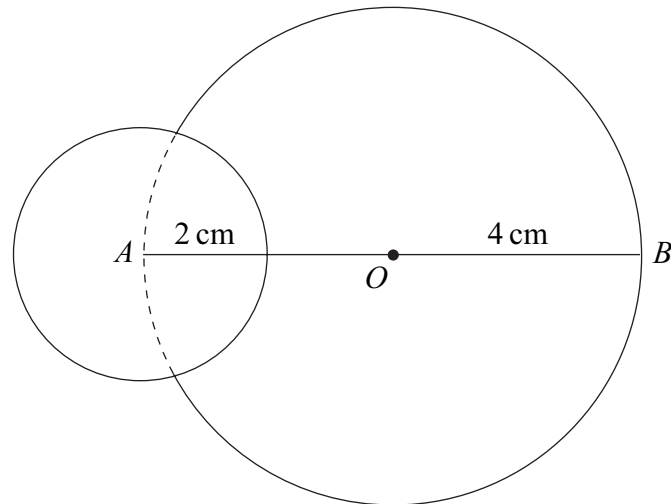
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0 5

- 3** A uniform circular lamina, of radius 4 cm and mass 0.4 kg, has a centre O , and AB is a diameter. To create a medal, a smaller uniform circular lamina, of radius 2 cm and mass 0.1 kg, is attached so that the centre of the smaller lamina is at the point A , as shown in the diagram.



- (a) Explain why the centre of mass of the medal is on the line AB . (1 mark)
- (b) Find the distance of the centre of mass of the medal from the point B . (3 marks)

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4 A particle has mass 200 kg and moves on a smooth horizontal plane. A single horizontal force, $\left(400 \cos\left(\frac{\pi}{2}t\right)\mathbf{i} + 600t^2\mathbf{j}\right)$ newtons, acts on the particle at time t seconds.

The unit vectors \mathbf{i} and \mathbf{j} are directed east and north respectively.

(a) Find the acceleration of the particle at time t . *(2 marks)*

(b) When $t = 4$, the velocity of the particle is $(-3\mathbf{i} + 56\mathbf{j}) \text{ m s}^{-1}$.

Find the velocity of the particle at time t . *(5 marks)*

(c) Find t when the particle is moving due west. *(3 marks)*

(d) Find the speed of the particle when it is moving due west. *(2 marks)*

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5

A particle is moving along a straight line. At time t , the velocity of the particle is v . The acceleration of the particle throughout the motion is $-\frac{\lambda}{v^4}$, where λ is a positive constant. The velocity of the particle is u when $t = 0$.

Find v in terms of u , λ and t .

(7 marks)

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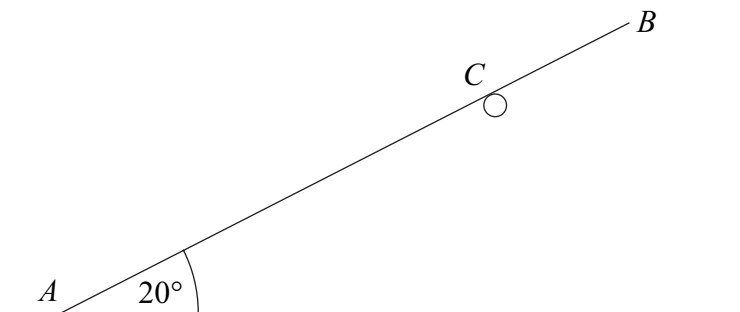
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7 A uniform rod AB , of length 4 m and mass 6 kg, rests in equilibrium with one end, A , on smooth horizontal ground. The rod rests on a rough horizontal peg at the point C , where AC is 3 m. The rod is inclined at an angle of 20° to the horizontal.



- (a)** Draw a diagram to show the forces acting on the rod. (2 marks)
- (b)** Find the magnitude of the normal reaction force between the rod and the ground. (3 marks)
- (c) (i)** Find the normal reaction acting on the rod at C .
- (ii)** Find the friction force acting on the rod at C . (5 marks)
- (d)** In this position, the rod is on the point of slipping.
Calculate the coefficient of friction between the rod and the peg. (2 marks)

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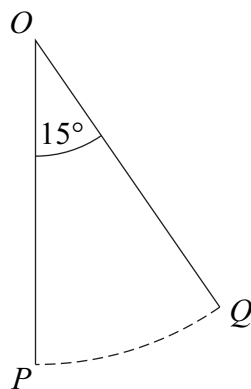
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8

A particle is attached to one end of a light inextensible string of length 3 metres. The other end of the string is attached to a fixed point O . The particle is set into motion horizontally at point P with speed v , so that it describes part of a vertical circle whose centre is O . The point P is vertically below O .



The particle first comes momentarily to rest at the point Q , where OQ makes an angle of 15° to the vertical.

(a) Find the value of v . (4 marks)

(b) When the particle is at rest at the point Q , the tension in the string is 22 newtons.

Find the mass of the particle. (3 marks)

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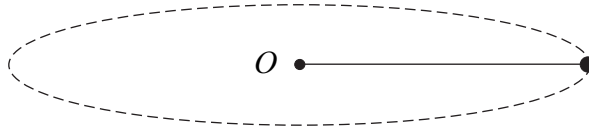
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9

A particle, of mass 8 kg, is attached to one end of a length of elastic string. The particle is placed on a smooth horizontal surface. The other end of the elastic string is attached to a point O fixed on the horizontal surface.

The elastic string has natural length 1.2 m and modulus of elasticity 192 N.



The particle is set in motion on the horizontal surface so that it moves in a circle, centre O , with constant speed 3 m s^{-1} .

Find the radius of the circle.

(8 marks)

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END OF QUESTIONS



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ANSWER IN THE SPACES PROVIDED**

