

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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4	
5	
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7	
8	
9	
TOTAL	



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)

QUESTION  
PART  
REFERENCE





**2** John is at the top of a cliff, looking out over the sea. He throws a rock, of mass 3 kg, horizontally with a velocity of  $4 \text{ m s}^{-1}$ .

The rock falls a vertical distance of 51 metres to reach the surface of the sea.

- (a) Calculate the kinetic energy of the rock when it is thrown. *(2 marks)*
- (b) Calculate the potential energy lost by the rock when it reaches the surface of the sea. *(2 marks)*
- (c) (i) Find the kinetic energy of the rock when it reaches the surface of the sea.
- (ii) Hence find the speed of the rock when it reaches the surface of the sea. *(4 marks)*
- (d) State one modelling assumption which has been made. *(1 mark)*

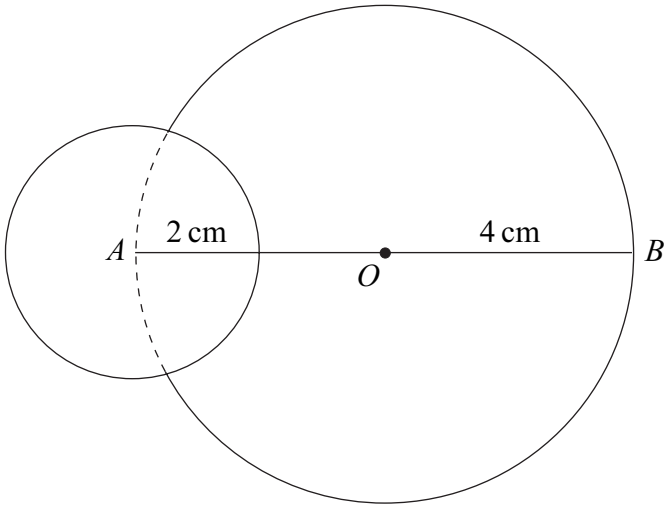
QUESTION  
PART  
REFERENCE





**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)

QUESTION  
PART  
REFERENCE

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QUESTION  
PART  
REFERENCE

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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)*

QUESTION PART REFERENCE

A series of horizontal dotted lines for writing answers.







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  $\lambda$  is a positive constant. The velocity of the particle is  $u$  when  $t = 0$ .

Find  $v$  in terms of  $u$ ,  $\lambda$  and  $t$ .

(7 marks)

QUESTION  
PART  
REFERENCE

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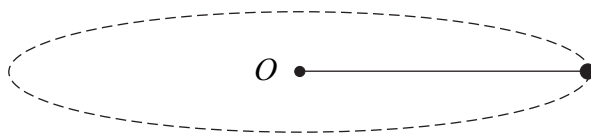




9

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  $3 \text{ m s}^{-1}$ .

Find the radius of the circle.

(8 marks)

QUESTION  
PART  
REFERENCE

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QUESTION  
PART  
REFERENCE

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**END OF QUESTIONS**



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ANSWER IN THE SPACES PROVIDED**

