

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education  
Advanced Level Examination  
January 2012

# Mathematics

**MM2B**

## Unit Mechanics 2B

**Wednesday 25 January 2012 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.
- You do not necessarily need to use all the space provided.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
<b>TOTAL</b>	



J A N 1 2 M M 2 B 0 1

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

- 1** A plane is dropping packets of aid as it flies over a flooded village. The speed of a packet when it leaves the plane is  $60 \text{ m s}^{-1}$ . The packet has mass  $25 \text{ kg}$ .
- The packet falls a vertical distance of  $34 \text{ metres}$  to reach the ground.
- (a) Calculate the kinetic energy of the packet when it leaves the plane. (2 marks)
- (b) Calculate the potential energy lost by the packet as it falls to the ground. (2 marks)
- (c) Assume that the effect of air resistance on the packet as it falls can be neglected.
- (i) Find the kinetic energy of the packet when it reaches the ground. (2 marks)
- (ii) Hence find the speed of the packet when it reaches the ground. (2 marks)

QUESTION  
PART  
REFERENCE



QUESTION  
PART  
REFERENCE

Turn over ►



- 2** A particle, of mass 50 kg, moves on a smooth horizontal plane. A single horizontal force

$$[(300t - 60t^2)\mathbf{i} + 100e^{-2t}\mathbf{j}] \text{ newtons}$$

acts on the particle at time  $t$  seconds.

The vectors  $\mathbf{i}$  and  $\mathbf{j}$  are perpendicular unit vectors.

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

- (b)** When  $t = 0$ , the velocity of the particle is  $(7\mathbf{i} - 4\mathbf{j}) \text{ m s}^{-1}$ .

Find the velocity of the particle at time  $t$ . (4 marks)

- (c)** Calculate the speed of the particle when  $t = 1$ . (4 marks)

QUESTION  
PART  
REFERENCE



QUESTION  
PART  
REFERENCE

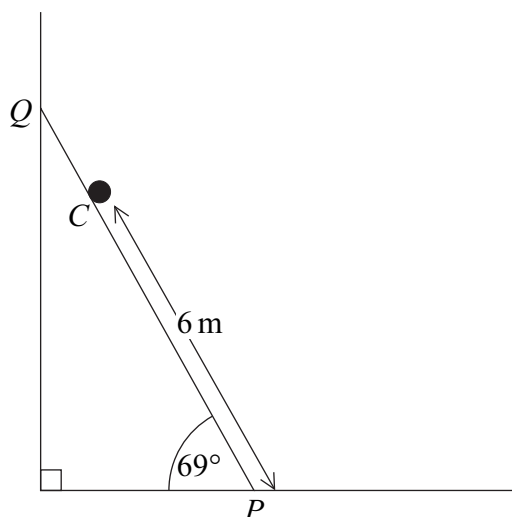
Turn over ►



3

A uniform ladder  $PQ$ , of length 8 metres and mass 28 kg, rests in equilibrium with its foot,  $P$ , on a rough horizontal floor and its top,  $Q$ , leaning against a smooth vertical wall. The vertical plane containing the ladder is perpendicular to the wall and the angle between the ladder and the floor is  $69^\circ$ .

A man, of mass 72 kg, is standing at the point  $C$  on the ladder so that the distance  $PC$  is 6 metres. The man may be modelled as a particle at  $C$ .



- (a) Draw a diagram to show the forces acting on the ladder. (2 marks)
- (b) With the man standing at the point  $C$ , the ladder is on the point of slipping.
- (i) Show that the magnitude of the reaction between the ladder and the vertical wall is 256 N, correct to three significant figures. (4 marks)
- (ii) Find the coefficient of friction between the ladder and the horizontal floor. (4 marks)

QUESTION  
PART  
REFERENCE




QUESTION  
PART  
REFERENCE

Turn over ►



QUESTION  
PART  
REFERENCE



QUESTION  
PART  
REFERENCE

Turn over ►



**4** A car travels along a straight horizontal road. When its speed is  $v \text{ m s}^{-1}$ , the car experiences a resistance force of magnitude  $25v$  newtons.

**(a)** The car has a maximum constant speed of  $42 \text{ m s}^{-1}$  on this road.

Show that the power being used to propel the car at this speed is 44 100 watts.

(2 marks)

**(b)** The car has mass 1500 kg.

Find the acceleration of the car when it is travelling at  $15 \text{ m s}^{-1}$  on this road under a power of 44 100 watts.

(4 marks)

QUESTION  
PART  
REFERENCE



[illegible]

A parcel is placed on a flat rough horizontal surface in a van. The van is travelling along a horizontal road. It travels around a bend of radius 34 m at a constant speed. The coefficient of friction between the parcel and the horizontal surface in the van is 0.85.

QUESTION	PART	REFERENCE
----------	------	-----------

[illegible]

[illegible]

P47647/Jan12/MM2B



**(a)** Show that  $\frac{dv}{dt} = -10(v - 0.5)$ . (2 marks)

**(b)** By using  $\int \frac{1}{v - 0.5} dv = -\int 10 dt$ , find  $v$  in terms of  $t$ . (5 marks)

**(c)** Find the time taken for the toy's velocity to reduce to  $0.55 \text{ m s}^{-1}$ . (3 marks)

[illegible]

[illegible]

The diagram shows a circle with center  $O$ . A vertical line segment connects  $O$  to point  $B$  on the circle. A horizontal line segment connects  $B$  to point  $A$  on the circle. The angle at  $B$  is labeled  $u$ .

(ii) Find the ratio  $u:v$ . (2 marks)

QUESTION	PART	REFERENCE
----------	------	-----------

This image shows a blank sheet of white paper designed for handwriting practice. It features ten horizontal blue dashed lines spaced evenly down the page. A single solid black vertical line runs parallel to the left edge, creating a narrow margin. The rest of the page is open space between the margin line and the right edge, suitable for writing practice.



[illegible]

P47647/Jan12/MM2B



[illegible]

[illegible]

P47647/Jan12/MM2B



The particle is pulled so that it is at the point  $A$ , on the surface, 3 metres from the point  $O$ .

- 
- A horizontal number line with three points marked: A, O, and B. Point O is the origin. A double-headed arrow above the line indicates a distance of 3 m from A to O. Another double-headed arrow below the line indicates a distance of 5 m from O to B.

**(e)** Hence, or otherwise, find the total distance travelled by the particle after it is released from the point  $A$ . *(1 mark)*

QUESTION	PART	REFERENCE
----------	------	-----------



[illegible]

[illegible]

This image shows a blank sheet of white paper designed for handwriting practice. It features a solid vertical line on the left side, creating a narrow margin. The rest of the page is filled with evenly spaced horizontal dashed lines, providing guides for letter height and placement. There are no other markings, text, or illustrations on the page.



**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**

