

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education  
Advanced Subsidiary Examination  
June 2009

# Mathematics

# MM1B

## Unit Mechanics 1B

**Specimen paper for examinations in June 2010 onwards**

**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 space 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.
- Unit Mechanics 1B has a **written paper only**.

**Advice**

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

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

# MM1B

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

- 1** Two particles,  $A$  and  $B$ , are moving on a smooth horizontal surface when they collide. During the collision, the two particles coalesce to form a single combined particle. Particle  $A$  has mass 3 kg and particle  $B$  has mass 7 kg.

Before the collision, the velocity of  $A$  is  $\begin{bmatrix} 6 \\ -2 \end{bmatrix} \text{ m s}^{-1}$  and the velocity of  $B$  is  $\begin{bmatrix} -1 \\ 4 \end{bmatrix} \text{ m s}^{-1}$ .

- (a)** Find the velocity of the combined particle after the collision. *(3 marks)*
- (b)** Find the speed of the combined particle after the collision. *(2 marks)*

QUESTION  
PART  
REFERENCE





**2** A lift is travelling upwards and accelerating uniformly. During a 5 second period, it travels 16 metres and the speed of the lift increases from  $u \text{ m s}^{-1}$  to  $4.2 \text{ m s}^{-1}$ .

**(a)** Find  $u$ . (3 marks)

**(b)** Find the acceleration of the lift. (3 marks)

QUESTION  
PART  
REFERENCE

A large rectangular area containing horizontal dotted lines for writing answers.



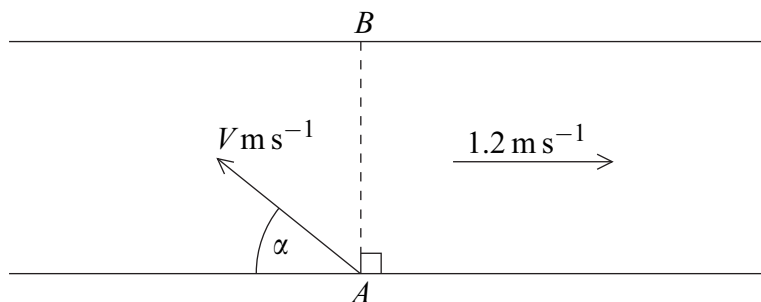






4 A river has parallel banks which are 16 metres apart. The water in the river flows at  $1.2 \text{ m s}^{-1}$  parallel to the banks. A boat sets off from one bank at the point  $A$  and travels perpendicular to the bank so that it reaches the point  $B$ , which is directly opposite the point  $A$ . It takes the boat 10 seconds to cross the river.

The velocity of the boat relative to the water has magnitude  $V \text{ m s}^{-1}$  and is at an angle  $\alpha$  to the bank, as shown in the diagram.



- (a) Show that the magnitude of the resultant velocity of the boat is  $1.6 \text{ m s}^{-1}$ . (1 mark)
- (b) Find  $V$ . (3 marks)
- (c) Find  $\alpha$ . (2 marks)
- (d) State one modelling assumption that you needed to make about the boat. (1 mark)

QUESTION  
PART  
REFERENCE

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....





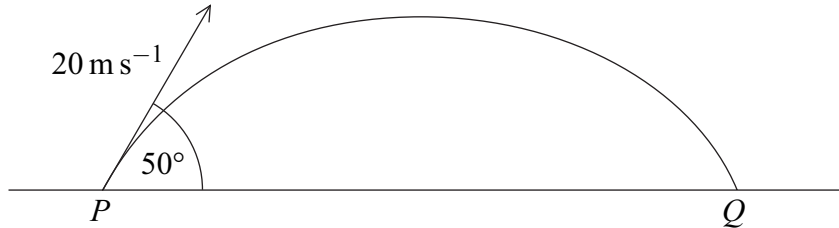






**6**

A ball is kicked from the point  $P$  on a horizontal surface. It leaves the surface with a velocity of  $20 \text{ m s}^{-1}$  at an angle of  $50^\circ$  above the horizontal and hits the surface for the first time at the point  $Q$ . Assume that the ball is a particle that moves only under the influence of gravity.



- (a) Show that the time that it takes the ball to travel from  $P$  to  $Q$  is  $3.13 \text{ s}$ , correct to three significant figures. (4 marks)
- (b) Find the distance between the points  $P$  and  $Q$ . (2 marks)
- (c) If a heavier ball were projected from  $P$  with the same velocity, how would the distance between  $P$  and  $Q$ , calculated using the same modelling assumptions, compare with your answer to part **(b)**? Give a reason for your answer. (2 marks)
- (d) Find the maximum height of the ball above the horizontal surface. (3 marks)
- (e) State the magnitude and direction of the velocity of the ball as it hits the surface. (2 marks)

QUESTION  
PART  
REFERENCE

A large rectangular area containing horizontal dashed lines, intended for writing the student's answers to the questions above.





7

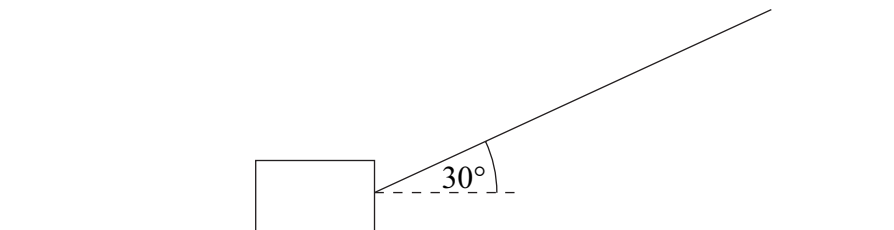
A particle moves on a smooth horizontal plane. It is initially at the point  $A$ , with position vector  $(9\mathbf{i} + 7\mathbf{j})$  m, and has velocity  $(-2\mathbf{i} + 2\mathbf{j})$  m s<sup>-1</sup>. The particle moves with a constant acceleration of  $(0.25\mathbf{i} + 0.3\mathbf{j})$  m s<sup>-2</sup> for 20 seconds until it reaches the point  $B$ . The unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are directed east and north respectively.

- (a) Find the velocity of the particle at the point  $B$ . (3 marks)
- (b) Find the velocity of the particle when it is travelling due north. (4 marks)
- (c) Find the position vector of the point  $B$ . (3 marks)
- (d) Find the average velocity of the particle as it moves from  $A$  to  $B$ . (2 marks)

QUESTION  
PART  
REFERENCE



- 8** The diagram shows a block, of mass 20 kg, being pulled along a rough horizontal surface by a rope inclined at an angle of  $30^\circ$  to the horizontal.



The coefficient of friction between the block and the surface is  $\mu$ . Model the block as a particle which slides on the surface.

- (a)** If the tension in the rope is 60 newtons, the block moves at a constant speed.
- (i)** Show that the magnitude of the normal reaction force acting on the block is 166 N. *(3 marks)*
- (ii)** Find  $\mu$ . *(4 marks)*
- (b)** If the rope remains at the same angle and the block accelerates at  $0.8 \text{ m s}^{-2}$ , find the tension in the rope. *(5 marks)*

QUESTION  
PART  
REFERENCE





QUESTION  
PART  
REFERENCE

Area with horizontal dotted lines for writing.

**END OF QUESTIONS**



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

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



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

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



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

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

