

Centre Number						Candidate Number				
Surname										
Other Names										
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



General Certificate of Education  
Advanced Subsidiary Examination  
June 2012

# Mathematics

# MM1B

## Unit Mechanics 1B

Thursday 24 May 2012 9.00 am to 10.30 am

**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 each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- 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.
- You do not necessarily need to use all the space provided.



J U N 1 2 M M 1 B 0 1

Answer **all** questions.

Answer each question in the space provided for that question.

- 1** As a boat moves, it travels at  $5 \text{ m s}^{-1}$  due north, relative to the water. The water is moving due west at  $2 \text{ m s}^{-1}$ .
- (a) Find the magnitude of the resultant velocity of the boat. *(2 marks)*
- (b) Find the bearing of the resultant velocity of the boat. *(3 marks)*

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**2**

Two toy trains,  $A$  and  $B$ , are moving in the same direction on a straight horizontal track when they collide. As they collide, the speed of  $A$  is  $4\text{ m s}^{-1}$  and the speed of  $B$  is  $3\text{ m s}^{-1}$ . Immediately after the collision, they move together with a speed of  $3.8\text{ m s}^{-1}$ .

The mass of  $A$  is  $2\text{ kg}$ . Find the mass of  $B$ .

*(3 marks)*

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- 3** A car is travelling at a speed of  $20 \text{ m s}^{-1}$  along a straight horizontal road. The driver applies the brakes and a constant braking force acts on the car until it comes to rest.
- (a)** Assume that no other horizontal forces act on the car.
- (i)** After the car has travelled 75 metres, its speed has reduced to  $10 \text{ m s}^{-1}$ . Find the acceleration of the car. *(3 marks)*
  - (ii)** Find the time taken for the speed of the car to reduce from  $20 \text{ m s}^{-1}$  to zero. *(2 marks)*
  - (iii)** Given that the mass of the car is 1400 kg, find the magnitude of the constant braking force. *(2 marks)*
- (b)** Given that a constant air resistance force of magnitude 200 N acts on the car during the motion, find the magnitude of the constant braking force. *(1 mark)*

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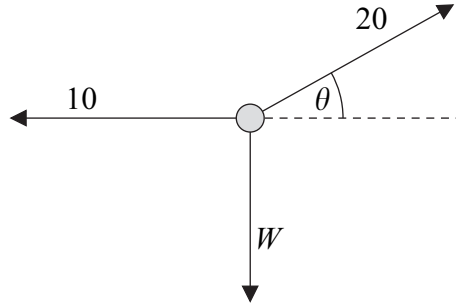
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**4** A particle, of weight  $W$  newtons, is held in equilibrium by two forces of magnitudes 10 newtons and 20 newtons. The 10-newton force is horizontal and the 20-newton force acts at an angle  $\theta$  above the horizontal, as shown in the diagram. All three forces act in the same vertical plane.



- (a) Find  $\theta$ . (3 marks)
- (b) Find  $W$ . (2 marks)
- (c) Calculate the mass of the particle. (2 marks)

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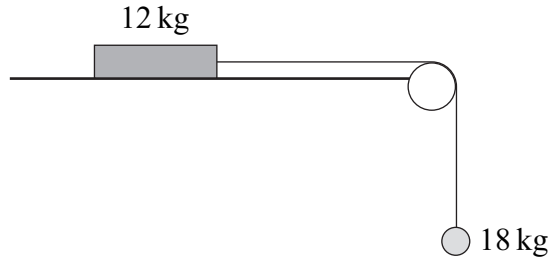
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- 5** A block, of mass 12 kg, lies on a horizontal surface. The block is attached to a particle, of mass 18 kg, by a light inextensible string which passes over a smooth fixed peg. Initially, the block is held at rest so that the string supports the particle, as shown in the diagram.



The block is then released.

- (a)** Assuming that the surface is smooth, use two equations of motion to find the magnitude of the acceleration of the block and particle. *(4 marks)*
- (b)** In reality, the surface is rough and the acceleration of the block is  $3 \text{ m s}^{-2}$ .
  - (i)** Find the tension in the string. *(3 marks)*
  - (ii)** Calculate the magnitude of the normal reaction force acting on the block. *(1 mark)*
  - (iii)** Find the coefficient of friction between the block and the surface. *(5 marks)*
- (c)** State two modelling assumptions, other than those given, that you have made in answering this question. *(2 marks)*

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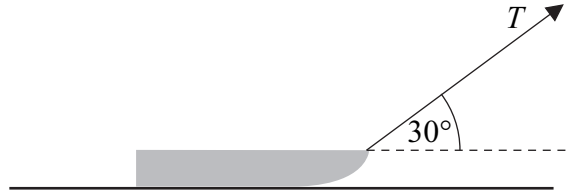
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A child pulls a sledge, of mass 8 kg, along a rough horizontal surface, using a light rope. The coefficient of friction between the sledge and the surface is 0.3. The tension in the rope is  $T$  newtons. The rope is kept at an angle of  $30^\circ$  to the horizontal, as shown in the diagram.



Model the sledge as a particle.

- (a) Draw a diagram to show all the forces acting on the sledge. (1 mark)
- (b) Find the magnitude of the normal reaction force acting on the sledge, in terms of  $T$ . (3 marks)
- (c) Given that the sledge accelerates at  $0.05 \text{ m s}^{-2}$ , find  $T$ . (6 marks)

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7 A particle moves with a constant acceleration of  $(0.1\mathbf{i} - 0.2\mathbf{j}) \text{ m s}^{-2}$ . It is initially at the origin where it has velocity  $(-\mathbf{i} + 3\mathbf{j}) \text{ m s}^{-1}$ . The unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are directed east and north respectively.

- (a) Find an expression for the position vector of the particle  $t$  seconds after it has left the origin. *(2 marks)*
- (b) Find the time that it takes for the particle to reach the point where it is due east of the origin. *(3 marks)*
- (c) Find the speed of the particle when it is travelling south-east. *(6 marks)*

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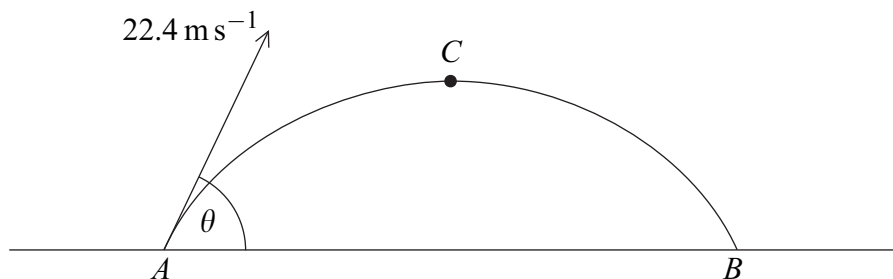
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- 8** A particle is launched from the point  $A$  on a horizontal surface, with a velocity of  $22.4 \text{ m s}^{-1}$  at an angle  $\theta$  above the horizontal, as shown in the diagram.



After 2 seconds, the particle reaches the point  $C$ , where it is at its maximum height above the surface.

- (a) Show that  $\sin \theta = 0.875$ . (3 marks)
- (b) Find the height of the point  $C$  above the horizontal surface. (3 marks)
- (c) The particle returns to the surface at the point  $B$ . Find the distance between  $A$  and  $B$ . (3 marks)
- (d) Find the length of time during which the height of the particle above the surface is greater than 5 metres. (5 marks)
- (e) Find the minimum speed of the particle. (2 marks)

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**END OF QUESTIONS**

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