

General Certificate of Education  
January 2007  
Advanced Subsidiary Examination



**MATHEMATICS**  
**Unit Mechanics 1B**

**MM1B**

Friday 12 January 2007 9.00 am to 10.30 am

**For this paper you must have:**

- an 8-page answer book
- the **blue** AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 30 minutes

**Instructions**

- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MM1B.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- 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 maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Unit Mechanics 1B has a **written paper only**.

**Advice**

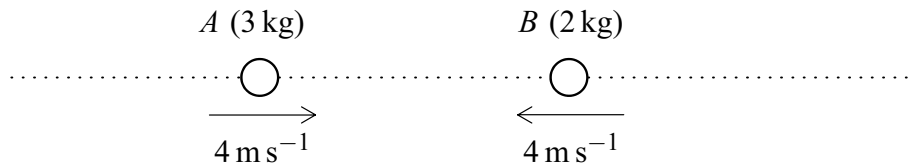
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

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Answer **all** questions.

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- 1 Two particles  $A$  and  $B$  have masses of 3 kg and 2 kg respectively. They are moving along a straight horizontal line towards each other. Each particle is moving with a speed of  $4 \text{ m s}^{-1}$  when they collide.



- (a) If the particles coalesce during the collision to form a single particle, find the speed of the combined particle after the collision. *(3 marks)*
- (b) If, after the collision,  $A$  moves in the same direction as before the collision with speed  $0.4 \text{ m s}^{-1}$ , find the speed of  $B$  after the collision. *(3 marks)*
- 2 A lift rises vertically from rest with a constant acceleration.

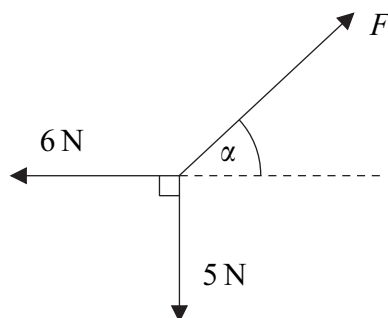
After 4 seconds, it is moving upwards with a velocity of  $2 \text{ m s}^{-1}$ .

It then moves with a constant velocity for 5 seconds.

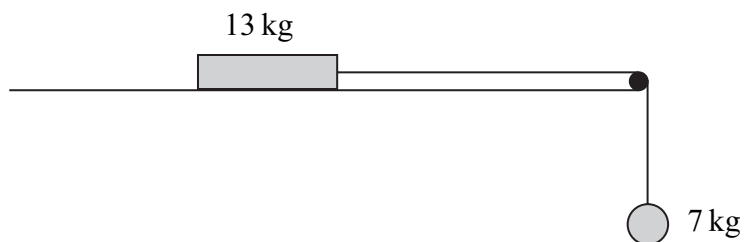
The lift then slows down uniformly, coming to rest after it has been moving for a total of 12 seconds.

- (a) Sketch a velocity–time graph for the motion of the lift. *(4 marks)*
- (b) Calculate the total distance travelled by the lift. *(2 marks)*
- (c) The lift is raised by a single vertical cable. The mass of the lift is 300 kg. Find the maximum tension in the cable during this motion. *(4 marks)*

- 3 The diagram shows three forces which act in the same plane and are in equilibrium.



- (a) Find  $F$ . (3 marks)
- (b) Find  $\alpha$ . (3 marks)
- 4 The diagram shows a block, of mass 13 kg, on a rough horizontal surface. It is attached by a string that passes over a smooth peg to a sphere of mass 7 kg, as shown in the diagram.

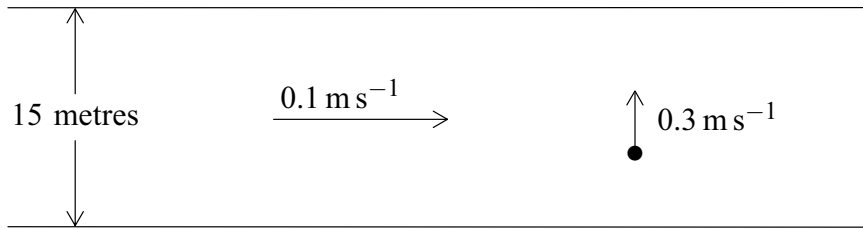


The system is released from rest, and after 4 seconds the block and the sphere both have speed  $6 \text{ m s}^{-1}$ , and the block has **not** reached the peg.

- (a) State **two** assumptions that you should make about the string in order to model the motion of the sphere and the block. (2 marks)
- (b) Show that the acceleration of the sphere is  $1.5 \text{ m s}^{-2}$ . (2 marks)
- (c) Find the tension in the string. (3 marks)
- (d) Find the coefficient of friction between the block and the surface. (6 marks)

Turn over ►

- 5 A girl in a boat is rowing across a river, in which the water is flowing at  $0.1 \text{ m s}^{-1}$ . The velocity of the boat relative to the water is  $0.3 \text{ m s}^{-1}$  and is perpendicular to the bank, as shown in the diagram.



- (a) Find the magnitude of the resultant velocity of the boat. *(2 marks)*
- (b) Find the acute angle between the resultant velocity and the bank. *(3 marks)*
- (c) The width of the river is 15 metres.
- (i) Find the time that it takes the boat to cross the river. *(2 marks)*
- (ii) Find the total distance travelled by the boat as it crosses the river. *(2 marks)*
- 6 A trolley, of mass 100 kg, rolls at a constant speed along a straight line down a slope inclined at an angle of  $4^\circ$  to the horizontal.

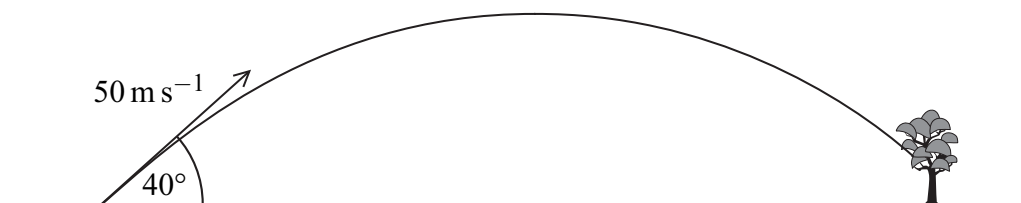
Assume that a constant resistance force, of magnitude  $P$  newtons, acts on the trolley as it moves. Model the trolley as a particle.

- (a) Draw a diagram to show the forces acting on the trolley. *(1 mark)*
- (b) Show that  $P = 68.4 \text{ N}$ , correct to three significant figures. *(3 marks)*
- (c) (i) Find the acceleration of the trolley if it rolls down a slope inclined at  $5^\circ$  to the horizontal and experiences the same constant force of magnitude  $P$  that you found in part (b). *(4 marks)*
- (ii) Make one criticism of the assumption that the resistance force on the trolley is constant. *(1 mark)*

- 7 A golf ball is struck from a point on horizontal ground so that it has an initial velocity of  $50 \text{ m s}^{-1}$  at an angle of  $40^\circ$  above the horizontal.

Assume that the golf ball is a particle and its weight is the only force that acts on it once it is moving.

- (a) Find the maximum height of the golf ball. (4 marks)
- (b) After it has reached its maximum height, the golf ball descends but hits a tree at a point which is at a height of 6 metres above ground level.



Find the time that it takes for the ball to travel from the point where it was struck to the tree. (6 marks)

- 8 A particle is initially at the origin, where it has velocity  $(5\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$ . It moves with a constant acceleration  $\mathbf{a} \text{ m s}^{-2}$  for 10 seconds to the point with position vector  $75\mathbf{i}$  metres.

- (a) Show that  $\mathbf{a} = 0.5\mathbf{i} + 0.4\mathbf{j}$ . (3 marks)
- (b) Find the position vector of the particle 8 seconds after it has left the origin. (3 marks)
- (c) Find the position vector of the particle when it is travelling parallel to the unit vector  $\mathbf{i}$ . (6 marks)

**END OF QUESTIONS**

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