

General Certificate of Education  
June 2008  
Advanced Subsidiary Examination



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

**MM1B**

Monday 2 June 2008 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 black ink or black 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**

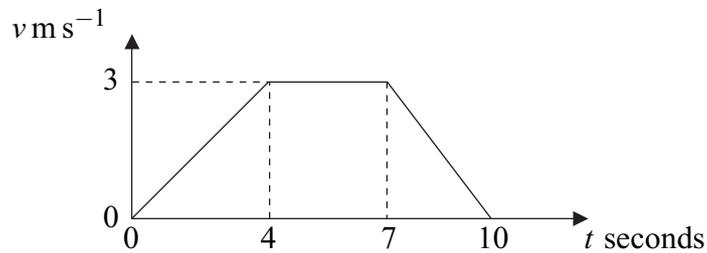
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Unit Mechanics 1B has a **written paper only**.

**Advice**

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

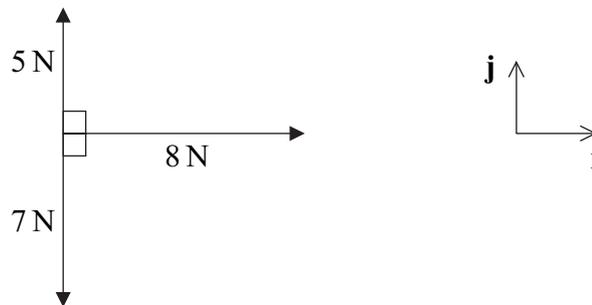
Answer **all** questions.

1 The diagram shows a velocity–time graph for a lift.



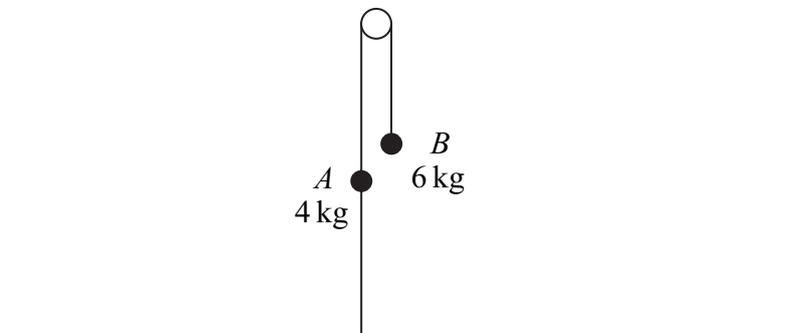
- (a) Find the distance travelled by the lift. (3 marks)
- (b) Find the acceleration of the lift during the first 4 seconds of the motion. (1 mark)
- (c) The lift is raised by a single vertical cable. The mass of the lift is 400 kg. Find the tension in the cable during the first 4 seconds of the motion. (3 marks)

2 The diagram shows three forces and the perpendicular unit vectors **i** and **j**, which all lie in the same plane.



- (a) Express the resultant of the three forces in terms of **i** and **j**. (2 marks)
- (b) Find the magnitude of the resultant force. (2 marks)
- (c) Draw a diagram to show the direction of the resultant force, and find the angle that it makes with the unit vector **i**. (3 marks)

- 3 Two particles,  $A$  and  $B$ , have masses  $4\text{ kg}$  and  $6\text{ kg}$  respectively. They are connected by a light inextensible string that passes over a smooth fixed peg. A second light inextensible string is attached to  $A$ . The other end of this string is attached to the ground directly below  $A$ . The system remains at rest, as shown in the diagram.

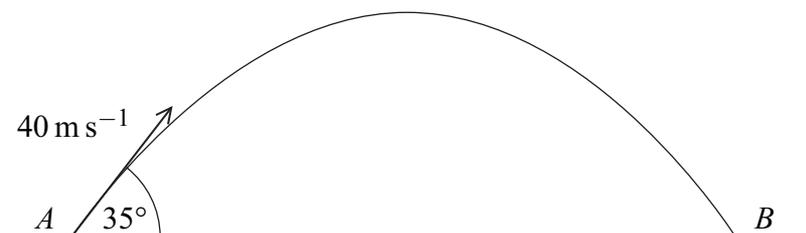


- (a) (i) Write down the tension in the string connecting  $A$  and  $B$ . *(1 mark)*
- (ii) Find the tension in the string connecting  $A$  to the ground. *(3 marks)*
- (b) The string connecting particle  $A$  to the ground is cut. Find the acceleration of  $A$  after the string has been cut. *(5 marks)*
- 4 An aeroplane is travelling due north at  $180\text{ m s}^{-1}$  relative to the air. The air is moving north-west at  $50\text{ m s}^{-1}$ .
- (a) Find the magnitude of the resultant velocity of the aeroplane. *(4 marks)*
- (b) Find the direction of the resultant velocity, giving your answer as a three-figure bearing to the nearest degree. *(4 marks)*
- 5 The unit vectors  $\mathbf{i}$  and  $\mathbf{j}$  are directed east and north respectively. A helicopter moves horizontally with a constant acceleration of  $(-0.4\mathbf{i} + 0.5\mathbf{j})\text{ m s}^{-2}$ . At time  $t = 0$ , the helicopter is at the origin and has velocity  $20\mathbf{i}\text{ m s}^{-1}$ .
- (a) Write down an expression for the velocity of the helicopter at time  $t$  seconds. *(2 marks)*
- (b) Find the time when the helicopter is travelling due north. *(3 marks)*
- (c) Find an expression for the position vector of the helicopter at time  $t$  seconds. *(2 marks)*
- (d) When  $t = 100$ :
- (i) show that the helicopter is due north of the origin; *(3 marks)*
- (ii) find the speed of the helicopter. *(3 marks)*

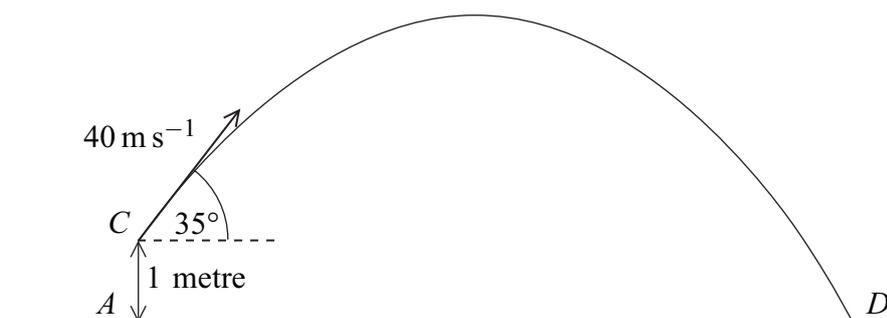
**Turn over ►**

- 6 A block, of mass 5 kg, slides down a rough plane inclined at  $40^\circ$  to the horizontal. When modelling the motion of the block, assume that there is no air resistance acting on it.
- Draw and label a diagram to show the forces acting on the block. (1 mark)
  - Show that the magnitude of the normal reaction force acting on the block is 37.5 N, correct to three significant figures. (2 marks)
  - Given that the acceleration of the block is  $0.8 \text{ m s}^{-2}$ , find the coefficient of friction between the block and the plane. (6 marks)
  - In reality, air resistance does act on the block. State how this would change your value for the coefficient of friction and explain why. (2 marks)
- 7 A ball is hit by a bat so that, when it leaves the bat, its velocity is  $40 \text{ m s}^{-1}$  at an angle of  $35^\circ$  above the horizontal. Assume that the ball is a particle and that its weight is the only force that acts on the ball after it has left the bat.

- A simple model assumes that the ball is hit from the point  $A$  and lands for the first time at the point  $B$ , which is at the same level as  $A$ , as shown in the diagram.



- Show that the time that it takes for the ball to travel from  $A$  to  $B$  is 4.68 seconds, correct to three significant figures. (4 marks)
  - Find the horizontal distance from  $A$  to  $B$ . (2 marks)
- A revised model assumes that the ball is hit from the point  $C$ , which is 1 metre above  $A$ . The ball lands at the point  $D$ , which is at the same level as  $A$ , as shown in the diagram.



- Find the time that it takes for the ball to travel from  $C$  to  $D$ . (6 marks)

8 Two particles,  $A$  and  $B$ , are travelling towards each other along a straight horizontal line.

Particle  $A$  has velocity  $2 \text{ m s}^{-1}$  and mass  $m \text{ kg}$ .

Particle  $B$  has velocity  $-2 \text{ m s}^{-1}$  and mass  $3 \text{ kg}$ .



The particles collide.

- (a) If the particles move in opposite directions after the collision, each with speed  $0.5 \text{ m s}^{-1}$ , find the value of  $m$ . *(3 marks)*
- (b) If the particles coalesce during the collision, forming a single particle which moves with speed  $0.5 \text{ m s}^{-1}$ , find the two possible values of  $m$ . *(5 marks)*

**END OF QUESTIONS**

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