

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

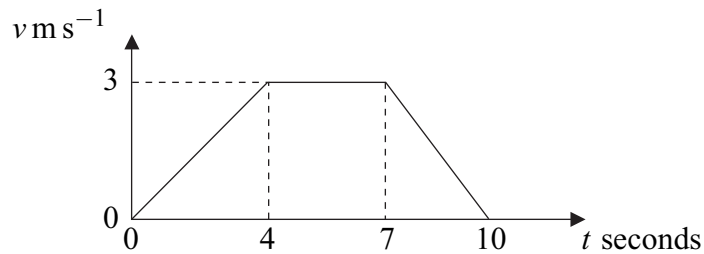
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Unit Mechanics 1B has a **written paper only**.

Advice

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

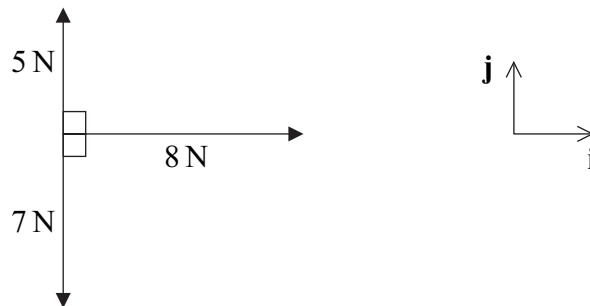
Answer **all** questions.

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



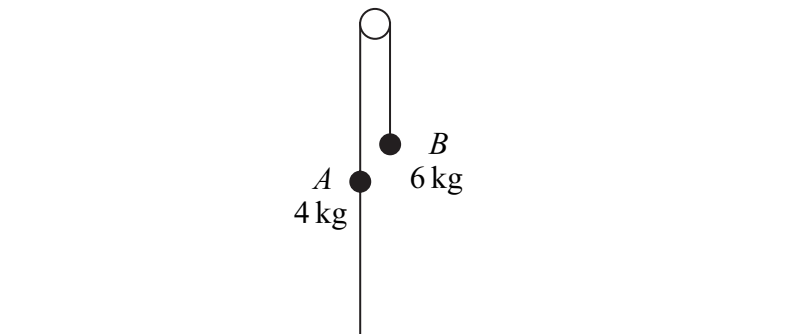
- (a) Find the distance travelled by the lift. (3 marks)
- (b) Find the acceleration of the lift during the first 4 seconds of the motion. (1 mark)
- (c) The lift is raised by a single vertical cable. The mass of the lift is 400 kg. Find the tension in the cable during the first 4 seconds of the motion. (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 kg and 6 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.

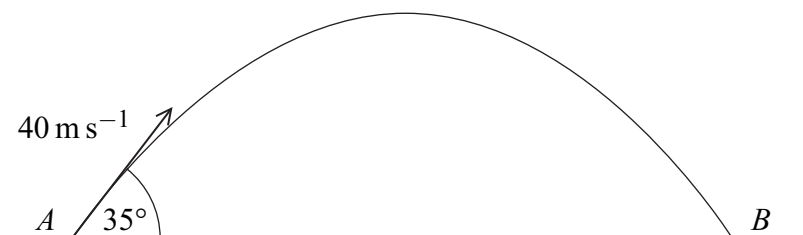


- (a) (i) Write down the tension in the string connecting A and B . (1 mark)
- (ii) Find the tension in the string connecting A to the ground. (3 marks)
- (b) The string connecting particle A to the ground is cut. Find the acceleration of A after the string has been cut. (5 marks)
- 4 An aeroplane is travelling due north at 180 m s^{-1} relative to the air. The air is moving north-west at 50 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)

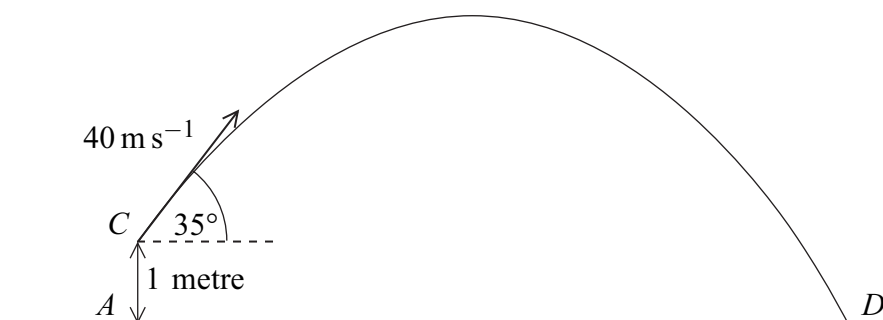
Turn over ►

- 6 A block, of mass 5 kg, slides down a rough plane inclined at 40° 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 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 m s^{-1} at an angle of 35° 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.

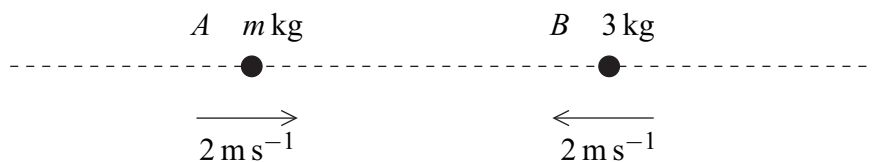


Find the time that it takes for the ball to travel from C to D . (6 marks)

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

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

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



The particles collide.

- (a) If the particles move in opposite directions after the collision, each with speed 0.5 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 m s^{-1} , find the two possible values of m . *(5 marks)*

END OF QUESTIONS

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