

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

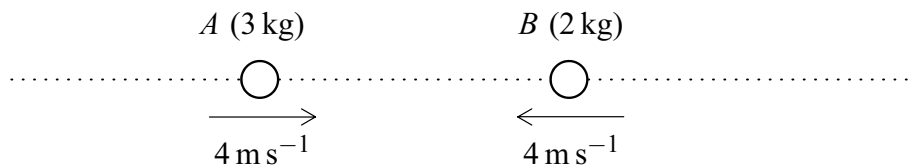
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Unit Mechanics 1B has a **written paper only**.

Advice

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

Answer **all** questions.

- 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 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 m s^{-1} , find the speed of B after the collision. *(3 marks)*
- 2 A lift rises vertically from rest with a constant acceleration.

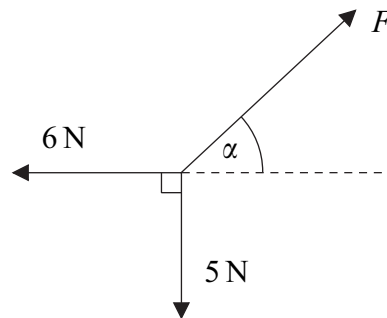
After 4 seconds, it is moving upwards with a velocity of 2 m s^{-1} .

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)*

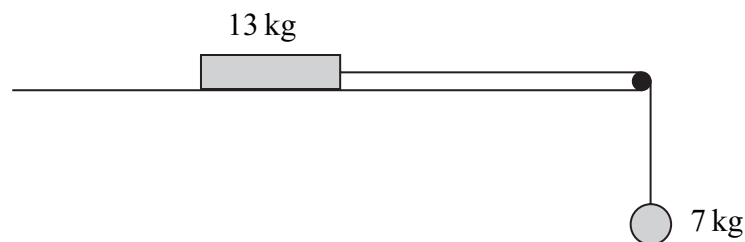
3 The diagram shows three forces which act in the same plane and are in equilibrium.



(a) Find F . (3 marks)

(b) Find α . (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 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)

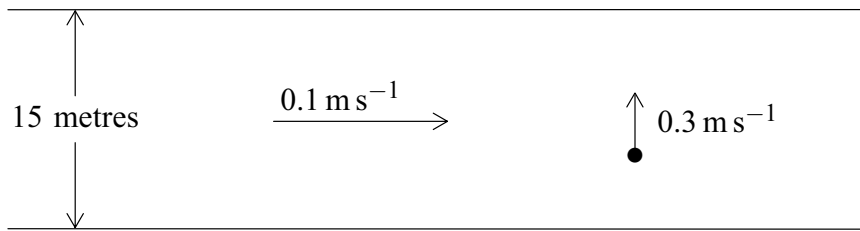
(b) Show that the acceleration of the sphere is 1.5 m s^{-2} . (2 marks)

(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 m s^{-1} . The velocity of the boat relative to the water is 0.3 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° to the horizontal.

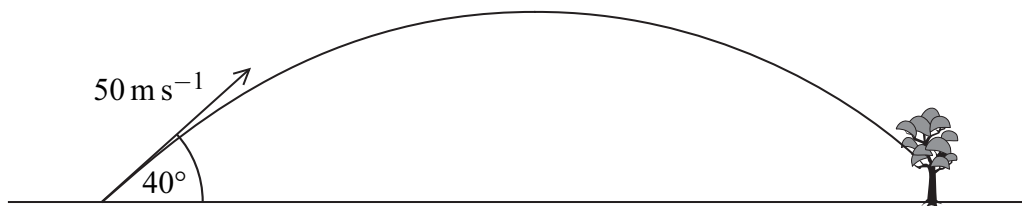
Assume that a constant resistance force, of magnitude P newtons, acts on the trolley as it moves. Model the trolley as a particle.

- (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° 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 m s^{-1} at an angle of 40° 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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