General Certificate of Education
June 2008
Advanced Subsidiary Examination

MATHEMATICS **MM1B**
Unit Mechanics 1B

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

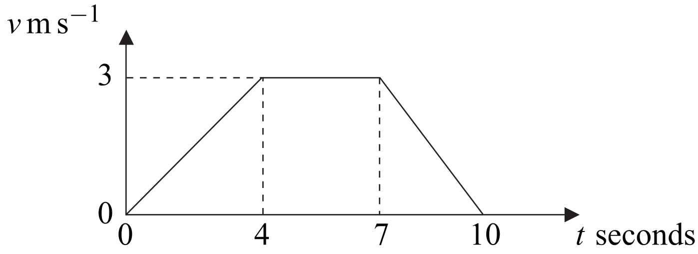
Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MM1B.
- Answer **all** questions.
- Show all necessary working; otherwise 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 $g = 9.8\,\mathrm{m\,s^{-2}}$, 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.

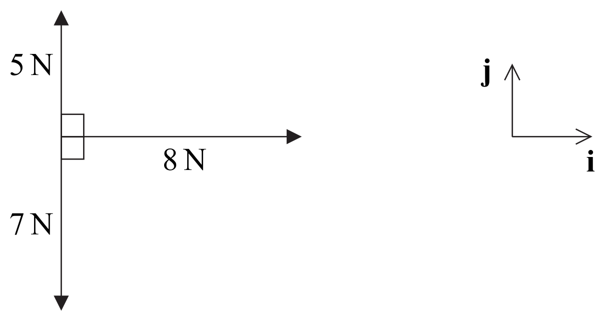


(a) Find the distance travelled by the lift. *(3 marks)*

(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.

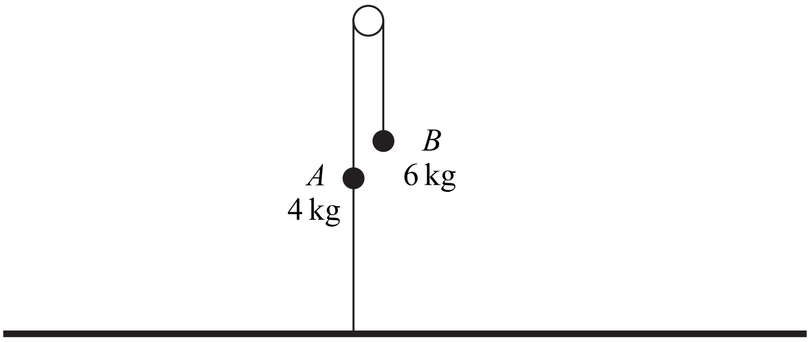


(a) Express the resultant of the three forces in terms of **i** and **j**. *(2 marks)*

(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 $180\,\mathrm{m\,s^{-1}}$ relative to the air. The air is moving north-west at $50\,\mathrm{m\,s^{-1}}$.

(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 $(-0.4\mathbf{i} + 0.5\mathbf{j})\,\mathrm{m\,s^{-2}}$. At time $t = 0$, the helicopter is at the origin and has velocity $20\mathbf{i}\,\mathrm{m\,s^{-1}}$.

(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)*

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.

(a) Draw and label a diagram to show the forces acting on the block. *(1 mark)*

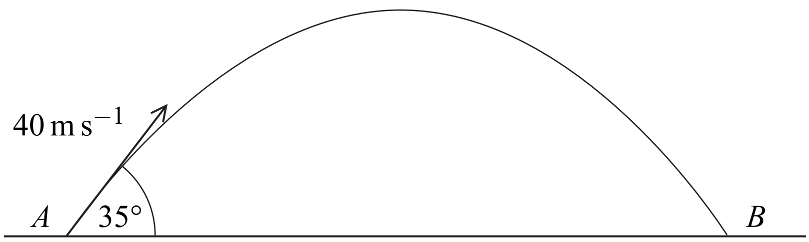
(b) Show that the magnitude of the normal reaction force acting on the block is 37.5 N, correct to three significant figures. *(2 marks)*

(c) Given that the acceleration of the block is $0.8\,\mathrm{m\,s^{-2}}$, find the coefficient of friction between the block and the plane. *(6 marks)*

(d) 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 $40\,\mathrm{m\,s^{-1}}$ 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.

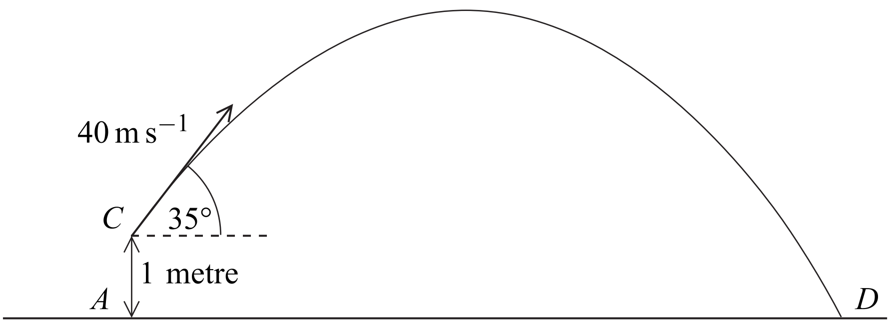
(a) A simple model assumes that the ball is hit from the point *A* and lands for the first time at the point *B*, which is at the same level as *A*, as shown in the diagram.



(i) 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)*

(ii) Find the horizontal distance from *A* to *B*. *(2 marks)*

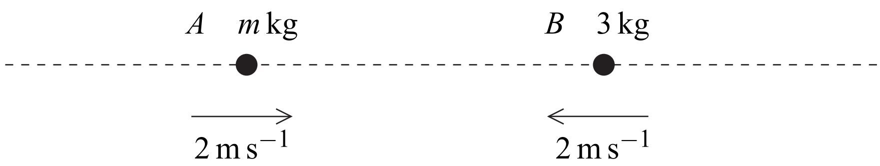
(b) A revised model assumes that the ball is hit from the point *C*, which is 1 metre above *A*. The ball lands at the point *D*, which is at the same level as *A*, as shown in the diagram.



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



The particles collide.

(a) If the particles move in opposite directions after the collision, each with speed $0.5\,\mathrm{m\,s^{-1}}$, find the value of m. *(3 marks)*

(b) If the particles coalesce during the collision, forming a single particle which moves with speed $0.5\,\mathrm{m\,s^{-1}}$, find the two possible values of m. *(5 marks)*

END OF QUESTIONS

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