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Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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7	
8	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Mathematics MM1B

Unit Mechanics 1B

Wednesday 9 June 2010 1.30 pm to 3.00 pm

For this paper you must have:
- 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.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer the questions in the spaces provided. Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- 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 marks for questions are shown in brackets.
- The maximum mark for this paper is 75.
- 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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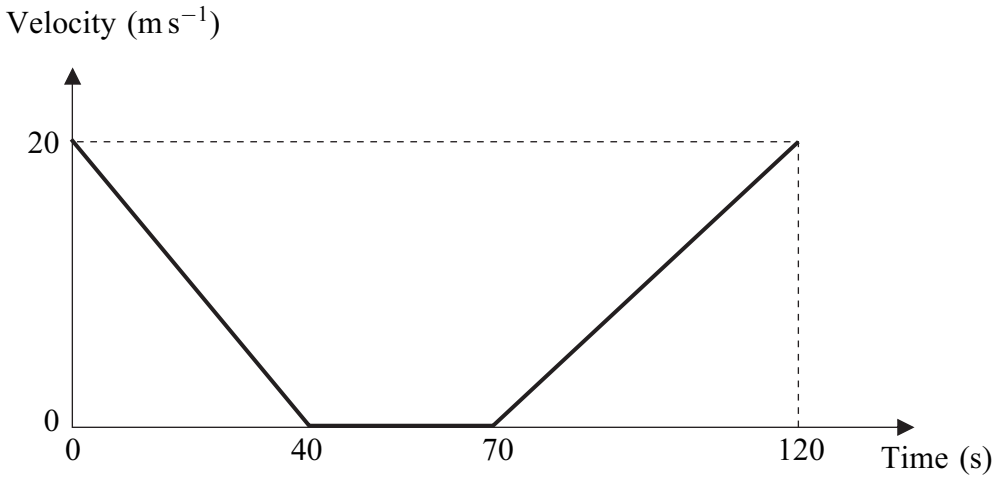
Answer **all** questions in the spaces provided.

1 A bus slows down as it approaches a bus stop. It stops at the bus stop and remains at rest for a short time as the passengers get on. It then accelerates away from the bus stop. The graph shows how the velocity of the bus varies.



Assume that the bus travels in a straight line during the motion described by the graph.

(a) State the length of time for which the bus is at rest. *(1 mark)*

(b) Find the distance travelled by the bus in the first 40 seconds. *(2 marks)*

(c) Find the total distance travelled by the bus in the 120-second period. *(2 marks)*

(d) Find the average speed of the bus in the 120-second period. *(2 marks)*

(e) If the bus had not stopped but had travelled at a constant 20 m s^{-1} for the 120-second period, how much further would it have travelled? *(2 marks)*

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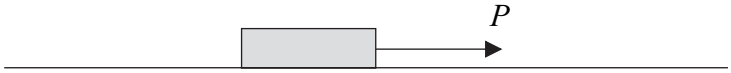
2 A block, of mass 10 kg, is at rest on a rough horizontal surface, when a horizontal force, of magnitude P newtons, is applied to the block, as shown in the diagram.



The coefficient of friction between the block and the surface is 0.5.

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

(b) (i) Calculate the magnitude of the normal reaction force acting on the block. *(1 mark)*

(ii) Find the maximum possible magnitude of the friction force between the block and the surface. *(1 mark)*

(iii) Given that $P = 30$, state the magnitude of the friction force acting on the block. *(1 mark)*

(c) Given that $P = 80$, find the acceleration of the block. *(3 marks)*

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3 Two particles, A and B, are moving on a smooth horizontal plane when they collide. The mass of A is 6 kg and the mass of B is m kg. Before the collision, the velocity of A is $\begin{bmatrix} 2 \\ 4 \end{bmatrix}$ m s^{-1} and the velocity of B is $\begin{bmatrix} 3 \\ -2 \end{bmatrix}$ m s^{-1}. After the collision, the velocity of A is $\begin{bmatrix} 1 \\ 3 \end{bmatrix}$ m s^{-1} and the velocity of B is $\begin{bmatrix} 7 \\ b \end{bmatrix}$ m s^{-1}.

(a) Find m. *(4 marks)*

(b) Find b. *(2 marks)*

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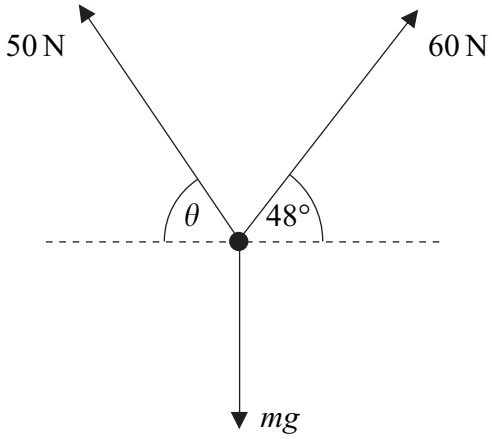
4 A particle, of mass m kg, remains in equilibrium under the action of three forces, which act in a vertical plane, as shown in the diagram. The force with magnitude 60 N acts at 48° above the horizontal and the force with magnitude 50 N acts at an angle θ above the horizontal.



(a) By resolving horizontally, find θ. *(4 marks)*

(b) Find m. *(3 marks)*

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5 An aeroplane is travelling along a straight line between two points, A and B, which are at the same height. The air is moving due east at a speed of $30\,\mathrm{m\,s^{-1}}$. Relative to the air, the aeroplane travels due north at a speed of $100\,\mathrm{m\,s^{-1}}$.

(a) Find the magnitude of the resultant velocity of the aeroplane. *(3 marks)*

(b) Find the bearing on which the aeroplane is travelling, giving your answer to the nearest degree. *(2 marks)*

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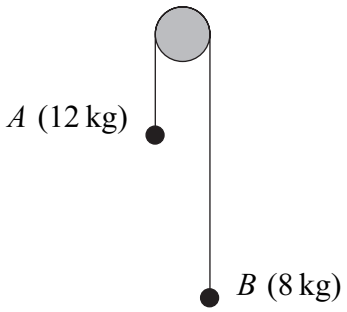
6 Two particles, A and B, have masses 12 kg and 8 kg respectively. They are connected by a light inextensible string that passes over a smooth fixed peg, as shown in the diagram.



The particles are released from rest and move vertically. Assume that there is no air resistance.

(a) By forming two equations of motion, show that the magnitude of the acceleration of each particle is $1.96\,\text{m}\,\text{s}^{-2}$. *(5 marks)*

(b) Find the tension in the string. *(2 marks)*

(c) After the particles have been moving for 2 seconds, both particles are at a height of 4 metres above a horizontal surface. When the particles are in this position, the string breaks.

(i) Find the speed of particle A when the string breaks. *(2 marks)*

(ii) Find the speed of particle A when it hits the surface. *(3 marks)*

(iii) Find the time that it takes for particle B to reach the surface after the string breaks. Assume that particle B does not hit the peg. *(5 marks)*

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7 A particle, of mass 10 kg, moves on a smooth horizontal surface. A single horizontal force, $(9\mathbf{i} + 12\mathbf{j})$ newtons, acts on the particle.

The unit vectors **i** and **j** are directed east and north respectively.

(a) Find the acceleration of the particle. *(2 marks)*

(b) At time t seconds, the velocity of the particle is $\mathbf{v}\,\mathrm{m\,s^{-1}}$. When $t = 0$, the velocity of the particle is $(2.2\mathbf{i} + \mathbf{j})\,\mathrm{m\,s^{-1}}$ and the particle is at the origin.

(i) Find the distance between the particle and the origin when $t = 5$. *(4 marks)*

(ii) Express **v** in terms of t. *(2 marks)*

(iii) Find t when the particle is travelling north-east. *(3 marks)*

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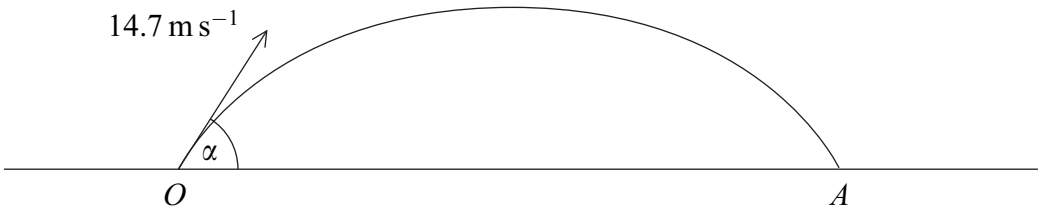
8 A ball is struck so that it leaves a horizontal surface travelling at $14.7\,\mathrm{m\,s^{-1}}$ at an angle α above the horizontal. The path of the ball is shown in the diagram.



(a) Show that the ball takes $\dfrac{3\sin\alpha}{2}$ seconds to reach its maximum height. *(3 marks)*

(b) The ball reaches a maximum height of 7 metres.

(i) Find α. *(5 marks)*

(ii) Find the range, OA. *(3 marks)*

(c) State two assumptions that you needed to make in order to answer the earlier parts of this question. *(2 marks)*

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END OF QUESTIONS

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