

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



General Certificate of Education
Advanced Subsidiary Examination
January 2011

Mathematics

MM1B

Unit Mechanics 1B

Wednesday 19 January 2011 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 $g = 9.8 \text{ m s}^{-2}$, 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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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TOTAL	



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Answer **all** questions in the spaces provided.

1

A trolley, of mass 5 kg, is moving in a straight line on a smooth horizontal surface. It has a velocity of 6 m s^{-1} when it collides with a stationary trolley, of mass $m \text{ kg}$. Immediately after the collision, the trolleys move together with velocity 2.4 m s^{-1} .

Find m .

(3 marks)

QUESTION
PART
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QUESTION
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REFERENCE

Turn over ►



Velocity-time graph for a car starting from rest. The y-axis is Velocity (m s^{-1}) and the x-axis is Time (seconds). The graph shows the following segments:

- From $t = 0$ to $t = 10$ s, velocity increases linearly from 0 to 4 m s^{-1} .
- From $t = 10$ s to $t = 20$ s, velocity is constant at 4 m s^{-1} .
- From $t = 20$ s to $t = 30$ s, velocity increases linearly from 4 m s^{-1} to 7 m s^{-1} .
- From $t = 30$ s to $t = 40$ s, velocity decreases linearly from 7 m s^{-1} to 0 m s^{-1} .

- (a)** Find the total distance travelled by the train. (4 marks)
- (b)** Find the average speed of the train. (2 marks)
- (c)** Find the acceleration of the train during the first 10 seconds of its motion. (2 marks)
- (d)** The mass of the train is 200 tonnes. Find the magnitude of the resultant force acting on the train during the first 10 seconds of its motion. (2 marks)

QUESTION	PART	REFERENCE
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This image shows a blank sheet of white paper designed for handwriting practice. It features a series of horizontal dashed lines spaced evenly down the page. A single vertical solid line runs parallel to the left edge, creating a narrow margin. The rest of the page is open space between the dashed lines, intended for writing practice.

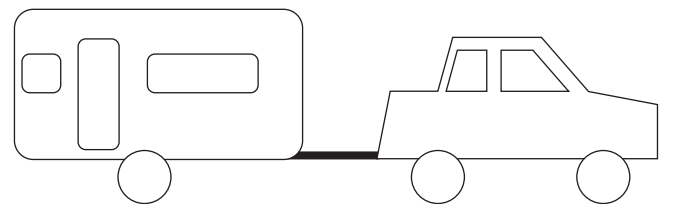
QUESTION
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0 5

- 3** A car, of mass 1200 kg, tows a caravan, of mass 1000 kg, along a straight horizontal road. The caravan is attached to the car by a horizontal tow bar, as shown in the diagram.



Assume that a constant resistance force of magnitude 200 newtons acts on the car and a constant resistance force of magnitude 300 newtons acts on the caravan. A constant driving force of magnitude P newtons acts on the car in the direction of motion. The car and caravan accelerate at 0.8 m s^{-2} .

- (a) (i)** Find P . (3 marks)
- (ii)** Find the magnitude of the force in the tow bar that connects the car to the caravan. (3 marks)
- (b) (i)** Find the time that it takes for the speed of the car and caravan to increase from 7 m s^{-1} to 15 m s^{-1} . (3 marks)
- (ii)** Find the distance that they travel in this time. (3 marks)
- (c)** Explain why the assumption that the resistance forces are constant is unrealistic. (1 mark)

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QUESTION
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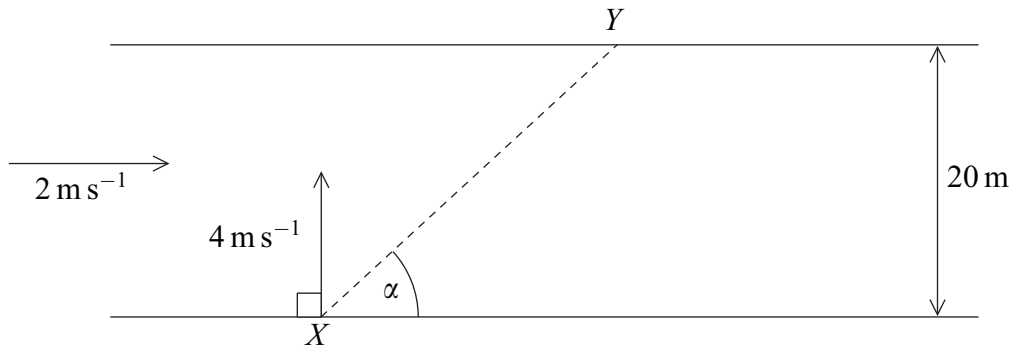
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4

A canoe is paddled across a river which has a width of 20 metres. The canoe moves from the point X on one bank of the river to the point Y on the other bank, so that its path is a straight line at an angle α to the banks. The velocity of the canoe relative to the water is 4 m s^{-1} perpendicular to the banks. The water flows at 2 m s^{-1} parallel to the banks.



Model the canoe as a particle.

- (a) Find the magnitude of the resultant velocity of the canoe. (2 marks)
- (b) Find the angle α . (2 marks)
- (c) Find the time that it takes for the canoe to travel from X to Y . (2 marks)

QUESTION
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- 5** A particle moves with constant acceleration $(-0.4\mathbf{i} + 0.2\mathbf{j}) \text{ m s}^{-2}$. Initially, it has velocity $(4\mathbf{i} + 0.5\mathbf{j}) \text{ m s}^{-1}$. The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.
- (a) Find an expression for the velocity of the particle at time t seconds. (2 marks)
- (b) (i) Find the velocity of the particle when $t = 22.5$. (2 marks)
- (ii) State the direction in which the particle is travelling at this time. (1 mark)
- (c) Find the time when the speed of the particle is 5 m s^{-1} . (6 marks)

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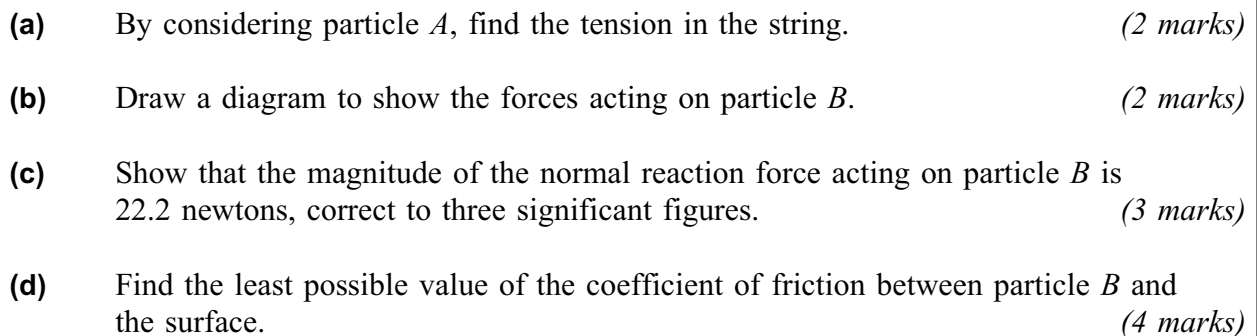


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Two particles, A and B , are connected by a light inextensible string which passes over a smooth peg. Particle A has mass 2 kg and particle B has mass 4 kg . Particle A hangs freely with the string vertical. Particle B is at rest in equilibrium on a rough horizontal surface with the string at an angle of 30° to the vertical. The particles, peg and string are shown in the diagram.

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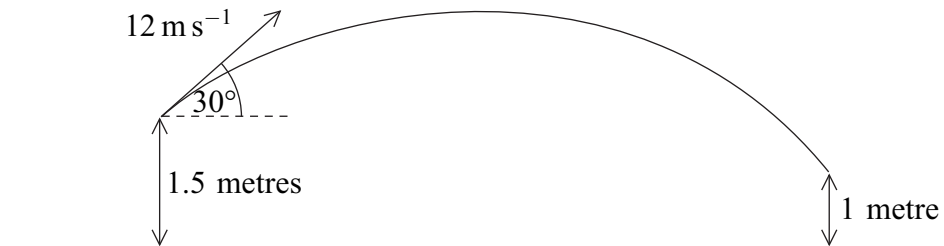
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An arrow is fired from a point at a height of 1.5 metres above horizontal ground. It has an initial velocity of 12 m s^{-1} at an angle of 30° above the horizontal. The arrow hits a target at a height of 1 metre above horizontal ground. The path of the arrow is shown in the diagram.



Model the arrow as a particle.

- (a) Show that the time taken for the arrow to travel to the target is 1.30 seconds, correct to three significant figures. (5 marks)
- (b) Find the horizontal distance between the point where the arrow is fired and the target. (2 marks)
- (c) Find the speed of the arrow when it hits the target. (4 marks)
- (d) Find the angle between the velocity of the arrow and the horizontal when the arrow hits the target. (2 marks)
- (e) State one assumption that you have made about the forces acting on the arrow. (1 mark)

QUESTION	PART	REFERENCE
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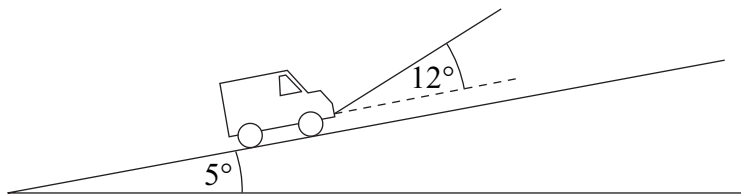
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A van, of mass 2000 kg, is towed up a slope inclined at 5° to the horizontal. The tow rope is at an angle of 12° to the slope. The motion of the van is opposed by a resistance force of magnitude 500 newtons. The van is accelerating up the slope at 0.6 m s^{-2} .



(a) Draw a diagram to show the forces acting on the van. (2 marks)

(b) Show that the tension in the tow rope is 3480 newtons, correct to three significant figures. (5 marks)

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[illegible]

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QUESTION
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REFERENCE**END OF QUESTIONS**

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