

Centre Number						Candidate Number				
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Other Names										
Candidate Signature										



General Certificate of Education
Advanced Subsidiary Examination
January 2012

Mathematics

MM1B

Unit Mechanics 1B

Friday 20 January 2012 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.
- You do not necessarily need to use all the space provided.

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



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

1

Two particles, A of mass 7 kg and B of mass 3 kg , are moving on a smooth horizontal plane when they collide. Just before the collision, the velocity of A is $(3\mathbf{i} + 8\mathbf{j})\text{ m s}^{-1}$ and the velocity of B is $(6\mathbf{i} - 5\mathbf{j})\text{ m s}^{-1}$. During the collision, the particles coalesce to form a single combined particle.

Find the velocity of the single combined particle after the collision. (3 marks)

QUESTION
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REFERENCE

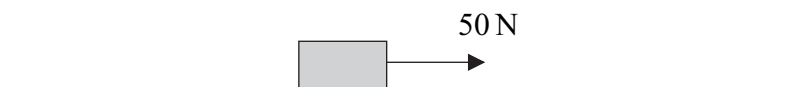


QUESTION
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Turn over ►



A block, of mass 4 kg, is made to move in a straight line on a rough horizontal surface by a horizontal force of 50 newtons, as shown in the diagram.



- (a)** Draw a diagram to show all the forces acting on the block. (1 mark)
- (b)** Find the magnitude of the normal reaction force acting on the block. (1 mark)
- (c)** The acceleration of the block is 3 m s^{-2} . Find the magnitude of the friction force acting on the block. (3 marks)
- (d)** Find the coefficient of friction between the block and the surface. (2 marks)
- (e)** Explain how and why your answer to part **(d)** would change if you assumed that air resistance did act on the block. (2 marks)

QUESTION	PART	REFERENCE
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QUESTION
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- (a)** Find the distance that the train moves in the first 28 seconds. *(2 marks)*
- (b)** Calculate the total distance moved by the train during the 50 seconds. *(3 marks)*
- (c)** Hence calculate the average speed of the train. *(2 marks)*
- (d)** Find the displacement of the train from its initial position when it has been moving for 50 seconds. *(1 mark)*
- (e)** Hence calculate the average velocity of the train. *(2 marks)*
- (f)** Find the acceleration of the train in the first 18 seconds of its motion. *(1 mark)*

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QUESTION
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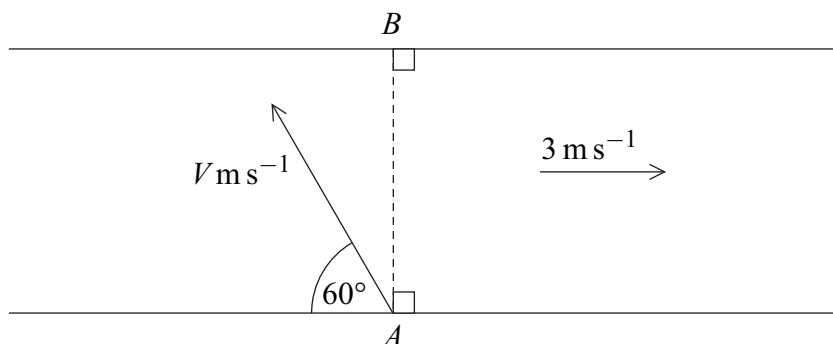
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A small ferry is used to cross a river which has straight parallel banks that are 200 metres apart. The water in the river moves at a constant speed of 3 m s^{-1} . The ferry travels from a point A on one bank to a point B directly opposite A on the other bank. The velocity of the ferry relative to the water is $V \text{ m s}^{-1}$ at an angle of 60° to the upstream bank, as shown in the diagram.



- (a)** Find V . (3 marks)
- (b)** Find the time that it takes for the ferry to cross the river, giving your answer to the nearest second. (3 marks)

QUESTION	PART	REFERENCE
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- 5** 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 towbar. A resistance force of magnitude R newtons acts on the car and a resistance force of magnitude $2R$ newtons acts on the caravan. The car and caravan accelerate at a constant 1.6 m s^{-2} when a driving force of magnitude 4720 newtons acts on the car.

- (a) Find R . (4 marks)
- (b) Find the tension in the towbar. (3 marks)

QUESTION
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QUESTION
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Turn over ►



- 6** A cyclist freewheels, with a constant acceleration, in a straight line down a slope. As the cyclist moves 50 metres, his speed increases from 4 m s^{-1} to 10 m s^{-1} .
- (a) (i)** Find the acceleration of the cyclist. (3 marks)
- (ii)** Find the time that it takes the cyclist to travel this distance. (3 marks)
- (b)** The cyclist has a mass of 70 kg. Calculate the magnitude of the resultant force acting on the cyclist. (2 marks)
- (c)** The slope is inclined at an angle α to the horizontal.
- (i)** Find α if it is assumed that there is no resistance force acting on the cyclist. (3 marks)
- (ii)** Find α if it is assumed that there is a constant resistance force of magnitude 30 newtons acting on the cyclist. (3 marks)
- (d)** Make a criticism of the assumption described in part **(c)(ii)**. (1 mark)

QUESTION
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- 7** A helicopter is initially at rest on the ground at the origin when it begins to accelerate in a vertical plane. Its acceleration is $(4.2\mathbf{i} + 2.5\mathbf{j}) \text{ m s}^{-2}$ for the first 20 seconds of its motion. The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are horizontal and vertical respectively.

Assume that the helicopter moves over horizontal ground.

- (a) Find the height of the helicopter above the ground at the end of the 20 seconds. (3 marks)
- (b) Find the velocity of the helicopter at the end of the 20 seconds. (2 marks)
- (c) Find the speed of the helicopter when it is at a height of 180 metres above the ground. (7 marks)

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QUESTION
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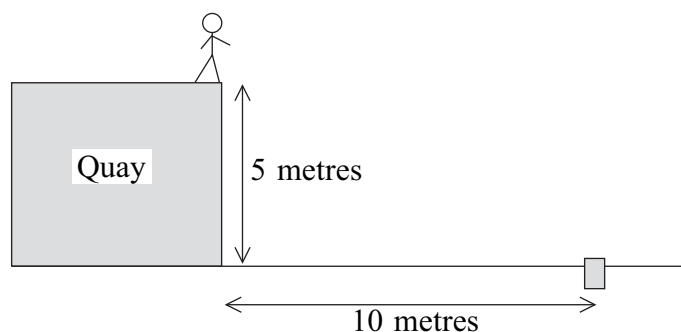
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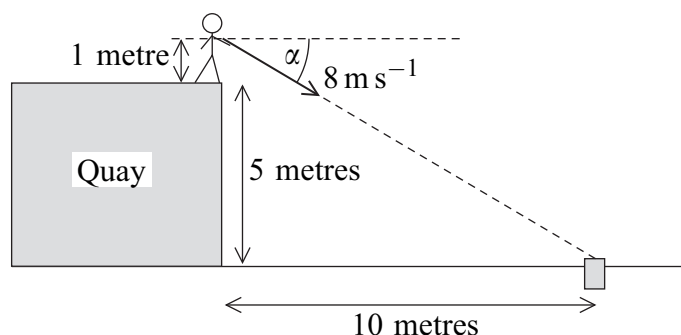
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- 8** A girl stands at the edge of a quay and sees a tin can floating in the water. The water level is 5 metres below the top of the quay and the can is at a horizontal distance of 10 metres from the quay, as shown in the diagram.



The girl decides to throw a stone at the can. She throws the stone from a height of 1 metre above the top of the quay. The initial velocity of the stone is 8 m s^{-1} at an angle α below the horizontal, so that the initial velocity of the stone is directed at the can, as shown in the diagram.



Assume that the stone is a particle and that it experiences no air resistance as it moves.

- (a) Find α . (2 marks)
- (b) Find the time that it takes for the stone to reach the level of the water. (6 marks)
- (c) Find the distance between the stone and the can when the stone hits the water. (4 marks)



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