Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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6	
7	
8	
TOTAL	

AQA

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Mathematics MM1B

Unit Mechanics 1B

Friday 12 June 2015 9.00 am to 10.30 am

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 each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- 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.

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- You do not necessarily need to use all the space provided.

Answer **all** questions.

Answer each question in the space provided for that question.

1 A child, of mass $48\,\text{kg}$, is initially standing at rest on a stationary skateboard. The child jumps off the skateboard and initially moves **horizontally** with a speed of $1.2\,\text{m s}^{-1}$. The skateboard moves with a speed of $16\,\text{m s}^{-1}$ in the opposite direction to the direction of motion of the child. Find the mass of the skateboard.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 1

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QUESTION PART REFERENCE

Answer space for question 1

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2 A yacht is sailing through water that is flowing due west at $2\,\mathrm{m\,s^{-1}}$. The velocity of the yacht relative to the water is $6\,\mathrm{m\,s^{-1}}$ due south. The yacht has a resultant velocity of $V\,\mathrm{m\,s^{-1}}$ on a bearing of θ.

(a) Find V.

[2 marks]

(b) Find θ, giving your answer to the nearest degree.

[3 marks]

QUESTION PART REFERENCE

Answer space for question 2

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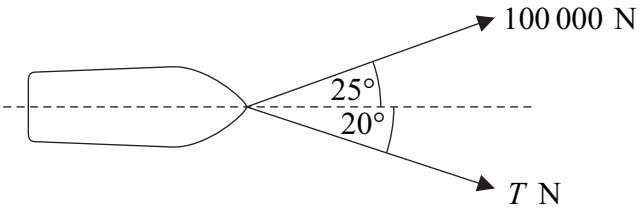
QUESTION PART REFERENCE

Answer space for question 2

3 A ship has a mass of 500 tonnes. Two tugs are used to pull the ship using cables that are horizontal. One tug exerts a force of $100\,000$ N at an angle of $25°$ to the centre line of the ship. The other tug exerts a force of T N at an angle of $20°$ to the centre line of the ship. The diagram shows the ship and forces as viewed from above.



The ship accelerates in a straight line along its centre line.

(a) Find T.

[3 marks]

(b) A resistance force of magnitude $20\,000$ N directly opposes the motion of the ship. Find the acceleration of the ship.

[4 marks]

QUESTION PART REFERENCE

Answer space for question 3

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QUESTION PART REFERENCE

Answer space for question 3

4 A particle moves with constant acceleration between the points A and B. At A, it has velocity $(4\mathbf{i} + 2\mathbf{j})\,\mathrm{m\,s^{-1}}$. At B, it has velocity $(7\mathbf{i} + 6\mathbf{j})\,\mathrm{m\,s^{-1}}$. It takes 10 seconds to move from A to B.

(a) Find the acceleration of the particle.

[3 marks]

(b) Find the distance between A and B.

[5 marks]

(c) Find the average velocity as the particle moves from A to B.

[2 marks]

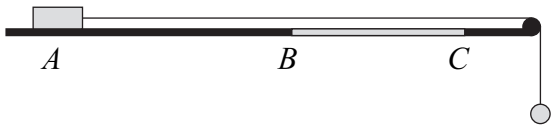
QUESTION PART REFERENCE

Answer space for question 4

QUESTION PART REFERENCE

Answer space for question 4

5 A block, of mass $3m$, is placed on a horizontal surface at a point A. A light inextensible string is attached to the block and passes over a smooth peg. The string is horizontal between the block and the peg. A particle, of mass $2m$, is attached to the other end of the string. The block is released from rest with the string taut and the string between the peg and the particle vertical, as shown in the diagram.



Assume that there is no air resistance acting on either the block or the particle, and that the size of the block is negligible.

The horizontal surface is smooth between the points A and B, but rough between the points B and C. Between B and C, the coefficient of friction between the block and the surface is 0.8.

(a) By forming equations of motion for both the block and the particle, find the acceleration of the block between A and B.

[4 marks]

(b) Given that the distance between the points A and B is 1.2 metres, find the speed of the block when it reaches B.

[3 marks]

(c) By forming equations of motion for both the block and the particle, find the acceleration of the block between B and C.

[5 marks]

(d) Given that the distance between the points B and C is 0.9 metres, find the speed of the block when it reaches C.

[3 marks]

(e) Explain why it is important to assume that the size of the block is negligible.

[1 mark]

QUESTION PART REFERENCE

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Answer space for question 5

6 Emma is in a park with her dog, Roxy. Emma throws a ball and Roxy catches it in her mouth. The ground in the park is horizontal. Emma throws the ball from a point at a height of 1.2 metres above the ground and Roxy catches the ball when it is at a height of 0.5 metres above the ground. Emma throws the ball with an initial velocity of $8\,\mathrm{m\,s^{-1}}$ at an angle of $30°$ above the horizontal.

(a) Find the time that the ball takes to travel from Emma's hand to Roxy's mouth.

[5 marks]

(b) Find the horizontal distance travelled by the ball during its flight.

[2 marks]

(c) During the flight, the speed of the ball is a maximum when it is at a height of h metres above the ground. Write down the value of h.

[1 mark]

(d) Find the maximum speed of the ball during its flight.

[4 marks]

QUESTION PART REFERENCE

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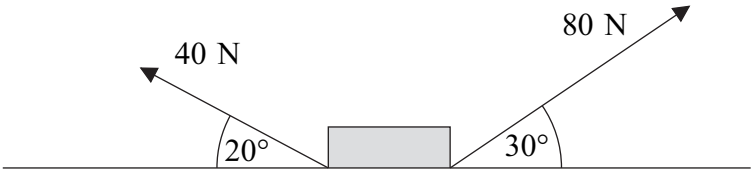
QUESTION PART REFERENCE

Answer space for question 6

7 Two forces, which act in a vertical plane, are applied to a crate. The crate has mass $50\,\text{kg}$, and is initially at rest on a rough horizontal surface. One force has magnitude $80\ \text{N}$ and acts at an angle of $30°$ to the horizontal and the other has magnitude $40\ \text{N}$ and acts at an angle of $20°$ to the horizontal. The forces are shown in the diagram.



The coefficient of friction between the crate and the surface is 0.6.

Model the crate as a particle.

(a) Draw a diagram to show the forces acting on the crate.

[2 marks]

(b) Find the magnitude of the normal reaction force acting on the crate.

[3 marks]

(c) Does the crate start to move when the two forces are applied to the crate? Show all your working.

[5 marks]

(d) State one aspect of the possible motion of the crate that is ignored by modelling it as a particle.

[1 mark]

QUESTION PART REFERENCE

Answer space for question 7

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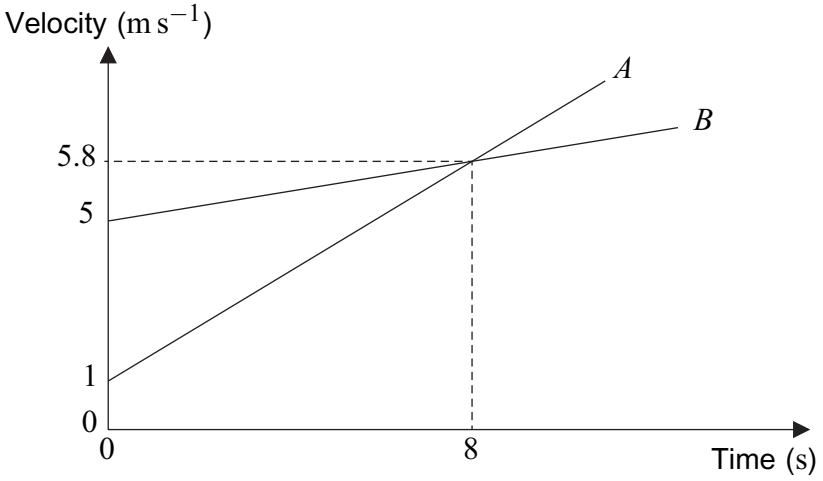
QUESTION PART REFERENCE

Answer space for question 7

8 Two trains, A and B, are moving on straight horizontal tracks which run alongside each other and are parallel. The trains both move with constant acceleration. At time $t = 0$, the fronts of the trains pass a signal. The velocities of the trains are shown in the graph below.



(a) Find the distance between the fronts of the two trains when they have the same velocity and state which train has travelled further from the signal.

[3 marks]

(b) Find the time when A has travelled 9 metres further than B.

[8 marks]

QUESTION PART REFERENCE

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QUESTION PART REFERENCE

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END OF QUESTIONS