

Centre Number						Candidate Number				
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Other Names										
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



General Certificate of Education
Advanced Subsidiary Examination
June 2014

Mathematics

MM1B

Unit Mechanics 1B

Monday 16 June 2014 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 $g = 9.8 \text{ m s}^{-2}$, 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.



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Answer **all** questions.

Answer each question in the space provided for that question.

- 1** A car is travelling along a straight horizontal road. It is moving at 14 m s^{-1} when it starts to accelerate. It accelerates at 0.8 m s^{-2} for 12 seconds.
- (a) Find the speed of the car at the end of the 12 seconds. **[3 marks]**
- (b) Find the distance travelled during the 12 seconds. **[3 marks]**
- (c) The mass of the car is 1400 kg. A horizontal forward driving force of 1600 N acts on the car during the 12 seconds. Find the magnitude of the resistance force that acts on the car. **[3 marks]**

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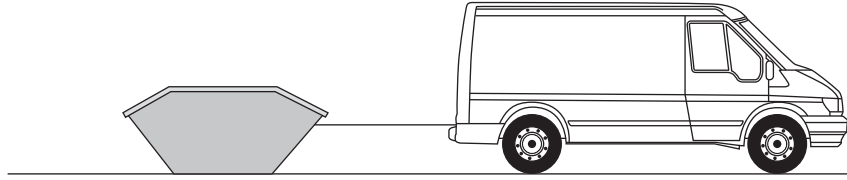
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3

A skip, of mass 800 kg, is at rest on a rough horizontal surface. The coefficient of friction between the skip and the ground is 0.4. A rope is attached to the skip and then the rope is pulled by a van so that the rope is horizontal while it is taut, as shown in the diagram.



The mass of the van is 1700 kg. A constant horizontal forward driving force of magnitude P newtons acts on the van. The skip and the van accelerate at 0.05 m s^{-2} .

Model both the van and the skip as particles connected by a light inextensible rope. Assume that there is no air resistance acting on the skip or on the van.

- (a) Find the speed of the van and the skip when they have moved 6 metres. [3 marks]
- (b) Draw a diagram to show the forces acting on the skip while it is accelerating. [1 mark]
- (c) Draw a diagram to show the forces acting on the van while it is accelerating. State one advantage of modelling the van as a particle when considering the vertical forces. [2 marks]
- (d) Find the magnitude of the friction force acting on the skip. [3 marks]
- (e) Find the tension in the rope. [3 marks]
- (f) Find P . [3 marks]

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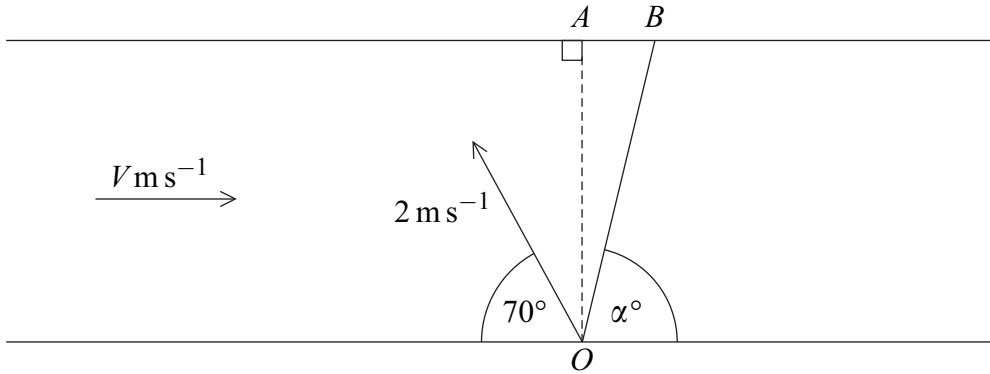
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A boat is crossing a river, which has two parallel banks. The width of the river is 20 metres. The water in the river is flowing at a speed of $V\text{ m s}^{-1}$. The boat sets off from the point O on one bank. The point A is directly opposite O on the other bank. The velocity of the boat relative to the water is 2 m s^{-1} at an angle of 70° to the bank. The boat lands at the point B which is 3 metres from A . The angle between the actual path of the boat and the bank is α° . The river and the velocities are shown in the diagram.



- (a) Find the time that it takes for the boat to cross the river. [3 marks]
- (b) Find α . [2 marks]
- (c) Find V . [5 marks]

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5

Two particles, A and B , have masses of m and km respectively, where k is a constant. The particles are moving on a smooth horizontal plane when they collide and coalesce to form a single particle. Just before the collision the velocities of A and B are $(4\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$ and $(6\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$ respectively. Immediately after the collision the combined particle has velocity $(5.2\mathbf{i} - 0.4\mathbf{j}) \text{ m s}^{-1}$.

Find k .

[5 marks]

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6 A bullet is fired from a rifle at a target, which is at a distance of 420 metres from the rifle. The bullet leaves the rifle travelling at $V \text{ m s}^{-1}$ and at an angle of 2° above the horizontal. The centre of the target, C , is at the same horizontal level as the rifle. The bullet hits the target at the point A , which is on a vertical line through C . The bullet takes 1.8 seconds to reach the point A .

- (a) Find V , showing clearly how you obtain your answer. **[3 marks]**

- (b) Find the distance between A and C . **[4 marks]**

- (c) State one assumption that you have made about the forces acting on the bullet. **[1 mark]**

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7 Two particles, A and B , move on a horizontal surface with constant accelerations of $-0.4\mathbf{i} \text{ m s}^{-2}$ and $0.2\mathbf{j} \text{ m s}^{-2}$ respectively. At time $t = 0$, particle A starts at the origin with velocity $(4\mathbf{i} + 2\mathbf{j}) \text{ m s}^{-1}$. At time $t = 0$, particle B starts at the point with position vector $11.2\mathbf{i}$ metres, with velocity $(0.4\mathbf{i} + 0.6\mathbf{j}) \text{ m s}^{-1}$.

(a) Find the position vector of A , 10 seconds after it leaves the origin. **[2 marks]**

(b) Show that the two particles collide, and find the position vector of the point where they collide. **[9 marks]**

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END OF QUESTIONS

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