



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Mathematics

MM1B

Unit Mechanics 1B

Thursday 26 May 2011 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 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.

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- 1 A crane is used to lift a load, using a single vertical cable which is attached to the load. The load accelerates uniformly from rest. When it has risen 0.9 metres, its speed is 0.6 m s^{-1} .
- (a) (i) Show that the acceleration of the load is 0.2 m s^{-2} . (3 marks)
- (ii) Find the time taken for the load to rise 0.9 metres. (2 marks)
- (b) Given that the mass of the load is 800 kg, find the tension in the cable while the load is accelerating. (3 marks)
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- 2 A wooden block, of mass 4 kg, is placed on a rough horizontal surface. The coefficient of friction between the block and the surface is 0.3. A horizontal force, of magnitude 30 newtons, acts on the block and causes it to accelerate.



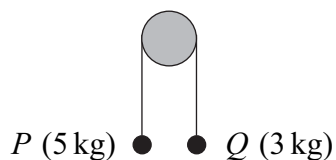
- (a) Draw a diagram to show all the forces acting on the block. (1 mark)
- (b) Calculate the magnitude of the normal reaction force acting on the block. (1 mark)
- (c) Find the magnitude of the friction force acting on the block. (2 marks)
- (d) Find the acceleration of the block. (3 marks)
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- 3 A pair of cameras records the time that it takes a car on a motorway to travel a distance of 2000 metres. A car passes the first camera whilst travelling at 32 m s^{-1} . The car continues at this speed for 12.5 seconds and then decelerates uniformly until it passes the second camera when its speed has decreased to 18 m s^{-1} .
- (a) Calculate the distance travelled by the car in the first 12.5 seconds. (1 mark)
- (b) Find the time for which the car is decelerating. (3 marks)
- (c) Sketch a speed–time graph for the car on this 2000-metre stretch of motorway. (3 marks)
- (d) Find the average speed of the car on this 2000-metre stretch of motorway. (2 marks)



- 4 Two particles, A and B , are moving on a smooth horizontal surface when they collide. The mass of A is 6 kg and the mass of B is $m\text{ kg}$. Before the collision, the velocity of A is $(5\mathbf{i} + 18\mathbf{j})\text{ m s}^{-1}$ and the velocity of B is $(2\mathbf{i} - 5\mathbf{j})\text{ m s}^{-1}$. After the collision, the velocity of A is $8\mathbf{i}\text{ m s}^{-1}$ and the velocity of B is $V\mathbf{j}\text{ m s}^{-1}$.
- (a) Find m . (3 marks)
- (b) Find V . (3 marks)
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- 5 Two particles, P and Q , are connected by a string that passes over a fixed smooth peg, as shown in the diagram. The mass of P is 5 kg and the mass of Q is 3 kg .

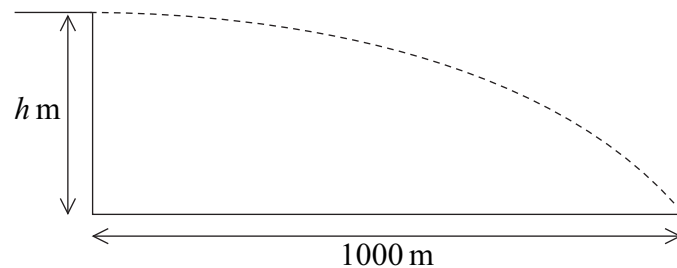


The particles are released from rest in the position shown.

- (a) By forming an equation of motion for each particle, show that the magnitude of the acceleration of each particle is 2.45 m s^{-2} . (5 marks)
- (b) Find the tension in the string. (2 marks)
- (c) State **two** modelling assumptions that you have made about the string. (2 marks)
- (d) Particle P hits the floor when it has moved 0.196 metres and Q has not reached the peg.
- (i) Find the time that it takes P to reach the floor. (3 marks)
- (ii) Find the speed of P when it hits the floor. (2 marks)



- 6** A bullet is fired horizontally from the top of a vertical cliff, at a height of h metres above the sea. It hits the sea 4 seconds after being fired, at a distance of 1000 metres from the base of the cliff, as shown in the diagram.

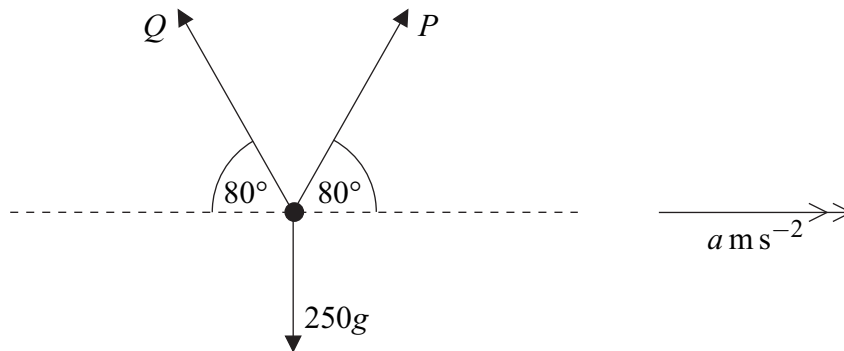


- (a) Find the initial speed of the bullet. (2 marks)
- (b) Find h . (2 marks)
- (c) Find the speed of the bullet when it hits the sea. (4 marks)
- (d) Find the angle between the velocity of the bullet and the horizontal when it hits the sea. (3 marks)
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- 7** A helicopter is initially hovering above a lighthouse. It then sets off so that its acceleration is $(0.5\mathbf{i} + 0.375\mathbf{j}) \text{ m s}^{-2}$. The helicopter does not change its height above sea level as it moves. The unit vectors \mathbf{i} and \mathbf{j} are directed east and north respectively.
- (a) Find the speed of the helicopter 20 seconds after it leaves its position above the lighthouse. (4 marks)
- (b) Find the bearing on which the helicopter is travelling, giving your answer to the nearest degree. (3 marks)
- (c) The helicopter stops accelerating when it is 500 metres from its initial position.
- Find the time that it takes for the helicopter to travel from its initial position to the point where it stops accelerating. (5 marks)



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- 8 Three forces act in a vertical plane on an object of mass 250 kg, as shown in the diagram.



The two forces P newtons and Q newtons each act at 80° to the horizontal. The object accelerates horizontally at $a \text{ m s}^{-2}$ under the action of these forces.

- (a) Show that

$$P = 125 \left(\frac{a}{\cos 80^\circ} + \frac{g}{\sin 80^\circ} \right) \quad (5 \text{ marks})$$

- (b) Find the value of a for which Q is zero. (3 marks)

END OF QUESTIONS

