Centre Number			Candidate Number		
Surname					
Other Names					
Candidate Signature					



General Certificate of Education Advanced Subsidiary Examination January 2013

# **Mathematics**

MM1B

**Unit Mechanics 1B** 

Wednesday 23 January 2013 9.00 am to 10.30 am

#### For this paper you must have:

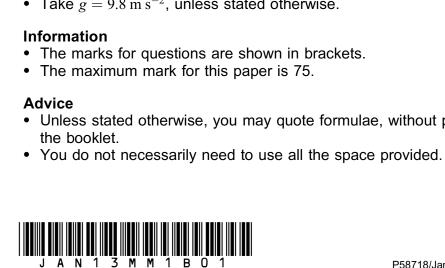
• the blue AQA booklet of formulae and statistical tables. You may use a graphics calculator.

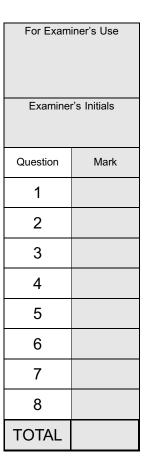
#### Time allowed

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.
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.





## Answer all questions.

### Answer each question in the space provided for that question.

1	A car travels on a straight horizontal race track. The car decelerates unifor a speed of $20\mathrm{ms^{-1}}$ to a speed of $12\mathrm{ms^{-1}}$ as it travels a distance of 640 m. The car then accelerates uniformly, travelling a further 1820 metres in 70 s	netres.
(a) (	) Find the time that it takes the car to travel the first 640 metres.	(3 marks)
(	i) Find the deceleration of the car during the first 640 metres.	(3 marks)
(b) (	) Find the acceleration of the car as it travels the further 1820 metres.	(3 marks)
(	i) Find the speed of the car when it has completed the further 1820 metres.	(3 marks)
(c)	Find the average speed of the car as it travels the 2460 metres.	(2 marks)
PART A	nswer space for question 1	
		•••••
		•••••
		•••••
		•••••
		•••••



QUESTION PART REFERENCE	Answer space for question 1
•••••	
•••••	
•••••	
••••••	
••••••	
••••••	
•••••	
••••••	
•••••	
• • • • • • • • • • • • • • • • • • • •	



Three forces act on a particle. These forces are $(9\mathbf{i} - 3\mathbf{j})$ newtons, (5 and $(-7\mathbf{i} + 3\mathbf{j})$ newtons. The vectors $\mathbf{i}$ and $\mathbf{j}$ are perpendicular unit v		
(a	) Find the resultant of these forces.	(2 marks)
(b	Find the magnitude of the resultant force.	(2 marks)
(с	Given that the particle has mass 5 kg, find the magnitude of the accelerate particle.	ion of the (2 marks)
(d	Find the angle between the resultant force and the unit vector i.	(3 marks)
QUESTION PART REFERENCE	Answer space for question 2	
		••••••
• • • • • • • • • • • • • • • • • • • •		•••••
••••••		•••••••••••
		••••••



QUESTION PART REFERENCE	Answer space for question 2
•••••	
•••••	



3	A box, of mass 3 kg, is placed on a rough slope inclined at an angle of 40° to the horizontal. It is released from rest and slides down the slope.
(a	Draw a diagram to show the forces acting on the box. (1 mark)
(b	Find the magnitude of the normal reaction force acting on the box. (2 marks)
(с	The coefficient of friction between the box and the slope is 0.2. Find the magnitude of the friction force acting on the box. (2 marks)
(d	Find the acceleration of the box. (3 marks)
(e	State an assumption that you have made about the forces acting on the box. (1 mark)
QUESTION PART REFERENCE	Answer space for question 3
• • • • • • • • • • • • • • • • • • • •	
•••••	
•	
•	



QUESTION PART REFERENCE	Answer space for question 3
•••••	
•••••	
•••••	
•••••	
•••••	
•••••	
•••••	
•••••	
•••••	
•••••	
••••••	
••••••	
•••••	
•••••	
••••••	
••••••	
••••••	
••••••	
••••••	
••••••	
•••••	



4	A tractor, of mass 3500 kg, is used to tow a trailer, of mass 2400 kg, across a horizontal field. The trailer is connected to the tractor by a horizontal tow bar. As they move, a constant resistance force of 800 newtons acts on the trailer and a constant resistance force of $R$ newtons acts on the tractor. A forward driving force of 2500 newtons acts on the tractor. The trailer and tractor accelerate at $0.2 \mathrm{ms^{-2}}$ .	
(a	Find R. (3 marks)	)
(b	Find the magnitude of the force that the tow bar exerts on the trailer. (3 marks)	)
(с	State the magnitude of the force that the tow bar exerts on the tractor. (1 mark)	)
QUESTION PART REFERENCE	Answer space for question 4	_
•••••		
•••••		
•••••		
•••••		
•••••		
•••••		
•••••		



QUESTION PART REFERENCE	Answer space for question 4
•••••	



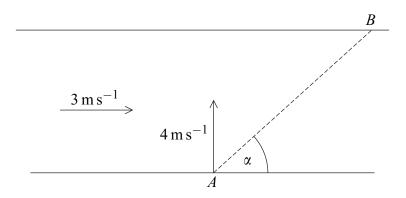
5	Two particles, $A$ and $B$ , are moving towards each other along the same straight horizontal line when they collide. Particle $A$ has mass 5 kg and particle $B$ has mass 4 kg. Just before the collision, the speed of $A$ is $4 \mathrm{ms^{-1}}$ and the speed of $B$ is $3 \mathrm{ms^{-1}}$ . After the collision, the speed of $A$ is $0.6 \mathrm{ms^{-1}}$ and both particles move on the same straight horizontal line.
	Find the two possible speeds of $B$ after the collision. (6 marks)
QUESTION PART REFERENCE	Answer space for question 5
••••••	
•••••	
••••••	
•••••	
••••••	
••••••	
••••••	



QUESTION PART REFERENCE	Answer space for question 5
•••••	
•••••	



A river has straight parallel banks. The water in the river is flowing at a constant velocity of  $3 \,\mathrm{m\,s^{-1}}$  parallel to the banks. A boat crosses the river, from the point A to the point B, so that its path is at an angle  $\alpha$  to the bank. The velocity of the boat relative to the water is  $4 \,\mathrm{m\,s^{-1}}$  perpendicular to the bank. The diagram shows these velocities and the path of the boat.



- (a) Show that  $\alpha = 53.1^{\circ}$ , correct to three significant figures. (2 marks)
- (b) The boat returns along the same straight path from B to A. Given that the speed of the boat relative to the water is still  $4 \,\mathrm{m\,s^{-1}}$ , find the magnitude of the resultant velocity of the boat on the return journey. (6 marks)

QUESTION PART REFERENCE	Answer space for question 6
THE ENEMOLE	
•••••	



QUESTION PART REFERENCE	Answer space for question 6
•••••	



QUESTION PART REFERENCE	Answer space for question 6
•••••	
••••••	
•••••	



QUESTION PART REFERENCE	Answer space for question 6
•••••	



7	A particle is initially at the point $A$ , which has position vector 13.6 $\mathbf{i}$ metres, with respect to an origin $O$ . At the point $A$ , the particle has velocity $(6\mathbf{i} + 2.4\mathbf{j}) \mathrm{ms^{-1}}$ , and in its subsequent motion, it has a constant acceleration of $(-0.8\mathbf{i} + 0.1\mathbf{j}) \mathrm{ms^{-2}}$ . The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.
(a	Find an expression for the velocity of the particle $t$ seconds after it leaves $A$ .  (2 marks)
(b	Find an expression for the position vector of the particle, with respect to the origin $O$ , $t$ seconds after it leaves $A$ . (3 marks)
(с	Find the distance of the particle from the origin O when it is travelling in a north-westerly direction. (7 marks)
QUESTION PART REFERENCE	Answer space for question 7
•••••	
•••••	
••••••	
•••••	
• • • • • • • • • • • • • • • • • • • •	

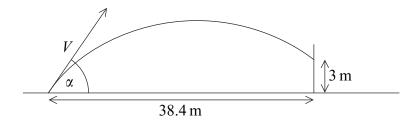


QUESTION PART REFERENCE	Answer space for question 7



A golf ball is hit from a point on a horizontal surface, so that it has an initial velocity  $V \,\mathrm{m}\,\mathrm{s}^{-1}$  at an angle  $\alpha$  above the horizontal. The ball travels through the air and after 2.4 seconds hits a vertical wall at a height of 3 metres. The wall is at a horizontal distance of 38.4 metres from the point where the ball was hit. The path of the ball is shown in the diagram.

18



Assume that the weight of the ball is the only force that acts on it as it travels through the air.

- (a) Find the horizontal component of the velocity of the ball. (2 marks)
- (b) Find V. (5 marks)
- (c) Find  $\alpha$ . (3 marks)

QUESTION PART REFERENCE	Answer space for question 8
REFERENCE	



QUESTION PART REFERENCE	Answer space for question 8
•••••	



QUESTION PART REFERENCE	Answer space for question 8
•••••	
•••••	
••••••	
••••••	
	END OF QUESTIONS
Copyrig	ht © 2013 AQA and its licensors. All rights reserved.

