

General Certificate of Education  
January 2007  
Advanced Subsidiary Examination



**MATHEMATICS**  
**Unit Mechanics 1A**

**MM1A/W**

Friday 12 January 2007 9.00 am to 10.15 am

**For this paper you must have:**

- an 8-page answer book
  - the **blue** AQA booklet of formulae and statistical tables.
- You may use a graphics calculator.

Time allowed: 1 hour 15 minutes

**Instructions**

- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MM1A/W.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- 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 maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- Unit Mechanics 1A has a **written paper and coursework**.

**Advice**

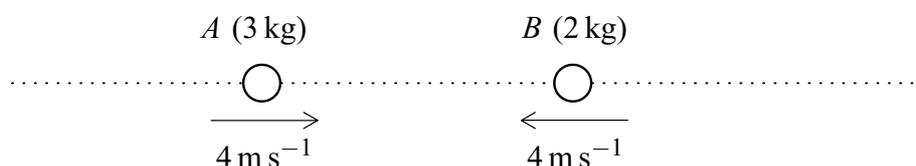
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.

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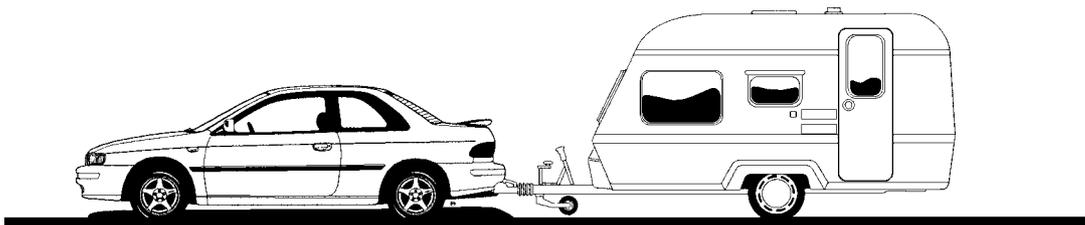
Answer **all** questions.

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- 1 Two particles  $A$  and  $B$  have masses of 3 kg and 2 kg respectively. They are moving along a straight horizontal line towards each other. Each particle is moving with a speed of  $4 \text{ m s}^{-1}$  when they collide.



- (a) If the particles coalesce during the collision to form a single particle, find the speed of the combined particle after the collision. *(3 marks)*
- (b) If, after the collision,  $A$  moves in the same direction as before the collision with speed  $0.4 \text{ m s}^{-1}$ , find the speed of  $B$  after the collision. *(3 marks)*
- 2 A motorcycle accelerates uniformly along a straight horizontal road so that, when it has travelled 20 metres, its velocity has increased from  $12 \text{ m s}^{-1}$  to  $16 \text{ m s}^{-1}$ .
- (a) Find the acceleration of the motorcycle. *(3 marks)*
- (b) Find the time that it takes for the motorcycle to travel this distance. *(3 marks)*
- 3 A car, of mass 1500 kg, is towing a caravan, of mass 900 kg, along a straight horizontal road. The caravan is connected to the car by a horizontal tow bar. Resistance forces of magnitudes 400 N and 800 N act on the car and caravan respectively. The acceleration of the car and caravan is  $0.8 \text{ m s}^{-2}$ .

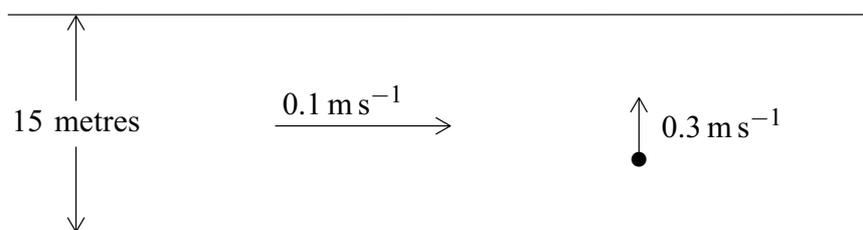


- (a) Show that the magnitude of the force that the car exerts on the caravan is 1520 N. *(3 marks)*
- (b) Find the magnitude of the driving force produced by the car's engine. *(3 marks)*

- 4 A cricket ball is hit from the floor of a sports hall, which has a height of 6 metres. The initial velocity of the ball is  $20 \text{ m s}^{-1}$  at an angle of  $60^\circ$  above the horizontal.

Assume that the cricket ball is a particle which moves only under the influence of gravity.

- (a) Show that the ball hits the ceiling of the sports hall approximately 0.389 seconds after it was hit. *(5 marks)*
- (b) Find the horizontal distance travelled by the ball before it hits the ceiling. *(2 marks)*
- (c) Find the speed of the ball just before it hits the ceiling. *(5 marks)*
- 5 A girl in a boat is rowing across a river, in which the water is flowing at  $0.1 \text{ m s}^{-1}$ . The velocity of the boat relative to the water is  $0.3 \text{ m s}^{-1}$  and is perpendicular to the bank, as shown in the diagram.



- (a) Find the magnitude of the resultant velocity of the boat. *(2 marks)*
- (b) Find the acute angle between the resultant velocity and the bank. *(3 marks)*
- (c) The width of the river is 15 metres.
- (i) Find the time that it takes the boat to cross the river. *(2 marks)*
- (ii) Find the total distance travelled by the boat as it crosses the river. *(2 marks)*

**Turn over for the next question**

- 6 A trolley, of mass 100 kg, rolls at a constant speed along a straight line down a slope inclined at an angle of  $4^\circ$  to the horizontal.

Assume that a constant resistance force, of magnitude  $P$  newtons, acts on the trolley as it moves. Model the trolley as a particle.

- (a) Draw a diagram to show the forces acting on the trolley. *(1 mark)*
- (b) Show that  $P = 68.4$  N, correct to three significant figures. *(3 marks)*
- (c) (i) Find the acceleration of the trolley if it rolls down a slope inclined at  $5^\circ$  to the horizontal and experiences the same constant force of magnitude  $P$  that you found in part (b). *(4 marks)*
- (ii) Make one criticism of the assumption that the resistance force on the trolley is constant. *(1 mark)*

- 7 A particle is initially at the origin, where it has velocity  $(5\mathbf{i} - 2\mathbf{j}) \text{ m s}^{-1}$ . It moves with a constant acceleration  $\mathbf{a} \text{ m s}^{-2}$  for 10 seconds to the point with position vector  $75\mathbf{i}$  metres.

- (a) Show that  $\mathbf{a} = 0.5\mathbf{i} + 0.4\mathbf{j}$ . *(3 marks)*
- (b) Find the position vector of the particle 8 seconds after it has left the origin. *(3 marks)*
- (c) Find the position vector of the particle when it is travelling parallel to the unit vector  $\mathbf{i}$ . *(6 marks)*

**END OF QUESTIONS**