

General Certificate of Education  
June 2005  
Advanced Subsidiary Examination



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

**MM1A/W**

Thursday 16 June 2005 Afternoon Session

**In addition to this paper you will require:**

- 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.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or 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.
- Mark allocations are shown in brackets.
- Unit Mechanics 1A has a **written paper and coursework**.

**Advice**

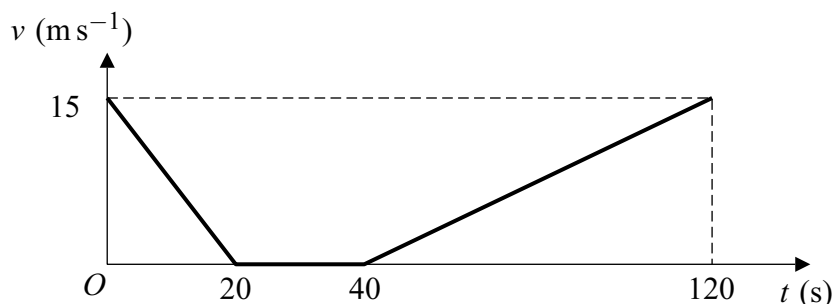
- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

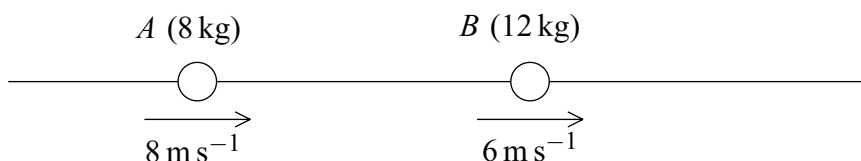
- 1 A train travels along a straight horizontal track between two points  $A$  and  $B$ .

Initially the train is at  $A$  and moving at  $15 \text{ m s}^{-1}$ . Due to a problem, the train has to slow down and stop. At time  $t = 40$  seconds it begins to move again. At time  $t = 120$  seconds the train is at  $B$  and moving at  $15 \text{ m s}^{-1}$  again.

The graph below shows how the velocity of the train varies as it moves from  $A$  to  $B$ .

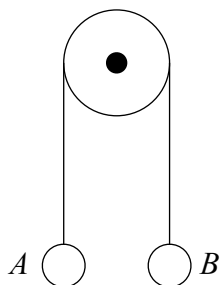


- (a) Use the graph to find the total distance between the points  $A$  and  $B$ . (4 marks)
- (b) The train should have travelled between  $A$  and  $B$  at a constant velocity of  $15 \text{ m s}^{-1}$ .
- (i) Calculate the time that the train would take to travel between  $A$  and  $B$  at a speed of  $15 \text{ m s}^{-1}$ . (1 mark)
- (ii) Calculate the time by which the train was delayed. (1 mark)
- (c) The train has mass 500 tonnes. Find the resultant force acting on the train when  $40 < t < 120$ . (4 marks)
- 2 Two particles,  $A$  and  $B$ , are moving in the same direction along a straight line. Particle  $A$  has mass  $8 \text{ kg}$  and speed  $8 \text{ m s}^{-1}$ . Particle  $B$  has mass  $12 \text{ kg}$  and speed  $6 \text{ m s}^{-1}$ . The two particles collide.



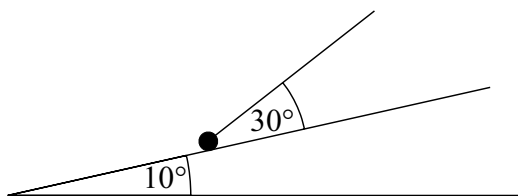
- (a) If, during the collision, the two particles coalesce, find the speed of the combined particle. (3 marks)
- (b) If, after the collision, particle  $A$  continues to move in the same direction at  $6.5 \text{ m s}^{-1}$ , find the speed of  $B$  after the collision. (3 marks)

- 3 An aeroplane is heading due east at  $200 \text{ m s}^{-1}$  relative to the air. A wind is blowing due north at  $30 \text{ m s}^{-1}$ .
- (a) Find the magnitude of the resultant velocity of the aeroplane. *(3 marks)*
- (b) Find the bearing on which the aeroplane actually travels. *(3 marks)*
- 4 Two particles,  $A$  of mass  $5 \text{ kg}$  and  $B$  of mass  $9 \text{ kg}$ , are attached to the ends of a light inextensible string. The string passes over a light smooth pulley as shown in the diagram. The particles are released from rest at the same height.



- (a) By forming an equation of motion for each particle, show that the magnitude of the acceleration of each particle is  $2.8 \text{ m s}^{-2}$ . *(5 marks)*
- (b) Find the tension in the string. *(2 marks)*
- (c) When  $B$  has been moving for  $0.5$  seconds it hits the floor. Find the height of  $A$ , above the floor, at this time. Assume that  $A$  is still below the pulley when  $B$  hits the floor. *(4 marks)*
- 5 An arrow is fired horizontally with a speed of  $30 \text{ m s}^{-1}$  from a height of  $2 \text{ m}$  above ground level. Model the arrow as a particle which does not experience air resistance.
- (a) Show that the time taken for the arrow to hit the ground is  $0.639$  seconds, correct to three significant figures. *(4 marks)*
- (b) Find the horizontal distance travelled by the arrow. *(2 marks)*
- (c) Describe what happens, during the flight of the arrow, to the magnitude of:
- (i) the horizontal component of the velocity;
- (ii) the vertical component of the velocity. *(2 marks)*

- 6 A particle moves on a smooth horizontal surface with acceleration  $(3\mathbf{i} - 5\mathbf{j}) \text{ m s}^{-2}$ . Initially the velocity of the particle is  $4\mathbf{j} \text{ m s}^{-1}$ .
- (a) Find an expression for the velocity of the particle at time  $t$  seconds. *(2 marks)*
- (b) Find the time when the particle is travelling in the  $\mathbf{i}$  direction. *(2 marks)*
- (c) Show that when  $t = 4$  the speed of the particle is  $20 \text{ m s}^{-1}$ . *(4 marks)*
- 7 A rough slope is inclined at an angle of  $10^\circ$  to the horizontal. A particle of mass  $6 \text{ kg}$  is on the slope. A string is attached to the particle and is at an angle of  $30^\circ$  to the slope. The tension in the string is  $20 \text{ N}$ . The diagram shows the slope, the particle and the string.



The particle moves up the slope with an acceleration of  $0.4 \text{ m s}^{-2}$ .

- (a) Draw a diagram to show the forces acting on the particle. *(1 mark)*
- (b) Show that the magnitude of the normal reaction force is  $47.9 \text{ N}$ , correct to three significant figures. *(4 marks)*
- (c) Find the coefficient of friction between the particle and the slope. *(6 marks)*

**END OF QUESTIONS**