

General Certificate of Education
June 2005
Advanced Subsidiary Examination



MATHEMATICS (SPECIFICATION A)
Unit Mechanics 1

MAM1/W

Wednesday 25 May 2005 Afternoon Session

In addition to this paper you will require:

- an 8-page answer book;
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 20 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 MAM1/W.
- Answer **all** questions.
- Take $g = 9.8 \text{ m s}^{-2}$ unless otherwise stated.
- 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 normally be given to three significant figures.
- Tie loosely any additional sheets you have used to the back of your answer book before handing it to the invigilator.

Information

- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.

Advice

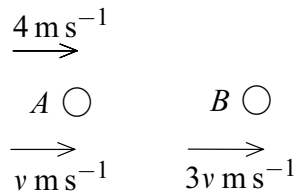
- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

- 1 A particle A of mass $3m$ kg is moving with speed 4 m s^{-1} in a straight line on a smooth horizontal surface.

The particle collides with a stationary particle B of mass m kg.

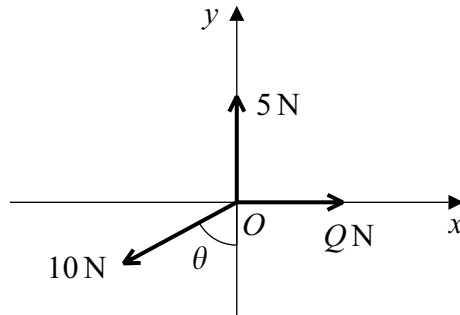
Immediately after the collision, A is moving with speed $v \text{ m s}^{-1}$, and B is moving with speed $3v \text{ m s}^{-1}$ in the same direction.



Find the value of v .

(3 marks)

- 2 A particle rests in equilibrium at a point O on a horizontal surface. It is acted on by three horizontal forces of magnitudes 5 N , 10 N and $Q \text{ N}$. The directions of these forces, relative to the horizontal axes Ox and Oy , are shown in the diagram below.



- (a) Show that $\theta = 60^\circ$.

(2 marks)

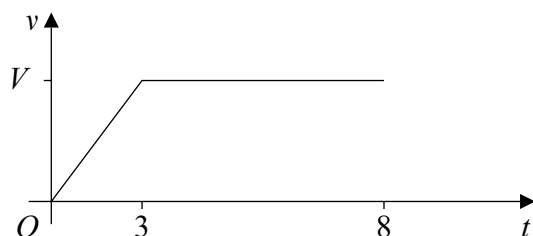
- (b) Find the value of Q .

(2 marks)

3 The velocity-time graph below models the first 8 seconds of a journey of a bus.

During the first 3 seconds of its journey, the bus travels from rest with constant acceleration until it reaches a speed of $V \text{ m s}^{-1}$.

During the next 5 seconds of its journey, the bus travels with constant speed $V \text{ m s}^{-1}$.



(a) (i) During the first 3 seconds the bus accelerates at 0.8 m s^{-2} .

Show that $V = 2.4$. (2 marks)

(ii) Find the total distance the bus travels during the first 8 seconds of its journey. (3 marks)

(b) After the first 8 seconds of its journey, the bus decelerates at a constant rate until it stops. During this stage of the journey the bus travels a further 4.8 metres.

Find the average speed of the bus during the whole journey. (4 marks)

TURN OVER FOR THE NEXT QUESTION

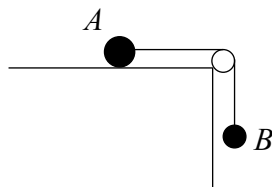
4 Mark is operating a radio-controlled aeroplane. The aeroplane is flying in a horizontal straight line. Its velocity is 6 m s^{-1} due North, relative to the air. The wind is blowing with velocity 2 m s^{-1} due East. The resultant speed of the aeroplane is $x \text{ m s}^{-1}$.

- (a) Draw an appropriate triangle of velocities. (2 marks)
- (b) Find the value of x . (2 marks)
- (c) Find the bearing on which the resultant velocity is directed. (2 marks)

5 A particle A of mass 0.2 kg is connected to a particle B of mass 0.3 kg by a light inextensible string.

The particle A is placed on a rough horizontal surface.

The string passes over a smooth fixed peg with B hanging freely, as shown in the diagram.

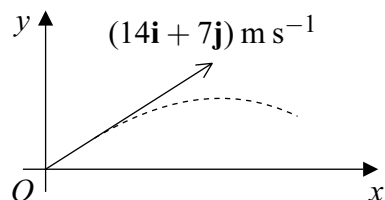


- (a) The system is held in equilibrium by a horizontal force, P newtons, which is applied to the particle A . The coefficient of friction between A and the rough horizontal surface is 0.5 .
- (i) Draw a diagram showing the forces acting on the particle A . (2 marks)
- (ii) Show that the magnitude of the maximum possible frictional force between A and the rough horizontal surface is 0.98 newtons. (2 marks)
- (iii) Find the tension in the string. (2 marks)
- (iv) Find the least value of P required to hold the system in equilibrium. (2 marks)
- (b) The horizontal force P is removed and the particles start to move from rest.
- (i) Find the magnitude of the acceleration of the particles during the subsequent motion. (5 marks)
- (ii) After falling 0.1 metres, the particle B hits the ground. Find the time between the system being released and B hitting the ground. (2 marks)

- 6 A particle P , of mass 0.5 kg, moves under the action of a force \mathbf{F} newtons, where $\mathbf{F} = 2t\mathbf{i} + 1.5\mathbf{j}$ at time t seconds.
- (a) Find the acceleration of P at time t . *(1 mark)*
- (b) The particle P starts its motion from rest.
Find the velocity of P at time t . *(2 marks)*
- (c) The particle P starts its motion at the point O .
- (i) Find the position vector of P relative to O at time t . *(3 marks)*
- (ii) Find the distance of P from O when it is moving parallel to the vector $\mathbf{i} + \mathbf{j}$. *(5 marks)*

TURN OVER FOR THE NEXT QUESTION

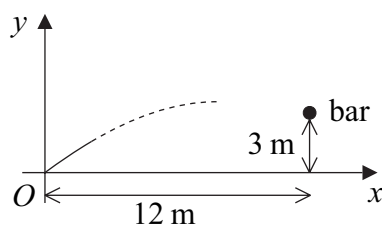
- 7 Jonny is practising kicking a rugby ball. He kicks the ball from a point O on horizontal ground with velocity $14\mathbf{i} + 7\mathbf{j} \text{ m s}^{-1}$. The vectors \mathbf{i} and \mathbf{j} are in the directions of axes Ox and Oy , and Oy is vertically upwards.



- (a) (i) Find the coordinates of the ball t seconds after it has been kicked. (3 marks)
- (ii) Show that the equation of the path of the ball is

$$y = \frac{20x - x^2}{40}. \quad (3 \text{ marks})$$

- (iii) Find the horizontal range of the ball. (2 marks)
- (b) The ball moves towards a horizontal bar which is 3 metres above the ground and at a horizontal distance of 12 metres from O , as shown in the diagram.



- Determine whether the ball passes above or below the bar. (3 marks)
- (c) State one modelling assumption that you have used in answering this question. (1 mark)

END OF QUESTIONS

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