General Certificate of Education
June 2005
Advanced Subsidiary Examination

MATHEMATICS (SPECIFICATION A) MAM1/W
Unit Mechanics 1

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 $g = 9.8\,\text{m}\,\text{s}^{-2}$ 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.

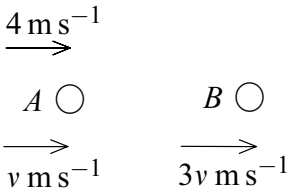
Advice
- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

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

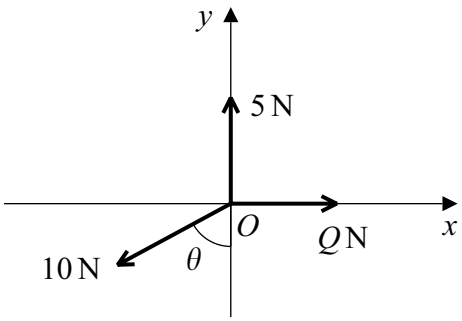
The particle collides with a stationary particle B of mass m kg.

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 N. The directions of these forces, relative to the horizontal axes Ox and Oy, are shown in the diagram below.



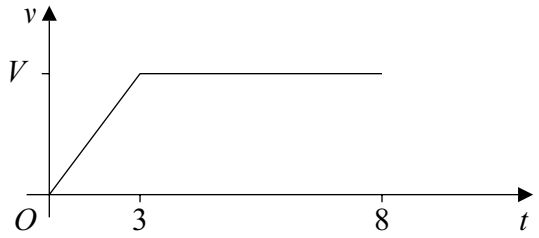
(a) Show that $\theta = 60°$. *(2 marks)*

(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 $V\,\mathrm{m\,s^{-1}}$.

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



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

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 $6\,\text{m s}^{-1}$ due North, relative to the air. The wind is blowing with velocity $2\,\text{m s}^{-1}$ due East. The resultant speed of the aeroplane is $x\,\text{m s}^{-1}$.

(a) Draw an appropriate triangle of velocities. *(2 marks)*

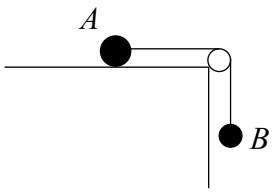
(b) Find the value of x. *(2 marks)*

(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)*

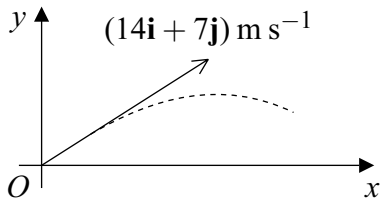
(c) The particle P starts its motion at the point O.

(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 **i** and **j** are in the directions of axes Ox and Oy, and Oy is vertically upwards.



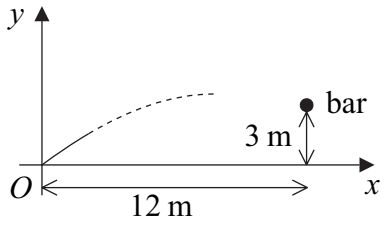
(a) (i) Find the coordinates of the ball t seconds after it has been kicked. *(3 marks)*

(ii) Show that the equation of the path of the ball is

$$y = \frac{20x - x^2}{40}.$$ *(3 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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