General Certificate of Education
January 2008
Advanced Subsidiary Examination

MATHEMATICS **MM1A/W**
Unit Mechanics 1A

Friday 11 January 2008 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.

Answer **all** questions.

1 A crane is used to lift a crate, of mass 70 kg, vertically upwards. As the crate is lifted, it accelerates uniformly from rest, rising 8 metres in 5 seconds.

(a) Show that the acceleration of the crate is $0.64\,\mathrm{m\,s^{-2}}$. *(2 marks)*

(b) The crate is attached to the crane by a single cable. Assume that there is no resistance to the motion of the crate.

Find the tension in the cable. *(3 marks)*

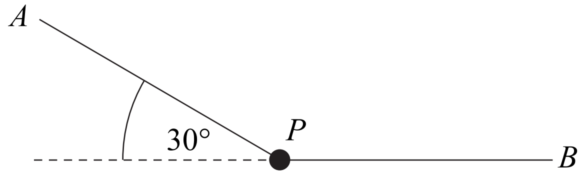
(c) Calculate the average speed of the crate during these 5 seconds. *(1 mark)*

2 The velocity of a ship, relative to the water in which it is moving, is $8\,\mathrm{m\,s^{-1}}$ due north. The water is moving due east with a speed of $U\,\mathrm{m\,s^{-1}}$. The resultant velocity of the ship has magnitude $10\,\mathrm{m\,s^{-1}}$.

(a) Find U. *(2 marks)*

(b) Find the direction of the resultant velocity of the ship. Give your answer as a bearing to the nearest degree. *(2 marks)*

3 A particle, of mass 4 kg, is suspended in equilibrium by two light strings, AP and BP. The string AP makes an angle of 30° to the horizontal and the other string, BP, is horizontal, as shown in the diagram.



(a) Draw and label a diagram to show the forces acting on the particle. *(1 mark)*

(b) Show that the tension in the string AP is 78.4 N. *(3 marks)*

(c) Find the tension in the horizontal string BP. *(2 marks)*

4 Two particles, A and B, are moving on a horizontal plane when they collide and coalesce to form a single particle. The mass of A is 5 kg and the mass of B is 15 kg. Before the collision, the velocity of A is $\begin{bmatrix} 2U \\ U \end{bmatrix}$ m s^{-1} and the velocity of B is $\begin{bmatrix} V \\ -1 \end{bmatrix}$ m s^{-1}. After the collision, the velocity of the combined particle is $\begin{bmatrix} V \\ 0 \end{bmatrix}$ m s^{-1}.

Find:

(a) U; *(3 marks)*

(b) V. *(2 marks)*

5 A block, of mass 15 kg, is placed on a rough horizontal surface. It is attached, by a light inextensible string that passes over a smooth peg, to a particle of mass 5 kg, which hangs freely, as shown in the diagram.

The coefficient of friction between the block and the surface is 0.2. The block and particle are released from rest and move with the string taut.

(a) Find the magnitude of the friction force acting on the block. *(3 marks)*

(b) Show that the acceleration of the system is 0.98 m s^{-2}. *(5 marks)*

(c) The block is travelling at 1.4 m s^{-1} when it reaches the peg.

Find the distance that the block has travelled when it reaches the peg. *(3 marks)*

Turn over for the next question

6 A pellet is fired from a window at a height of 3 metres above horizontal ground. Initially, the pellet travels at $70\,\mathrm{m\,s^{-1}}$ at an angle of $10°$ above the horizontal.

(a) Show that the time for which the pellet travels before it hits the ground is 2.71 seconds, correct to three significant figures. *(6 marks)*

(b) Find the horizontal distance that the pellet travels before it hits the ground. *(2 marks)*

(c) Find the minimum speed of the pellet during its flight. *(2 marks)*

(d) Find the speed of the pellet when it hits the ground. *(4 marks)*

7 A Jet Ski is at the origin and is travelling due north at $5\,\mathrm{m\,s^{-1}}$ when it begins to accelerate uniformly. After accelerating for 40 seconds, it is travelling due east at $4\,\mathrm{m\,s^{-1}}$. The unit vectors $\mathbf{i}$ and $\mathbf{j}$ are directed east and north respectively.

(a) Show that the acceleration of the Jet Ski is $(0.1\,\mathbf{i} - 0.125\,\mathbf{j})\,\mathrm{m\,s^{-2}}$. *(4 marks)*

(b) Find the position vector of the Jet Ski at the end of the 40 second period. *(3 marks)*

(c) The Jet Ski is travelling southeast t seconds after it leaves the origin.

(i) Find t. *(5 marks)*

(ii) Find the velocity of the Jet Ski at this time. *(2 marks)*

END OF QUESTIONS