General Certificate of Education
June 2008
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

MATHEMATICS
Unit Mechanics 1A

MM1A/W

Monday 2 June 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

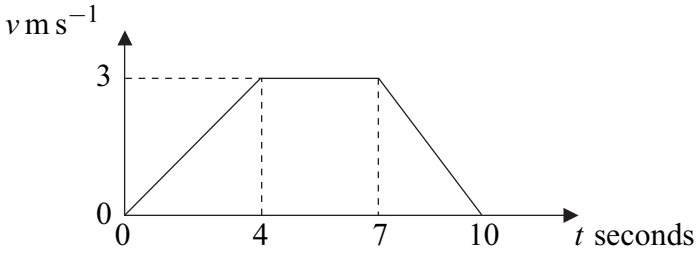
Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MM1A/W.
- Answer **all** questions.
- Show all necessary working; otherwise 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 $g = 9.8\,\text{m}\,\text{s}^{-2}$, 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 The diagram shows a velocity–time graph for a lift.

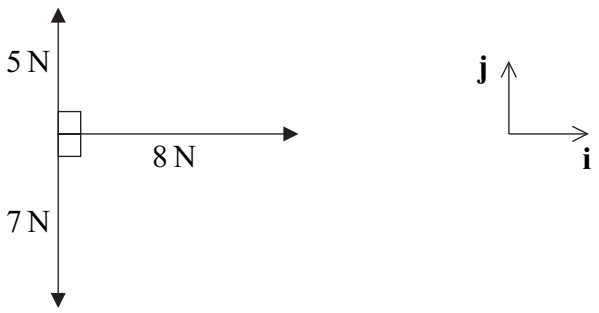


(a) Find the distance travelled by the lift. *(3 marks)*

(b) Find the acceleration of the lift during the first 4 seconds of the motion. *(1 mark)*

(c) The lift is raised by a single vertical cable. The mass of the lift is 400 kg. Find the tension in the cable during the first 4 seconds of the motion. *(3 marks)*

2 The diagram shows three forces and the perpendicular unit vectors **i** and **j**, which all lie in the same plane.



(a) Express the resultant of the three forces in terms of **i** and **j**. *(2 marks)*

(b) Find the magnitude of the resultant force. *(2 marks)*

(c) Draw a diagram to show the direction of the resultant force, and find the angle that it makes with the unit vector **i**. *(3 marks)*

3 Two particles, A and B, are connected by a light inextensible string, which passes over a smooth peg. Particle A is on a rough horizontal surface and has mass 3 kg. Particle B hangs freely, as shown in the diagram, and has mass 2 kg. The coefficient of friction between A and the horizontal surface is μ.

The particles are released from rest and move with a constant acceleration of magnitude $0.9\,\text{m s}^{-2}$.

(a) Find the tension in the string. *(3 marks)*

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

(c) Calculate the magnitude of the normal reaction force acting on A. *(1 mark)*

(d) Find the magnitude of the friction force that acts on A. *(2 marks)*

(e) Find μ. *(2 marks)*

4 An aeroplane is travelling due north at $180\,\text{m s}^{-1}$ relative to the air. The air is moving north-west at $50\,\text{m s}^{-1}$.

(a) Find the magnitude of the resultant velocity of the aeroplane. *(4 marks)*

(b) Find the direction of the resultant velocity, giving your answer as a three-figure bearing to the nearest degree. *(4 marks)*

5 A ball is kicked so that it leaves a horizontal surface, at the point A, travelling at $16\,\text{m s}^{-1}$ and at an angle θ above the horizontal. The ball hits the surface again 2 seconds later, at the point B. Assume that the ball is a particle that moves only under the influence of gravity.

(a) Show that $\theta = 37.8°$, correct to three significant figures. *(3 marks)*

(b) Find the time for which the ball is more than 2 metres above the surface. *(5 marks)*

Turn over for the next question

6 The unit vectors **i** and **j** are directed east and north respectively. A helicopter moves horizontally with a constant acceleration of $(-0.4\mathbf{i} + 0.5\mathbf{j})\,\mathrm{m\,s^{-2}}$. At time $t = 0$, the helicopter is at the origin and has velocity $20\mathbf{i}\,\mathrm{m\,s^{-1}}$.

(a) Write down an expression for the velocity of the helicopter at time t seconds. *(2 marks)*

(b) Find the time when the helicopter is travelling due north. *(3 marks)*

(c) Find an expression for the position vector of the helicopter at time t seconds. *(2 marks)*

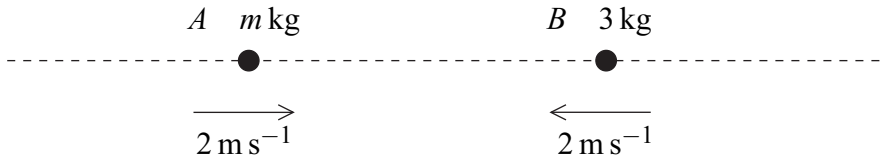
(d) When $t = 100$:

(i) show that the helicopter is due north of the origin; *(3 marks)*

(ii) find the speed of the helicopter. *(3 marks)*

7 Two particles, A and B, are travelling towards each other along a straight horizontal line.

Particle A has velocity $2\,\mathrm{m\,s^{-1}}$ and mass $m\,\mathrm{kg}$.
Particle B has velocity $-2\,\mathrm{m\,s^{-1}}$ and mass $3\,\mathrm{kg}$.



The particles collide.

(a) If the particles move in opposite directions after the collision, each with speed $0.5\,\mathrm{m\,s^{-1}}$, find the value of m. *(3 marks)*

(b) If the particles coalesce during the collision, forming a single particle which moves with speed $0.5\,\mathrm{m\,s^{-1}}$, find the two possible values of m. *(5 marks)*

END OF QUESTIONS