GCE AS/A level

0980/01

MATHEMATICS M1
Mechanics 1

A.M. THURSDAY, 24 May 2012

1½ hours

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a 12 page answer book;
- a Formula Booklet;
- a calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Answer **all** questions.

Take g as $9{\cdot}8\,\text{ms}^{-2}$.

Sufficient working must be shown to demonstrate the **mathematical** method employed.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

1. A lift of mass 2500 kg is ascending with an acceleration of $1{\cdot}8\,\text{ms}^{-2}$.

(a) Calculate the tension in the lift cable. [3]

(b) A person of mass M kg stands on the floor of the lift. Given that the magnitude of the reaction of the floor of the lift on the person is 696 N, find the value of M. [3]

2. A particle of mass 3 kg moves in a straight line on a rough horizontal surface. The coefficient of friction between the particle and the surface is $\frac{6}{49}$.

(a) Find the frictional force and show that the deceleration of the particle is $1{\cdot}2\,\text{ms}^{-2}$. [4]

(b) The speed of the particle at the point O is $9\,\text{ms}^{-1}$ and it comes to rest at point A. Calculate the distance OA. [3]

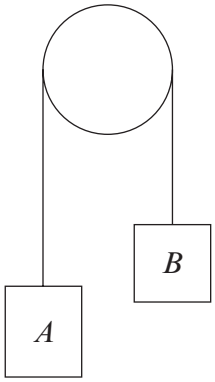
3. Two spheres A and B, with masses 6 kg and 2 kg respectively, move towards each other on a smooth horizontal surface and collide directly. Just before the collision, the speed of A is $7\,\text{ms}^{-1}$ and the speed of B is $3\,\text{ms}^{-1}$. Immediately after the collision, both spheres move in the same direction with the speed of B being twice that of the speed of A.

(a) Show that the speed of B immediately after the collision is $7{\cdot}2\,\text{ms}^{-1}$. [4]

(b) Determine the coefficient of restitution between the spheres. [3]

(c) Find the magnitude of the impulse exerted by sphere A on sphere B in the collision. [2]

4. Two particles A and B are connected by a light inextensible string which passes over a smooth fixed pulley. Particle A has mass 3 kg and particle B has mass M kg. Initially, the particles are held at rest with the string just taut and the hanging parts of the string vertical, as shown in the diagram.



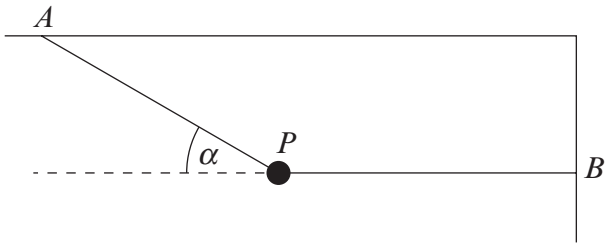
The system is then released from rest and particle B moves downwards with acceleration $0{\cdot}4g\,\text{ms}^{-2}$, where g is the acceleration due to gravity.
Calculate the tension in the string and the value of M. [7]

5. A sledge, of mass 39 kg, moves on a rough slope inclined at an angle α to the horizontal, where $\tan\alpha = \frac{5}{12}$. The coefficient of friction between the sledge and the slope is 0·3.

(a) Given that the sledge is moving freely down a line of greatest slope, calculate the magnitude of the acceleration of the sledge. Give your answer correct to 2 decimal places. [6]

(b) Given that the sledge is being pulled up the slope with acceleration $0{\cdot}4\,\text{ms}^{-2}$ by means of a rope parallel to a line of greatest slope, find the tension in the rope. [3]

6. The diagram shows a particle P, of mass 4 kg, held in equilibrium by two light inextensible strings AP and BP. The string AP makes an angle α with the horizontal and is attached to the ceiling at the point A. The string BP is horizontal and is attached to the wall at the point B. The tension in the string BP is 30 N.



Find the angle α and the tension in the string AP. Give your answers correct to 2 decimal places. [8]

7. A skydiver drops from rest from a hot air balloon and falls vertically under gravity for 5 s before his parachute opens. After the parachute has opened, his speed of descent reduces with uniform retardation for a further 10 s until his speed is $4\,\text{ms}^{-1}$. He then continues to travel at a constant speed of $4\,\text{ms}^{-1}$ until he reaches the ground 2 minutes after he left the hot air balloon.

(a) Calculate the speed of the skydiver just before his parachute opens. [3]

(b) Draw a sketch of the velocity-time graph for the skydiver's descent. [4]

(c) Determine the height of the skydiver above the ground when he drops from the hot air balloon. [3]

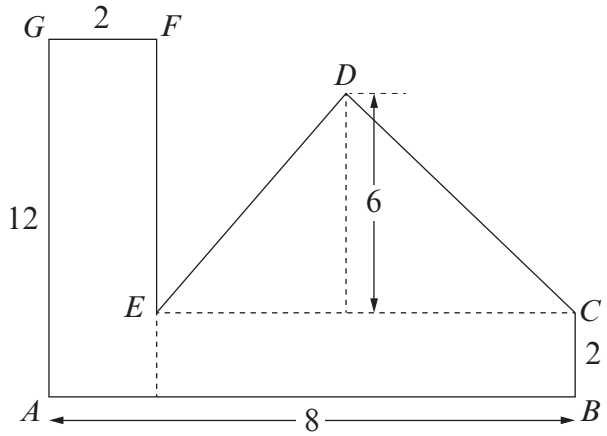
8. A light uniform rod AB has length 1·4 m. A particle of mass 5 kg is attached to end A, and a particle of mass 2 kg is attached to end B. The rod rests horizontally in equilibrium on a smooth support at C.

(a) Calculate the reaction of the support at C. [2]

(b) Find the distance AC. [4]

TURN OVER

9. The diagram shows a uniform lamina $ABCDEFG$. The lamina consists of two rectangles forming an L-shape $ABCEFG$ and an isosceles triangle CDE with $DE = DC$. Dimensions, in cm, are shown in the diagram.



(a) Calculate the distance of the centre of mass of the lamina from

(i) AG,

(ii) AB. [10]

The lamina is suspended freely from the point G and hangs in equilibrium.

(b) Find the angle AG makes with the vertical. [3]