GCE AS/A level

0980/01

MATHEMATICS – M1
Mechanics

A.M. THURSDAY, 6 June 2013

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 vehicle moves along a straight horizontal road. At time $t = 0$ s, the vehicle passes a point A and is moving with a speed of 20 ms^{-1}. It continues with this constant speed of 20 ms^{-1} for 8 s. The vehicle then slows down with uniform deceleration for 10 s so that at time $t = 18$ s, the speed of the vehicle is 6 ms^{-1}. This speed is maintained until the vehicle reaches the point B at time $t = 40$ s.

(a) Sketch a velocity-time graph for the motion of the vehicle between A and B. [3]

(b) Find the magnitude of the deceleration between $t = 8$ and $t = 18$. [3]

(c) Calculate the distance AB. [3]

2. A person of mass 64 kg is standing in a lift which is of mass M kg. When the lift is accelerating downwards at a constant rate of 0·425 ms^{-2}, the tension in the lift cable is 7500 N.

(a) Calculate the value of M. [3]

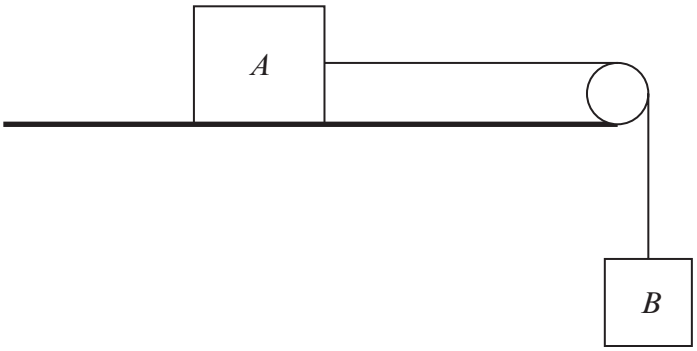
(b) Find the reaction between the person and the floor of the lift. [3]

3. An object is projected vertically upwards with speed u ms^{-1} from a point A which is 2·8 m above horizontal ground. The object reaches its greatest height of 18·225 m above A before falling to the ground.

(a) Show that the value of u is 18·9. [3]

(b) Find the time between the object being projected and the object hitting the ground. [4]

4. The diagram shows two bodies A and B, of mass 9 kg and 5 kg respectively, connected by a light inextensible string passing over a smooth light pulley fixed at the edge of a **rough** horizontal table. The heavier body A lies on the table and the lighter body B hangs freely below the pulley.



Initially, the system is held at rest with the string taut. The system is then released.

(a) Given that the magnitude of the acceleration of the bodies is 1·61 ms^{-2}, calculate the tension in the string and the coefficient of friction between A and the table. [8]

(b) Given that the coefficient of friction is 0·6, determine whether the bodies will move or remain at rest and evaluate the tension in the string. [3]

5. The diagram shows a uniform plank AB of mass 12 kg and length 2 m. The plank rests horizontally in equilibrium on two supports at C and at D, where $AC = 0{\cdot}8$ m and $AD = x$ m.

(a) The reaction of the support on the plank at D has magnitude 84 N.

(i) Determine the reaction of the support on the plank at C.

(ii) Calculate the value of x. [7]

(b) A rock of mass M kg is placed at A so that the plank is on the point of tilting about C. Calculate the value of M. [3]

6. A particle P, of mass 2 kg, is moving with speed u ms^{-1} in a straight line on a smooth horizontal surface. The particle P collides directly with another particle Q, of mass 5 kg, which is at rest on the surface. Immediately after the collision, P moves with speed 2 ms^{-1} in a direction opposite to the original direction of motion, and the speed of Q is 3 ms^{-1}.

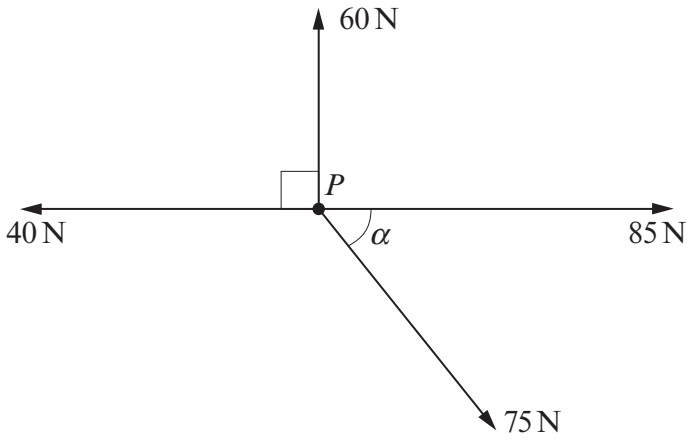
(a) Find the value of u. [3]

(b) Determine the coefficient of restitution between P and Q. [3]

(c) Calculate the magnitude of the impulse exerted by P on Q. [2]

(d) After the collision between P and Q, particle Q strikes a vertical wall which is perpendicular to its direction of motion. The coefficient of restitution between Q and the wall is 0·25. Calculate the speed with which Q rebounds from the wall. [2]

7. Four coplanar horizontal forces of magnitude 60 N, 85 N, 75 N and 40 N act on a particle P, of mass 5 kg, in the directions shown in the diagram, where $\tan \alpha = \frac{3}{4}$.

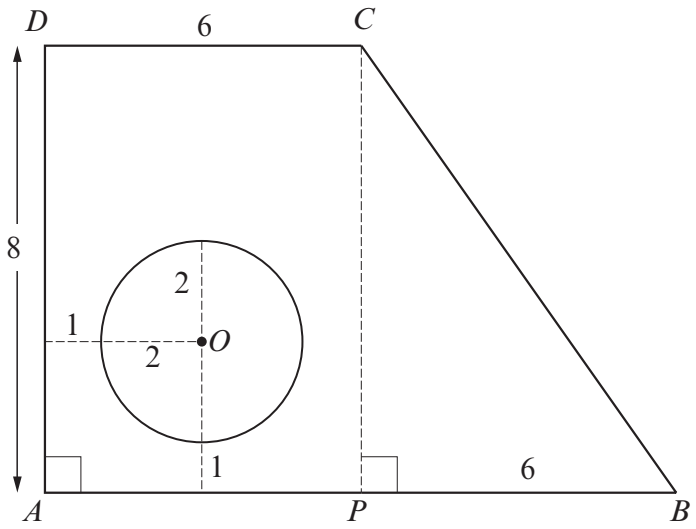


(a) Calculate the magnitude of the resultant force and determine the angle it makes with the 85 N force. [9]

(b) Deduce the magnitude of the acceleration of the particle P. [2]

TURN OVER

8. The diagram shows a uniform lamina in the form of a trapezium $ABCD$ with a circular hole, of radius 2 cm, removed. The angle $D\hat{A}B$ is 90°. The dimensions, in cm, are shown in the diagram. The centre O of the circular hole is 3 cm from AD and 3 cm from AB.



(a) Find the distances of the centre of mass of the lamina from AD and AB. [10]

(b) When the lamina is freely suspended from a point Q on AD, it hangs in equilibrium with AB vertical. Write down the distance of Q from A. [1]

