



**GCE AS/A level**

0980/01

**MATHEMATICS – M1**  
**Mechanics**

P.M. FRIDAY, 25 January 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  $9.8 \text{ ms}^{-2}$ .

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

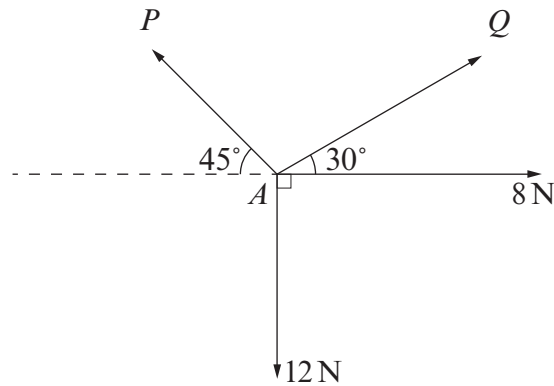
#### **INFORMATION FOR CANDIDATES**

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 car moves with constant acceleration along a straight horizontal road. It passes the point  $O$  with speed  $12 \text{ ms}^{-1}$ . It then passes point  $A$ , 4 seconds later, with speed  $32 \text{ ms}^{-1}$ .
- (a) Show that the acceleration of the car is  $5 \text{ ms}^{-2}$ . [3]
- (b) Determine the distance  $OA$ . [3]
- (c) The point  $M$  is the midpoint of  $OA$ . Calculate the speed of the car as it passes  $M$ . Give your answer correct to one decimal place. [3]
2. (a) Two particles  $A$  and  $B$  lie at rest on a smooth horizontal surface. Particle  $A$  has mass  $3 \text{ kg}$  and particle  $B$  has mass  $7 \text{ kg}$ . Particle  $A$  is projected with speed  $4 \text{ ms}^{-1}$  towards particle  $B$  and collides directly with it. When the particles collide, they coalesce to form one particle.
- (i) Write down the coefficient of restitution between the particles.
- (ii) Determine the speed of the combined particle after the collision. [4]
- (b) Another particle of mass  $6 \text{ kg}$  travelling with speed  $5 \text{ ms}^{-1}$  collides directly with a vertical wall and rebounds. The coefficient of restitution between the particle and the wall is  $0.25$ .
- (i) Calculate the speed of the particle after the collision with the wall.
- (ii) Find the impulse exerted by the wall on the particle. State your units clearly. [5]
3. A particle is projected vertically upwards with an initial speed of  $15 \text{ ms}^{-1}$  from a point  $A$ , which is  $1.2 \text{ m}$  above horizontal ground.
- (a) Determine the time taken for the particle to reach the ground. Give your answer correct to one decimal place. [4]
- (b) Suppose a heavier particle is projected vertically upwards from the same point  $A$  and with the same initial speed of  $15 \text{ ms}^{-1}$ . Would the time taken for the particle to reach the ground be greater, the same, or less than your answer in (a)? Give a reason for your answer. [1]

4. The diagram shows four forces acting at a point  $A$  in a horizontal plane.

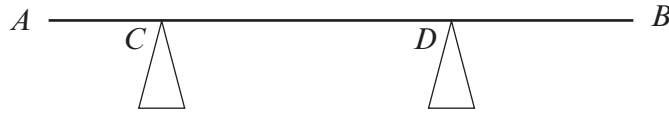


Given that the forces are in equilibrium, calculate the value of  $P$  and the value of  $Q$ . Give your answers correct to one decimal place. [7]

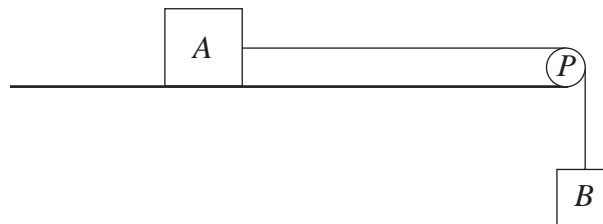
5. An object of mass  $75\text{ kg}$  lies on a rough plane, which is inclined at an angle of  $25^\circ$  to the horizontal. The coefficient of friction between the object and the plane is  $0.3$ . A force of magnitude  $T\text{ N}$  acts on the object in a direction parallel to a line of greatest slope of the plane.
- (a) Given that the object is just prevented from sliding down the plane, calculate the value of  $T$ . [6]
- (b) Given that  $T = 0$ , find the magnitude of the acceleration of the object. [3]
6. A parcel of mass  $25\text{ kg}$  is on the floor of a lift, which is descending with an acceleration of  $a\text{ ms}^{-2}$ . The mass of the lift is  $775\text{ kg}$ .
- (a) Given that the tension in the lift cable is  $6500\text{ N}$ , calculate the value of  $a$ . [3]
- (b) Find the magnitude of the reaction of the floor of the lift on the parcel. [3]

# TURN OVER

7. A uniform beam  $AB$ , of length 6 m, rests in a horizontal position on two smooth supports at  $C$  and  $D$ , where  $AC = 1$  m and  $BD = 1.2$  m, as shown in the diagram.

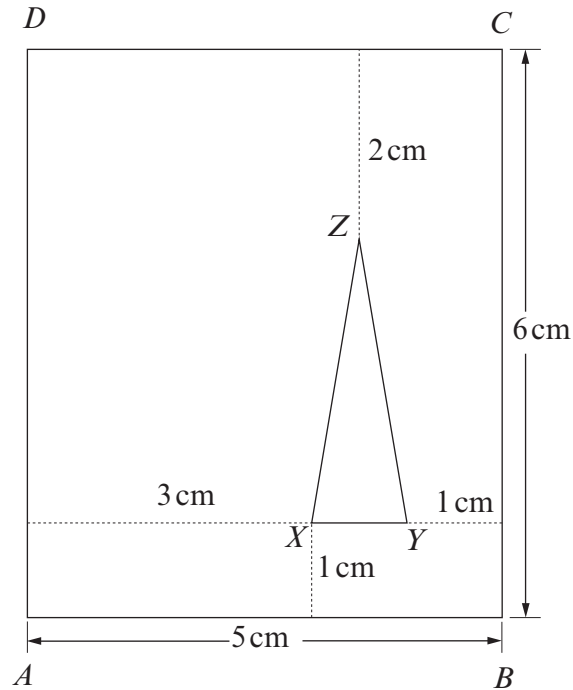


- (a) When a vertical force of magnitude 1800 N is applied upwards to the beam at the end  $A$ , the beam is about to tilt about the support at  $D$ . Determine the weight of the beam. [5]
- (b) The vertical force is now removed so that the beam is resting in equilibrium on the two supports. Calculate the magnitude of the reaction of each of the supports at  $C$  and  $D$  on the beam. [5]
8. The diagram shows a body  $A$ , of mass 5 kg, lying on a smooth horizontal table. It is connected to another body  $B$ , of mass 9 kg, by a light inextensible string, which passes over a smooth light pulley  $P$  fixed at the edge of the table so that  $B$  hangs freely.



Initially, the system is held at rest with the string taut. A horizontal force of magnitude 126 N is then applied to  $A$  in the direction  $PA$  so that  $B$  is raised. Find the magnitude of the acceleration of  $A$  and the tension in the string. [7]

9. The diagram shows a lamina, made of uniform material, consisting of a rectangle  $ABCD$  with triangle  $XYZ$  removed. Triangle  $XYZ$  is isosceles with  $XZ = YZ$  and  $XY$  parallel to  $AB$ . Dimensions are as shown in the diagram.



- (a) Calculate the distances of the centre of mass of the lamina from  $AD$  and  $AB$ . [9]
- (b) The lamina is freely suspended from  $A$  and hangs in equilibrium. Calculate the angle that  $AB$  makes with the vertical. [3]
- (c) When the lamina is suspended freely from a point  $P$  on  $DC$ , it hangs with  $AD$  vertical. Write down the length of  $DP$ . [1]