



**GCE AS/A level**

0980/01



S15-0980-01

**MATHEMATICS – M1**  
**Mechanics**

A.M. FRIDAY, 5 June 2015

1 hour 30 minutes

### **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  $9.8 \text{ ms}^{-2}$ .

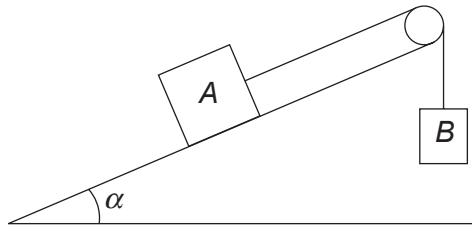
Sufficient working must be shown to demonstrate the **mathematical** method employed.

### **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 man of mass  $M$  kg stands on the floor of a lift which is ascending with constant acceleration of  $0.2 \text{ ms}^{-2}$ . The reaction of the floor of the lift on the man is  $680 \text{ N}$ . The mass of the lift is  $1800 \text{ kg}$ . Determine the value of  $M$  and the tension in the lift cable. [6]
2. The diagram shows a body  $A$  lying on a rough plane. The plane is inclined at an angle  $\alpha$  to the horizontal, where  $\sin \alpha = \frac{5}{13}$ . Body  $A$  is connected by a light inextensible string passing over a light smooth pulley to another body  $B$ , which is hanging freely. The masses of  $A$  and  $B$  are  $4 \text{ kg}$  and  $5 \text{ kg}$  respectively.

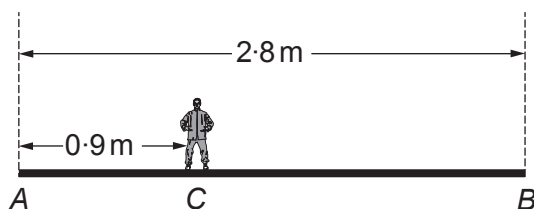


The system is in equilibrium with  $A$  on the point of moving up the plane.

Show that the coefficient of friction between the body  $A$  and the plane is  $\frac{15}{16}$ . [8]

3. A sphere  $A$ , of mass  $3 \text{ kg}$ , moving with speed  $8 \text{ ms}^{-1}$  on a smooth horizontal floor collides directly with another sphere  $B$ , of mass  $5 \text{ kg}$ , moving on the floor in the same direction with speed  $2 \text{ ms}^{-1}$ . The coefficient of restitution between sphere  $A$  and sphere  $B$  is  $\frac{1}{3}$ .
- (a) Determine the speed of  $A$  and the speed of  $B$  immediately after the collision. [7]
- (b) Calculate the magnitude of the impulse exerted by  $A$  on  $B$ . [2]
4. The  $x$ - $y$  plane is horizontal and four particles, of masses  $5 \text{ kg}$ ,  $2 \text{ kg}$ ,  $3 \text{ kg}$  and  $6 \text{ kg}$ , are at points  $(4, -1)$ ,  $(2, 3)$ ,  $(-2, 5)$  and  $(-3, 0)$  respectively. Find the coordinates of the centre of mass of the four particles. [6]

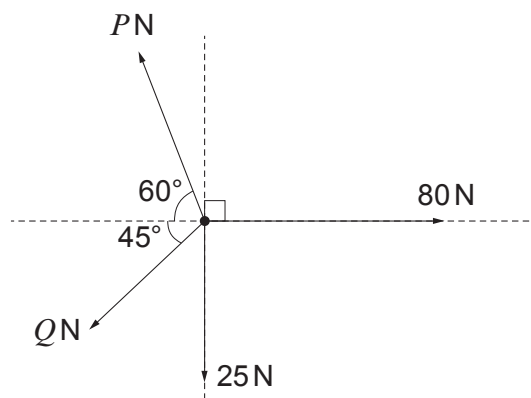
5. The diagram shows a plank  $AB$ , of mass  $15\text{ kg}$  and length  $2.8\text{ m}$ , being held in equilibrium with  $AB$  horizontal by means of two vertical ropes, one attached to the end  $A$  and the other attached to the end  $B$ . A man of mass  $80\text{ kg}$  stands on the plank at point  $C$ , where  $AC = 0.9\text{ m}$ .



- (a) Modelling the plank as a uniform rod, find the tensions in the ropes attached to the end  $A$  and the end  $B$  of the plank. [7]
- (b) The plank is now modelled as a **non-uniform** rod. Given that the tension in the rope attached to  $A$  is  $1.5$  times the tension in the rope attached to  $B$ , determine the distance of the centre of mass of the plank from  $A$ . [5]
6. A bus travels on a straight horizontal road. It leaves bus stop  $A$  starting from rest and accelerates at a constant rate for  $10\text{ s}$  until it reaches a speed of  $20\text{ ms}^{-1}$ . It then continues to travel at this constant speed and,  $T$  seconds after it stops accelerating, it passes a point  $B$ .
- (a) Sketch a velocity-time graph for the motion of the bus between  $A$  and  $B$ . [3]
- (b) Find the acceleration of the bus. [2]
- (c) Determine an expression for the distance between  $A$  and  $B$  in terms of  $T$ . [3]
- (d) A car leaves  $A$   $5$  seconds after the bus has left. It starts from rest and travels with a constant acceleration of magnitude  $2\text{ ms}^{-2}$ . Given that the car overtakes the bus at the point  $B$ , find the distance between  $A$  and  $B$ . [5]

# TURN OVER

7. The diagram shows four horizontal forces of magnitude  $PN$ ,  $QN$ ,  $25\text{N}$  and  $80\text{N}$  acting at a point.

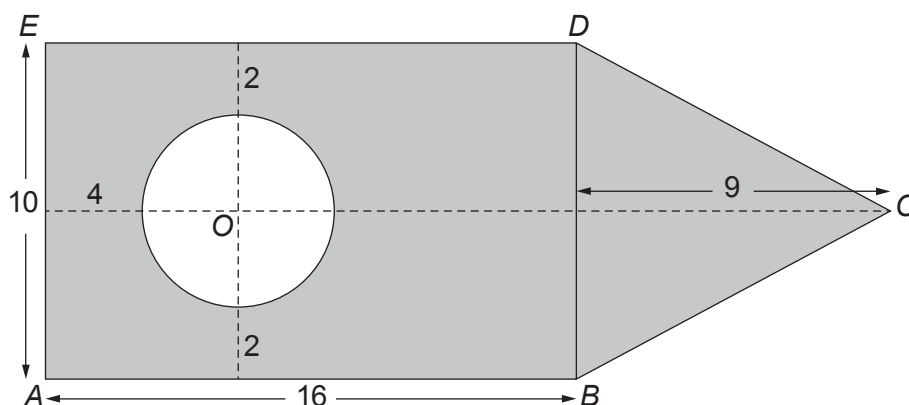


Given that the forces are in equilibrium, calculate the value of  $P$  and the value of  $Q$ . Give your answers correct to one decimal place. [7]

8. An object is projected vertically downwards from a point  $A$  with an initial speed of  $2.1\text{ ms}^{-1}$  towards a horizontal surface. The point  $A$  is at a height of  $4\text{ m}$  above the surface. The coefficient of restitution between the object and the surface is  $\frac{4}{7}$ .

- (a) Show that the speed of the object immediately after it has rebounded from the surface is  $5.2\text{ ms}^{-1}$ . [5]
- (b) Determine the smallest number of bounces after which the speed of the object immediately after rebound is less than  $1\text{ ms}^{-1}$ . [2]

9. The diagram shows a lamina  $ABCDE$  which is made of a uniform material. It consists of a rectangular piece  $ABDE$  together with a triangular piece  $BCD$ . A circular section, with centre  $O$ , is removed from  $ABDE$ . In triangle  $BCD$ ,  $BC = CD$ . The dimensions, in  $\text{cm}$ , are as shown in the diagram.



Find the distances of the centre of mass of the lamina from  $AE$  and  $AB$ . [7]

**END OF PAPER**