



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 ms^{-2} .

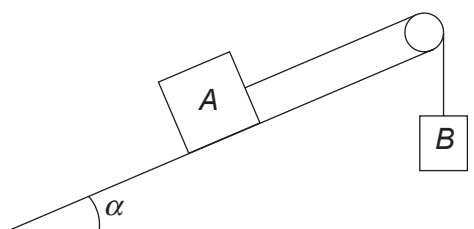
Sufficient working must be shown to demonstrate the **mathematical** method employed.

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 ms^{-2} . The reaction of the floor of the lift on the man is 680 N . The mass of the lift is 1800 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 α 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 kg and 5 kg respectively.

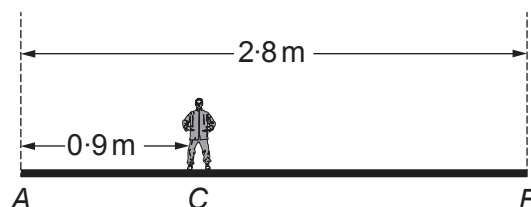


The system is in equilibrium with A on the point of moving up the plane.

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 kg , moving with speed 8 ms^{-1} on a smooth horizontal floor collides directly with another sphere B , of mass 5 kg , moving on the floor in the same direction with speed 2 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 kg , 2 kg , 3 kg and 6 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]

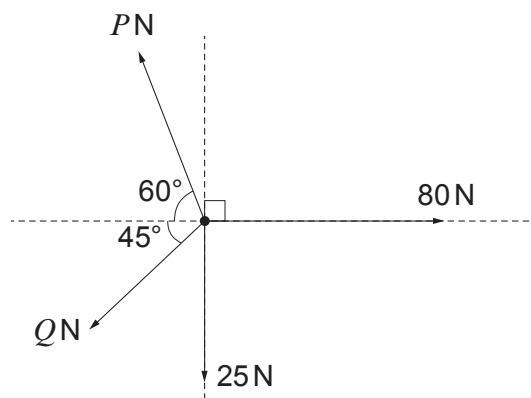
5. The diagram shows a plank AB , of mass 15 kg and length 2.8 m , being held in equilibrium with AB horizontal by means of two vertical ropes, one attached to the end A and the other attached to the end B . A man of mass 80 kg stands on the plank at point C , where $AC = 0.9\text{ m}$.



- (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 s until it reaches a speed of 20 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 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 N and 80 N acting at a point.

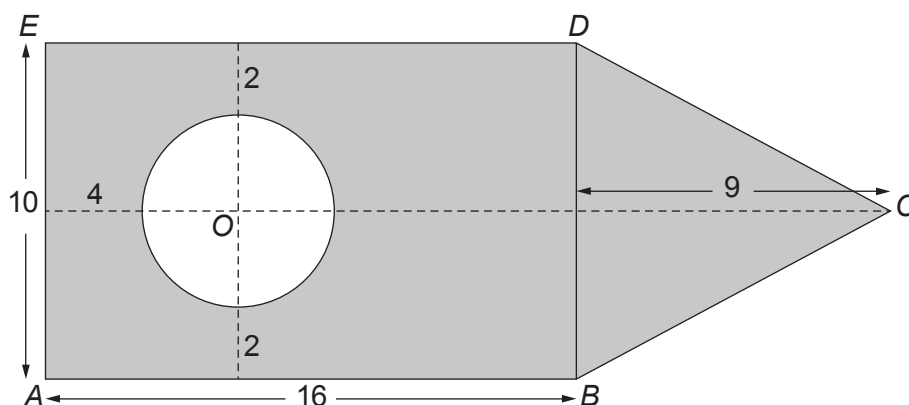


Given that the forces are in equilibrium, calculate the value of P and the value of Q . Give your answers correct to one decimal place. [7]

8. An object is projected vertically downwards from a point A with an initial speed of 2.1 ms^{-1} towards a horizontal surface. The point A is at a height of 4 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 ms^{-1} . [5]
- (b) Determine the smallest number of bounces after which the speed of the object immediately after rebound is less than 1 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 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