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

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

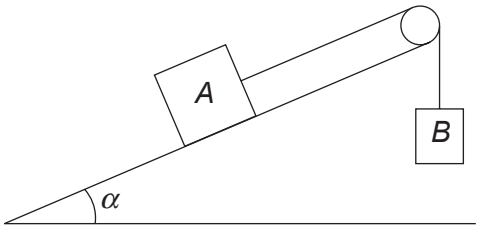
INFORMATION FOR CANDIDATES

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 man of mass M kg stands on the floor of a lift which is ascending with constant acceleration of $0{\cdot}2\,\text{ms}^{-2}$. 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]

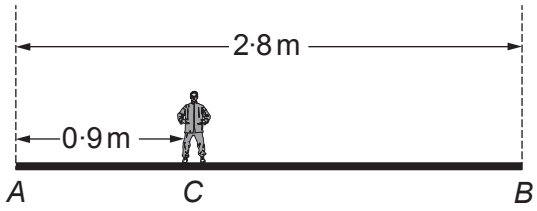
3. A sphere A, of mass 3 kg, moving with speed $8\,\text{ms}^{-1}$ on a smooth horizontal floor collides directly with another sphere B, of mass 5 kg, moving on the floor in the same direction with speed $2\,\text{ms}^{-1}$. The coefficient of restitution between sphere A and sphere B is $\frac{1}{3}$.

(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 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 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]

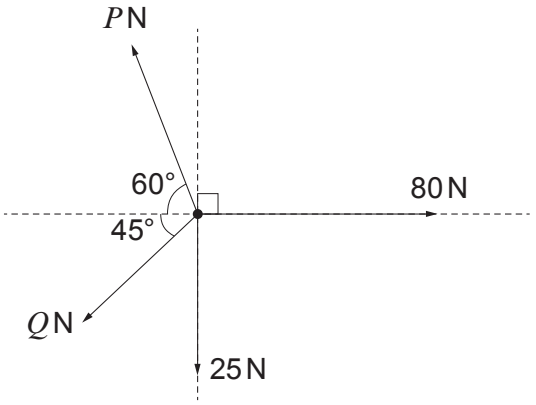
(b) Find the acceleration of the bus. [2]

(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, 25N and 80N acting at a point.



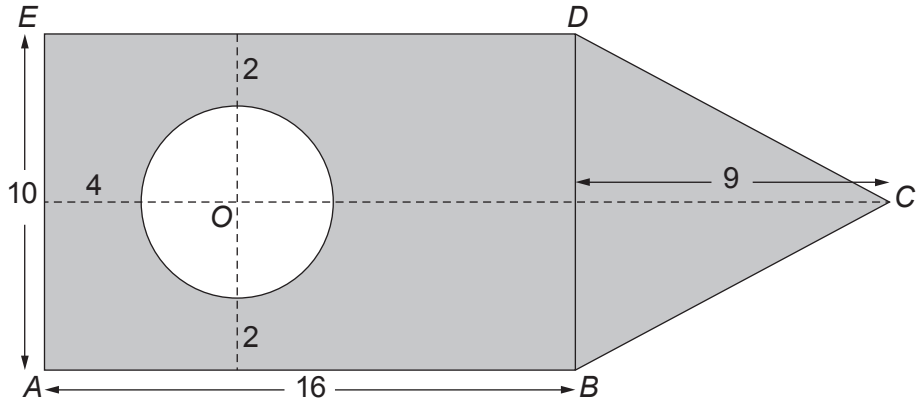
Given that the forces are in equilibrium, calculate the value of P and the value of Q. Give your answers correct to one decimal place. [7]

8. An object is projected vertically downwards from a point *A* with an initial speed of $2{\cdot}1\,\text{ms}^{-1}$ towards a horizontal surface. The point *A* is at a height of 4m 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 $5{\cdot}2\,\text{ms}^{-1}$. [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 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

