GCE AS/A level

0980/01

MATHEMATICS – M1

Mechanics

A.M. FRIDAY, 5 June 2015

1 hour 30 minutes plus your additional time allowance

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, black ball-point pen or your usual method.

Answer ALL questions.

Take g as $9{\cdot}8\,\mathrm{ms}^{-2}$.

Sufficient working must be shown to demonstrate the MATHEMATICAL method employed.

INFORMATION FOR CANDIDATES

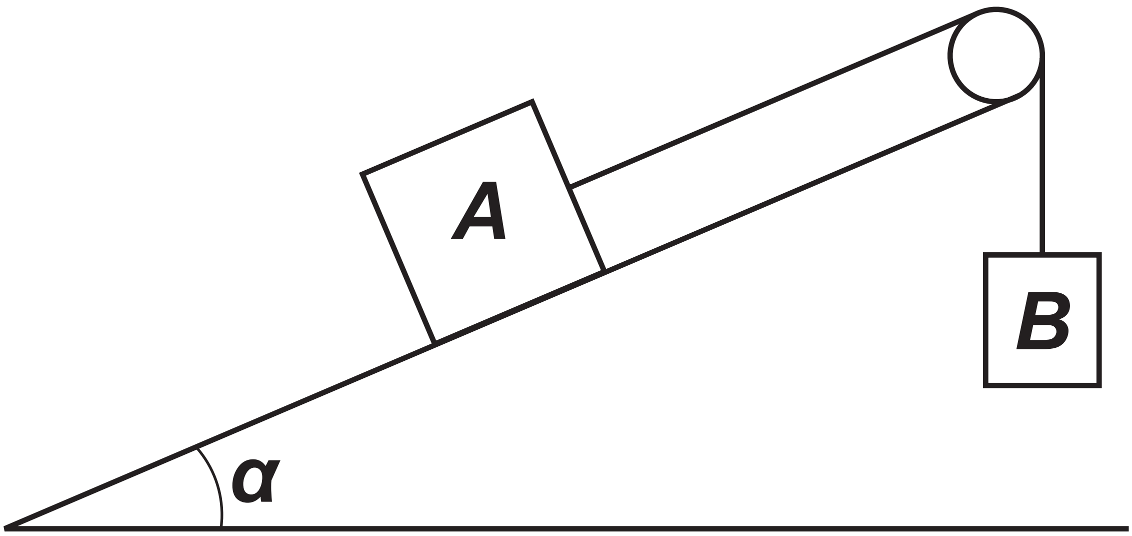
The number of marks is given in brackets at the end of each question or part-question.

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 $0{\cdot}2\ \mathrm{ms}^{-2}$. The reaction of the floor of the lift on the man is $680\ \mathrm{N}$. The mass of the lift is $1800\ \mathrm{kg}$. Determine the value of M and the tension in the lift cable. [6 marks]

2. The diagram shows a body A lying on a rough plane. The plane is inclined at an angle α to the horizontal, where $\sin\alpha = \dfrac{5}{13}$

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 $\dfrac{15}{16}$ [8 marks]

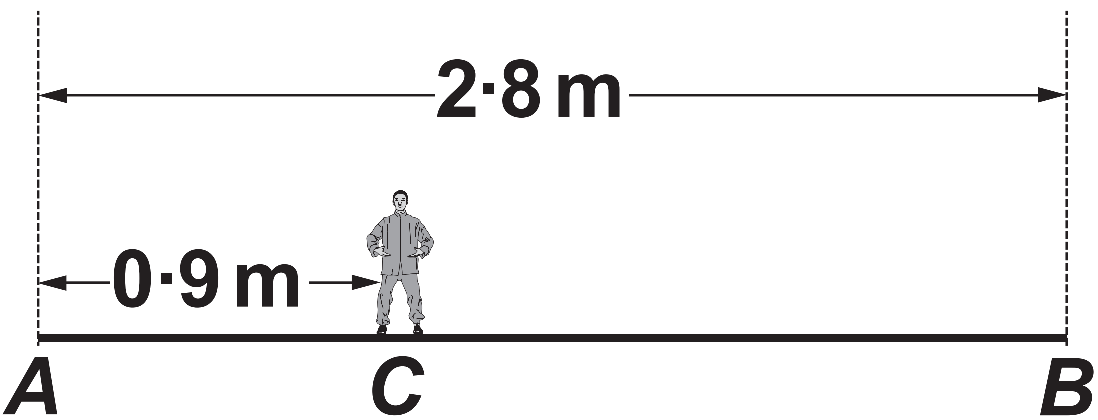
3. A sphere A, of mass $3\,\text{kg}$, moving with speed $8\,\text{ms}^{-1}$ on a smooth horizontal floor collides directly with another sphere B, of mass $5\,\text{kg}$, moving on the floor in the same direction with speed $2\,\text{ms}^{-1}$. The coefficient of restitution between sphere A and sphere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

(a) Determine the speed of A and the speed of B immediately after the collision. [7 marks]

(b) Calculate the magnitude of the impulse exerted by A on B [2 marks]

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 marks]

5. The diagram shows a plank AB, of mass $15\,\text{kg}$ and length $2{\cdot}8\,\text{m}$, 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 $AC = 0{\cdot}9\,\text{m}$



(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]

5(b) **The plank is now modelled as a NON-UNIFORM rod. Given that the tension in the rope attached to A is $1 \cdot 5$ times the tension in the rope attached to B, determine the distance of the centre of mass of the plank from A.** **[5 marks]**

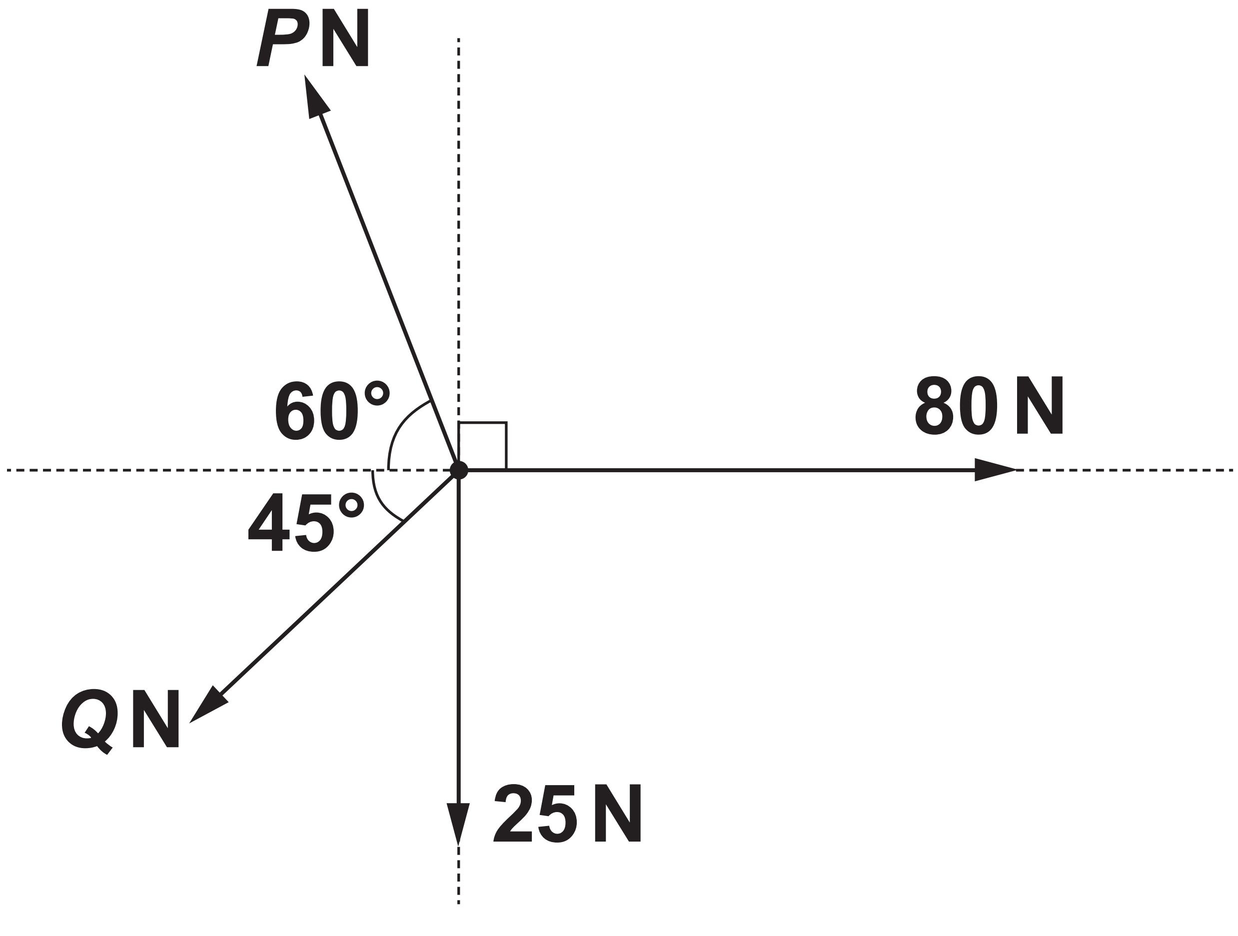
6. A bus travels on a straight horizontal road. It leaves bus stop A starting from rest and accelerates at a constant rate for 10 s until it reaches a speed of 20 ms^{-1}. It then continues to travel at this constant speed and, T seconds after it stops accelerating, it passes a point B.

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

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

(c) Determine an expression for the distance between A and B in terms of T. [3 marks]

(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 marks]


P N
60°
45°
80 N
Q N
25 N

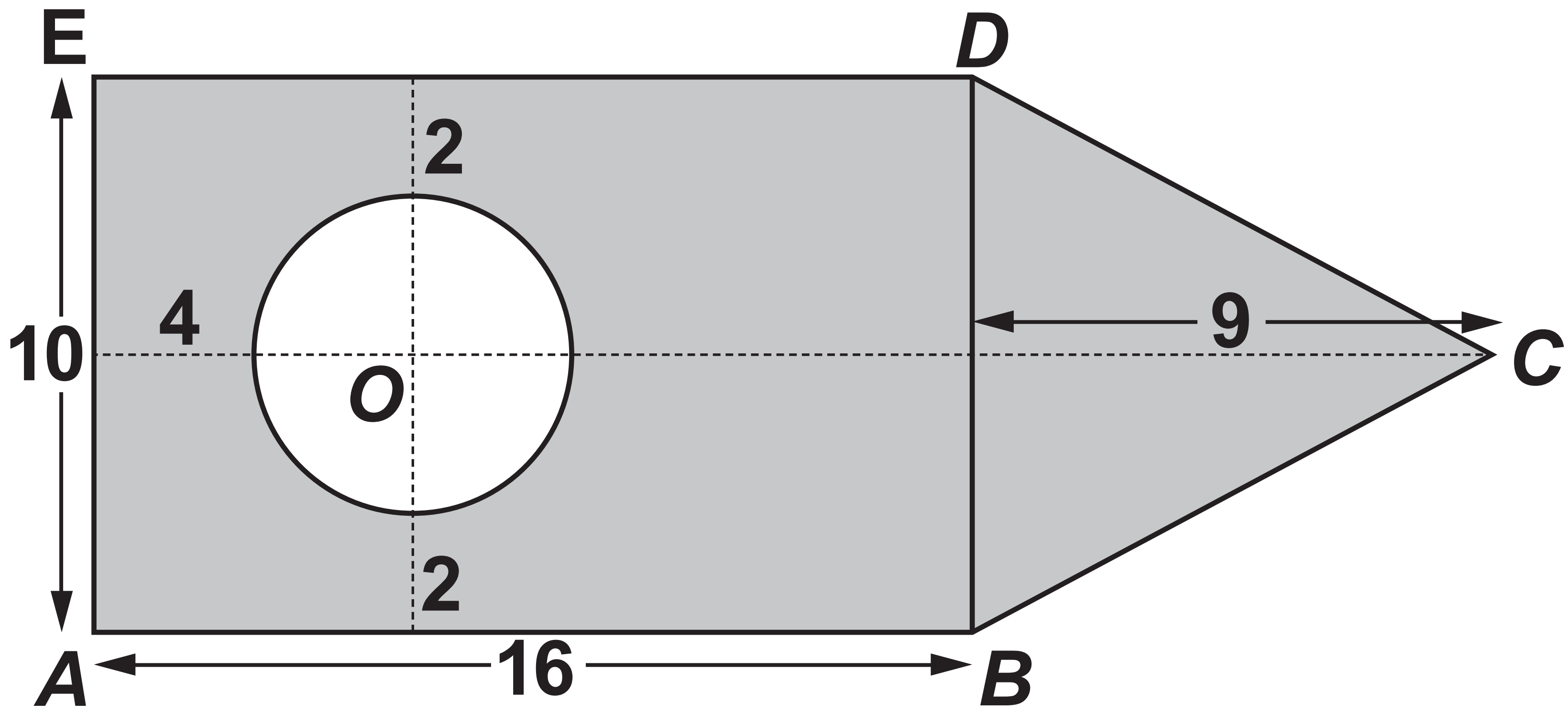
7. The diagram opposite shows four horizontal forces of magnitude P N, Q N, 25 N and 80 N acting at a point.

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 marks]

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

(b) Determine the smallest number of bounces after which the speed of the object immediately after rebound is less than $1\,\mathrm{ms}^{-1}$. [2 marks]


E
D
2
4
10
O
9
C
2
A
16
B

9. The diagram opposite 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 marks]

END OF PAPER