GCE AS/A level

0980/01

MATHEMATICS – M1
Mechanics

P.M. FRIDAY, 25 January 2013

1½ hours

0980
010001

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 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 kg and particle B has mass 7 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 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.

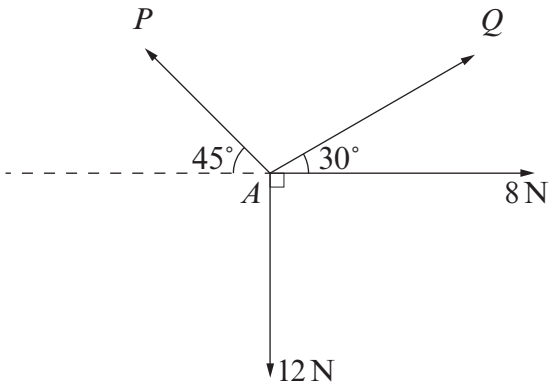
(ii) Find the impulse exerted by the wall on the particle. State your units clearly. [5]

3. A particle is projected vertically upwards with an initial speed of $15\,\text{ms}^{-1}$ from a point A, which is 1·2 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 kg lies on a rough plane, which is inclined at an angle of 25° to the horizontal. The coefficient of friction between the object and the plane is 0·3. A force of magnitude T 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 kg is on the floor of a lift, which is descending with an acceleration of a ms^{-2}. The mass of the lift is 775 kg.

(a) Given that the tension in the lift cable is 6500 N, calculate the value of a. [3]

(b) Find the magnitude of the reaction of the floor of the lift on the parcel. [3]

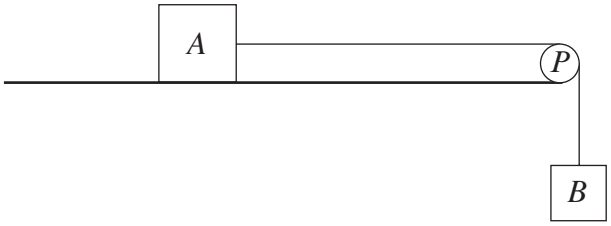
TURN OVER

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 $BD = 1{\cdot}2$ 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]

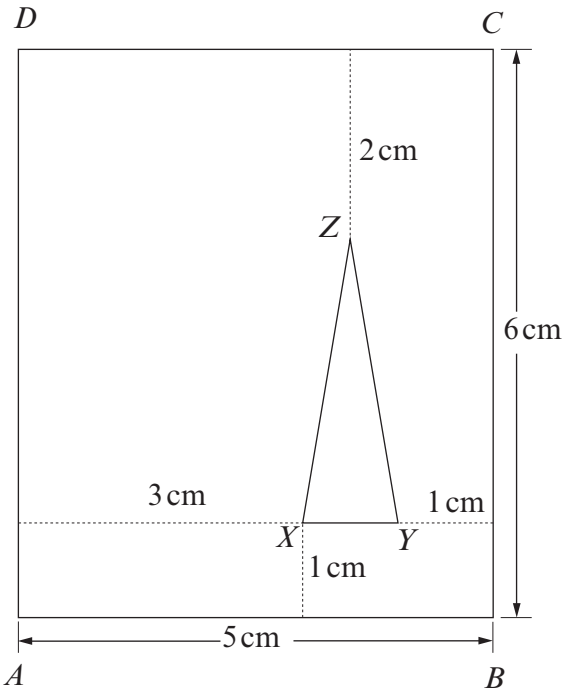
(b) The vertical force is now removed so that the beam is resting in equilibrium on the two supports. Calculate the magnitude of the reaction of each of the supports at C and D on the beam. [5]

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]

