WJEC
CBAC

GCE AS/A level

980/01

MATHEMATICS M1
Mechanics 1

A.M. MONDAY, 24 January 2011

1½ hours

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 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 train, starting from rest at station A, travels on a straight horizontal track towards station B. On leaving station A, the train accelerates at a constant rate for 60 s until it reaches a speed of $30\,\text{ms}^{-1}$ at point X. The train then continues at $30\,\text{ms}^{-1}$ to a point Y when a constant deceleration is applied for 40 s, so that the speed of the train as it passes station B is $15\,\text{ms}^{-1}$. The distance between stations A and B is 24 km.

(a) Draw a sketch of the velocity-time graph showing the motion of the train between A and B. [4]

(b) Find the acceleration of the train and the distance travelled whilst the train was accelerating. [4]

(c) Find the total time for the train to travel from A to B. [4]

2. A crate, of mass 80 kg, lies on the floor of a lift. Find the reaction of the floor of the lift on the crate when

(a) the lift is moving down with acceleration $0{\cdot}3\,\text{ms}^{-2}$, [3]

(b) the lift is moving up with acceleration $0{\cdot}2\,\text{ms}^{-2}$, [3]

(c) the lift is moving up with constant speed. [1]

3. A ball is dropped from rest from a point above a smooth horizontal floor. The ball falls vertically for 0·8 s before it hits the floor and bounces to a height of 0·9 m above the floor.

(a) Calculate the speed of the ball when it first hits the floor. [3]

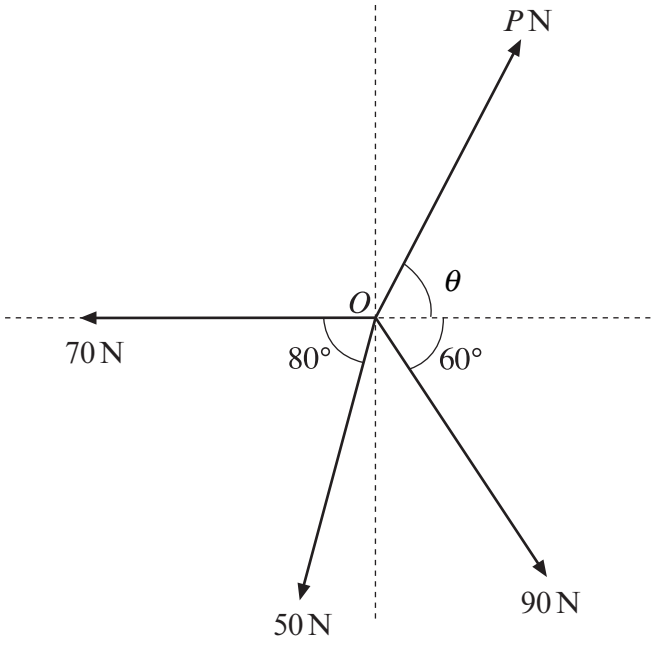
(b) Find the coefficient of restitution between the floor and the ball. Give your answer correct to three significant figures. [5]

4. A sphere A, of mass 3 kg, moving with speed $8\,\text{ms}^{-1}$ on a smooth horizontal plane, collides directly with another sphere B, of mass 7 kg, moving with speed $5\,\text{ms}^{-1}$ on the plane in the same direction. The coefficient of restitution between the spheres is 0·4.

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

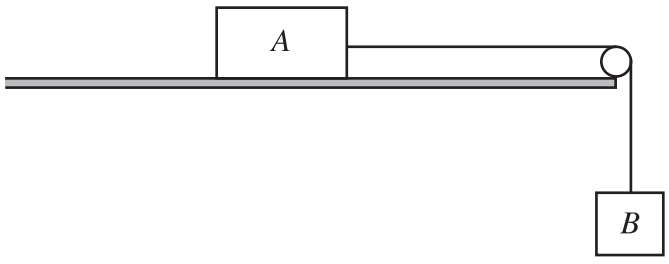
(b) Find the impulse exerted by A on B. [2]

5. The diagram shows four horizontal forces acting at a point O. The forces are in equilibrium.



Calculate the value of P and the size of the angle θ. Give each of your answers correct to one decimal place. [8]

6. The diagram shows two bodies A and B, of mass 5 kg and 3 kg respectively, connected by a light inextensible string passing over a smooth light pulley fixed at the edge of a **rough** horizontal table. The heavier body A lies on the table and the lighter body B hangs freely below the pulley.



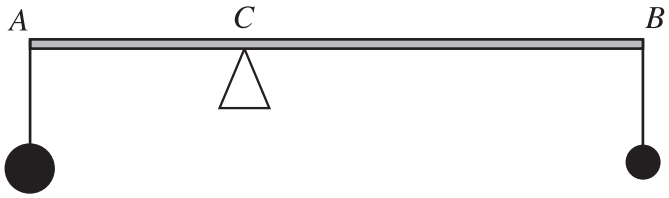
Initially, the system is at rest with the string just taut. The system is then released.

(a) Given that the coefficient of friction between A and the table is 0·4, calculate the magnitude of the acceleration of A and the tension in the string. [9]

(b) Given instead that the bodies remain at rest, find the least value of the coefficient of friction. [3]

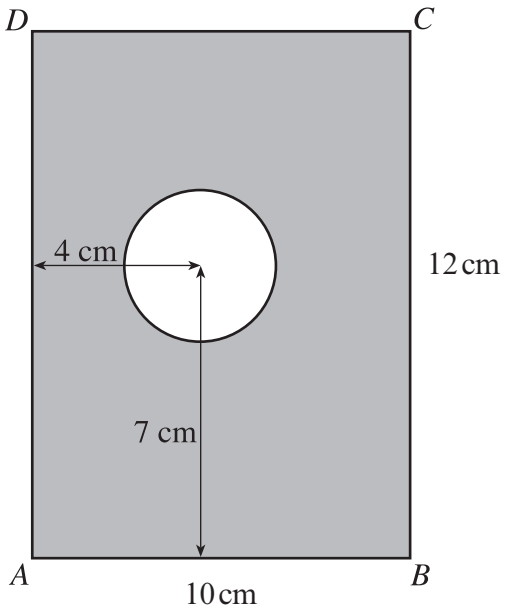
TURN OVER

7. A uniform rod AB, of mass 3 kg, has length 2 m. A particle of mass 5 kg is attached to the end A, and a particle of mass 2 kg is attached to the end B. The diagram shows the rod resting horizontally in equilibrium on a smooth support at the point C, where $AC = x$ m.



Calculate the magnitude of the reaction of the support at C and the value of x. [6]

8. The diagram shows a uniform lamina formed by removing a circle, of radius 3 cm, from a rectangular card $ABCD$ where $AB = 10$ cm and $BC = 12$ cm. The centre of the circle is 7 cm from AB and 4 cm from AD.



(a) Calculate the distances of the centre of mass of the lamina from AD and AB.
Give your answers correct to three decimal places. [9]

(b) The lamina is freely suspended from A and hangs in equilibrium.
Calculate the angle 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 value of DP. [1]