WJEC
CBAC

GCE AS/A level

980/01

MATHEMATICS M1
Mechanics 1

A.M. MONDAY, 13 June 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 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 stone is thrown vertically **downwards** from the top of a cliff with an initial velocity of $1\,\text{ms}^{-1}$ and hits the sea 2·5 seconds later.

(a) Find the speed with which the stone hits the sea. [3]

(b) Calculate the height of the cliff. [3]

2. A person, of mass 60 kg, is standing in a lift, which is of mass 540 kg. When the lift is accelerating upwards at a constant rate of $a\,\text{ms}^{-2}$, the tension in the lift cable is 6600 N.

(a) Calculate the value of a. [3]

(b) Find the reaction between the person and the floor of the lift. [3]

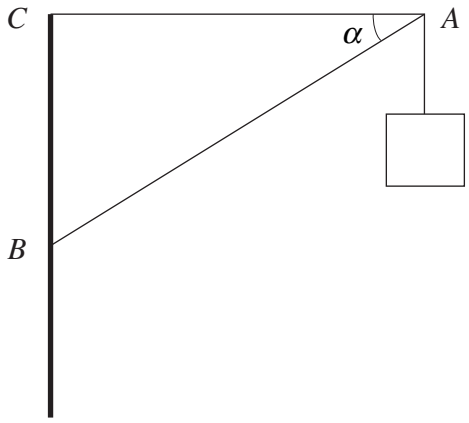
3. The points A, B and C lie, in that order, on a straight horizontal road. A car travels on the road with constant acceleration $a\,\text{ms}^{-2}$. When the car is at A, its speed is $u\,\text{ms}^{-1}$. The distance AB is 10 m and the car takes 2 s to travel from A to B. The car takes 7 s to travel from A to C and its speed at C is $17\,\text{ms}^{-1}$.

(a) Find the value of u and the value of a. [7]

(b) Draw a velocity-time graph for the motion of the car between A and C. [2]

(c) Calculate the distance AC. [2]

4. The diagram shows a sign attached to a point A. It is supported by two light rods AB and AC. The rod AC is horizontal and the rod AB is inclined at an angle of α to the horizontal, where $\sin\alpha = 0{\cdot}6$.

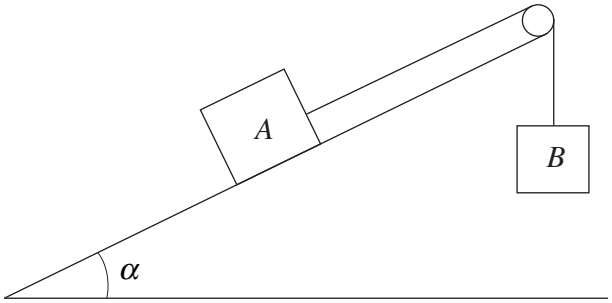


The mass of the sign is 12 kg. Calculate

(a) the thrust in the rod AB, [3]

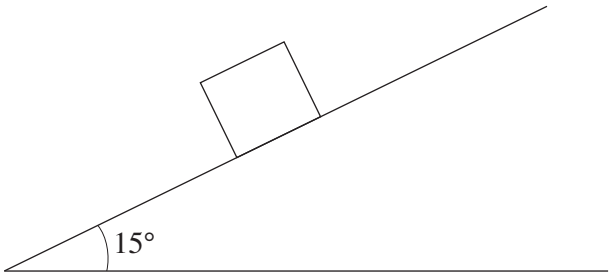
(b) the tension in the rod AC. [3]

5. The diagram shows a particle A, on a smooth inclined plane, joined by a light inextensible string passing over a smooth pulley to a particle B, which hangs freely. The plane is inclined at an angle α to the horizontal, where $\sin \alpha = \frac{5}{13}$. The masses of A and B are 13 kg and 15 kg respectively. The string is in the same vertical plane as a line of greatest slope of the plane.



Initially, the particles are held at rest with the string taut. The system is released. Calculate the magnitude of the acceleration of the particle A and the tension in the string. [7]

6. The diagram shows an object, of mass 8 kg, on a rough plane inclined at an angle of 15° to the horizontal.



(a) Given that the object is at rest, calculate the least possible value of the coefficient of friction. Give your answer correct to two decimal places. [6]

(b) Given that the coefficient of friction is 0·1, find the acceleration of the object down the plane. [4]

7. Two particles A and B are sliding **towards** each other on a smooth horizontal surface and collide directly. Particle A has mass 3 kg and particle B has mass 4 kg. Just before the collision, A has speed 5 ms^{-1} and B has speed 3 ms^{-1}.
Immediately after the collision, A has reversed its direction of motion and its speed is 2 ms^{-1}.

(a) Show that the speed of B immediately after the collision is 2·25 ms^{-1}. [3]

(b) Find the coefficient of restitution between A and B. [3]

(c) Determine the magnitude of the impulse exerted by A on B during the collision. [2]

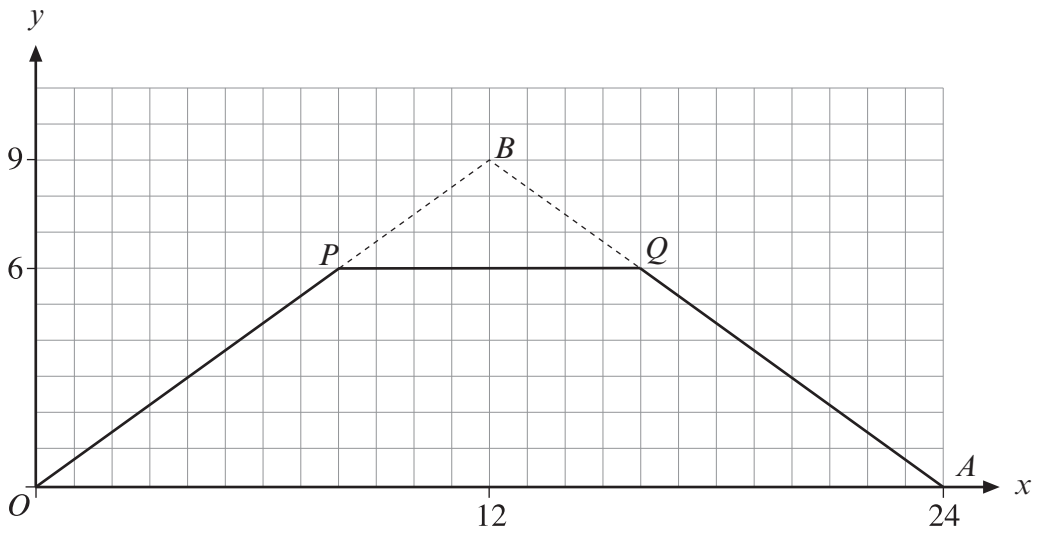
TURN OVER

8. The diagram shows a uniform rod AB, of mass 4 kg and length 1·6 m, with a particle, of mass 0·5 kg, attached at a point C of the rod, where $AC = 0{\cdot}5$ m.
The rod is resting horizontally in equilibrium on two smooth supports at points X and Y of the rod, where $AX = 0{\cdot}6$ m and $AY = 1{\cdot}2$ m.

(a) Calculate the reaction at X and the reaction at Y. [7]

(b) When an additional particle of mass M kg is attached to the point C, the rod is on the point of turning about X. Calculate the value of M. [4]

9. A uniform lamina $OAQP$ is formed by removing the triangle PQB from the triangle OAB as shown in the diagram below, which is drawn to scale. The triangle OAB is isosceles with $OB = AB$. The line PQ is parallel to the line OA.



(a) Calculate the coordinates of the centre of mass of the lamina $OAQP$. [7]

(b) The lamina is freely suspended from P and hangs in equilibrium.
Calculate the angle PQ makes with the vertical. [3]