



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.

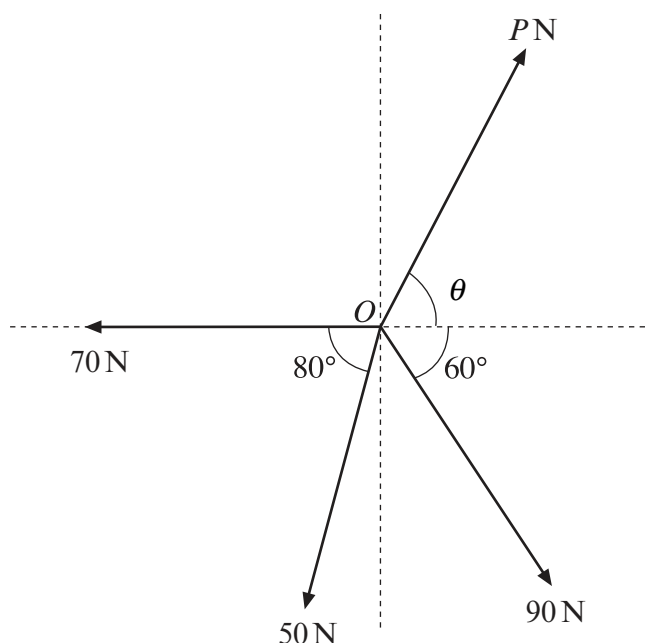
INFORMATION FOR CANDIDATES

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.

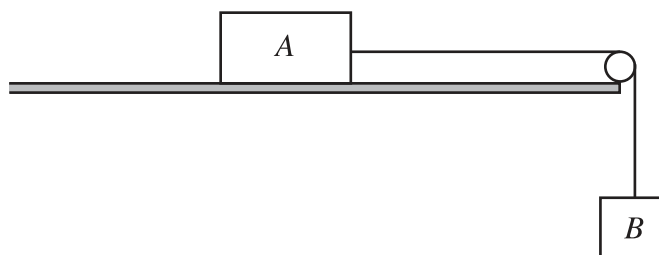
1. A train, starting from rest at station A , travels on a straight horizontal track towards station B . On leaving station A , the train accelerates at a constant rate for 60 s until it reaches a speed of 30 ms^{-1} at point X . The train then continues at 30 ms^{-1} to a point Y when a constant deceleration is applied for 40 s, so that the speed of the train as it passes station B is 15 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 0.3 ms^{-2} , [3]
 - (b) the lift is moving up with acceleration 0.2 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 ms^{-1} on a smooth horizontal plane, collides directly with another sphere B , of mass 7 kg, moving with speed 5 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.

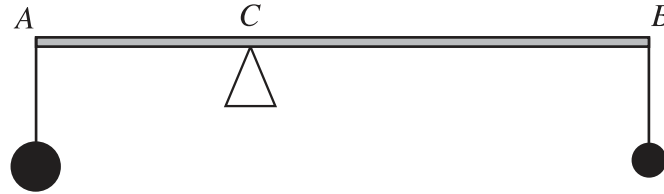


Initially, the system is at rest with the string just taut. The system is then released.

- (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

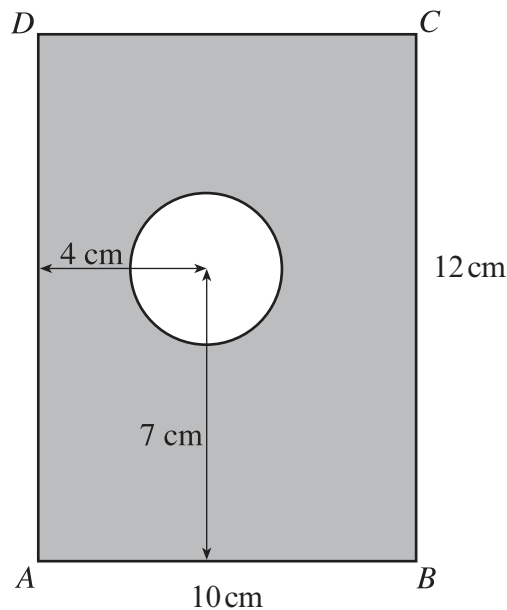
7. A uniform rod AB , of mass 3 kg, has length 2 m. A particle of mass 5 kg is attached to the end A , and a particle of mass 2 kg is attached to the end B . The diagram shows the rod resting horizontally in equilibrium on a smooth support at the point C , where $AC = x$ m.



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]