GCE AS/A level

0980/01

MATHEMATICS M1
Mechanics 1

A.M. MONDAY, 23 January 2012

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 lift is moving upwards. It accelerates from rest with uniform acceleration $0{\cdot}4\,\text{ms}^{-2}$ until it reaches a speed of $2\,\text{ms}^{-1}$. It then travels at this constant speed of $2\,\text{ms}^{-1}$ for 17 s before decelerating uniformly to rest in 8 s.

(a) Calculate the time taken for the lift to reach the speed of $2\,\text{ms}^{-1}$. [3]

(b) Sketch a velocity-time graph for the lift's journey. [3]

(c) Find the distance travelled by the lift during the journey. [3]

(d) A man, of mass 70 kg, is standing in the lift during its journey.
Calculate the greatest value of the reaction exerted by the floor of the lift on the man during the journey. [4]

2. A sphere A, of mass 4 kg, moving with speed $3\,\text{ms}^{-1}$ on a smooth horizontal table collides directly with another sphere B, of mass 5 kg, moving in the opposite direction with speed $2\,\text{ms}^{-1}$. The coefficient of restitution between the spheres is 0·2.

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

After the collision, sphere B collides directly with a vertical wall. The coefficient of restitution between B and the wall is 0·6.

(b) Find the magnitude of the impulse exerted on B by the wall. [4]

3. A rough plane is inclined at an angle α to the horizontal where $\sin\alpha = \frac{3}{5}$. A body of mass 80 kg lies on the plane. The coefficient of friction between the body and the plane is μ.

(a) Find the normal reaction of the plane on the body. [2]

(b) The body is on the point of slipping down the plane. Find the value of μ. [4]

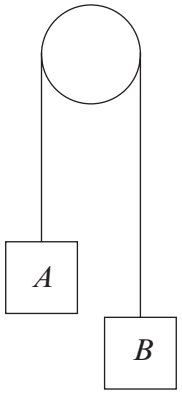
(c) Calculate the magnitude of the force acting along a line of greatest slope that will move the body up the plane with an acceleration of $0{\cdot}7\,\text{ms}^{-2}$. [4]

4. A stone is thrown vertically upwards with a speed of $14{\cdot}7\,\text{ms}^{-1}$ from a point A which is 49 m above the ground.

(a) Find the time taken for the stone to reach the ground. [3]

(b) Calculate the speed of the stone when it hits the ground. [3]

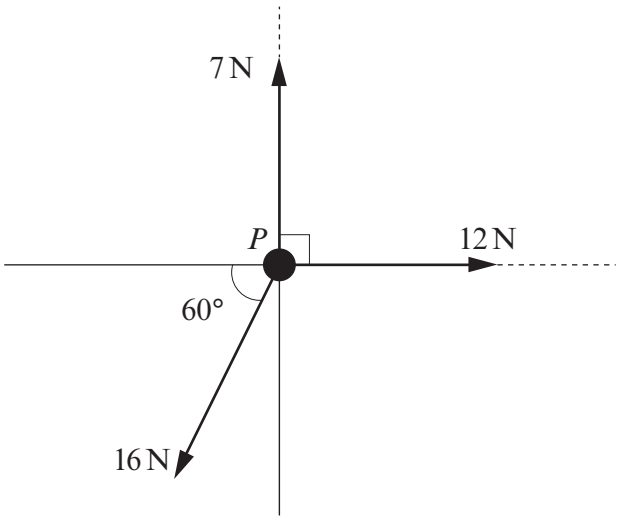
5. The diagram shows two objects A and B, of mass 5 kg and 9 kg respectively, connected by a light inextensible string passing over a smooth peg. Initially, the objects are held at rest. The system is then released.



(a) Find the magnitude of the acceleration of A and the tension in the string. [7]

(b) What assumption did the word "light", underlined in the first sentence, enable you to make in your solution? [1]

6. A particle P lies on a horizontal plane. Three horizontal forces of magnitude 7 N, 12 N and 16 N acting in directions as shown in the diagram are applied to P.



(a) Show that the magnitude of the resultant of the three forces is approximately 7·9 N. Find the angle between the direction of the resultant and the direction of the 12 N force. [8]

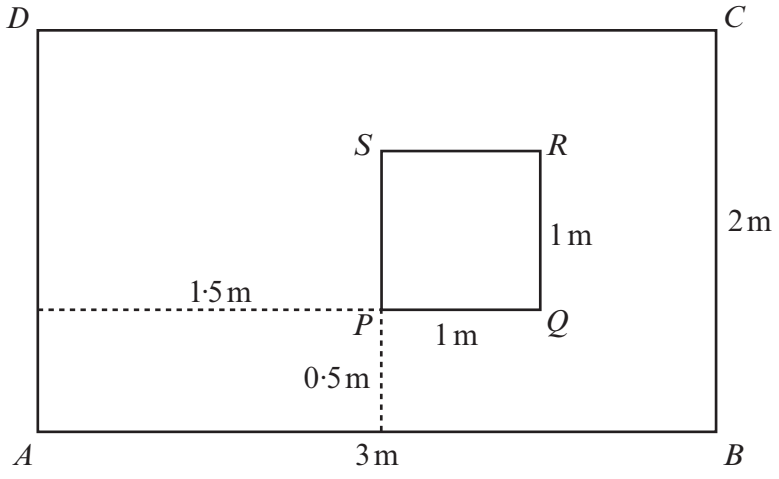
(b) The particle P has mass 5 kg and the coefficient of friction between P and the plane is 0·1. Taking the magnitude of the resultant of the three forces to be 7·9 N, calculate the magnitude of the acceleration of P. [4]

7. The diagram shows a body, of mass 65 kg, attached to the end B of a uniform rigid rod AB of length 4 m. The mass of the rod is 35 kg. The rod is held horizontally in equilibrium by two smooth cylindrical pegs, one at A and another at C, where $AC = 1{\cdot}2$ m.

(a) Write down the moment of the weight of the rod about the point A.
State your units clearly. [2]

(b) Find the forces exerted on the rod at A and C. [6]

8. The diagram below shows a decoration made from a uniform material. The rectangle $ABCD$ has $AB = 3$ m and $BC = 2$ m. An extra square piece $PQRS$ of the same material, with $PQ = 1$ m, is glued onto $ABCD$ such that PQ is 0·5 m from AB and PS is 1·5 m from AD. The line PQ is parallel to the line AB.



Calculate the distances of the centre of mass of the decoration from AD and AB. [7]