



**ADVANCED GCE**  
**MATHEMATICS**

**4729/01**

Mechanics 2

**WEDNESDAY 9 JANUARY 2008**

Afternoon

Time: 1 hour 30 minutes

**Additional materials:** Answer Booklet (8 pages)  
List of Formulae (MF1)

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration due to gravity is denoted by  $g \text{ m s}^{-2}$ . Unless otherwise instructed, when a numerical value is needed, use  $g = 9.8$ .
- You are permitted to use a graphical calculator in this paper.

**INFORMATION FOR CANDIDATES**

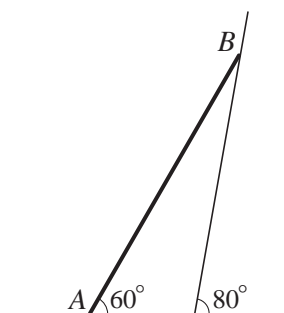
- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.
- **You are reminded of the need for clear presentation in your answers.**

This document consists of 4 printed pages.

## 2

- 1 A ball is projected with speed  $12 \text{ m s}^{-1}$  at an angle of elevation of  $55^\circ$  above the horizontal. At the instant when the ball reaches its greatest height, it hits a vertical wall, which is perpendicular to the ball's path. The coefficient of restitution between the ball and the wall is 0.65. Calculate the speed of the ball
- (i) immediately before its impact with the wall, [2]
- (ii) immediately after its impact with the wall. [2]
- 2 A particle of mass  $m \text{ kg}$  is projected directly up a rough plane with a speed of  $5 \text{ m s}^{-1}$ . The plane makes an angle of  $30^\circ$  with the horizontal and the coefficient of friction is 0.2. Calculate the distance the particle travels up the plane before coming instantaneously to rest. [6]

3



A uniform rod  $AB$ , of weight  $25 \text{ N}$  and length  $1.6 \text{ m}$ , rests in equilibrium in a vertical plane with the end  $A$  in contact with rough horizontal ground and the end  $B$  resting against a smooth wall which is inclined at  $80^\circ$  to the horizontal. The rod is inclined at  $60^\circ$  to the horizontal (see diagram). Calculate the magnitude of the force acting on the rod at  $B$ . [6]

- 4 A car of mass  $1200 \text{ kg}$  has a maximum speed of  $30 \text{ m s}^{-1}$  when travelling on a horizontal road. The car experiences a resistance of  $k\nu \text{ N}$ , where  $\nu \text{ m s}^{-1}$  is the speed of the car and  $k$  is a constant. The maximum power of the car's engine is  $45\,000 \text{ W}$ .
- (i) Show that  $k = 50$ . [2]
- (ii) Find the maximum possible acceleration of the car when it is travelling at  $20 \text{ m s}^{-1}$  on a horizontal road. [3]
- (iii) The car climbs a hill, which is inclined at an angle of  $10^\circ$  to the horizontal, at a constant speed of  $15 \text{ m s}^{-1}$ . Calculate the power of the car's engine. [3]
- 5 A particle  $P$  of mass  $2m$  is moving on a smooth horizontal surface with speed  $u$  when it collides directly with a particle  $Q$  of mass  $km$  whose speed is  $3u$  in the opposite direction. As a result of the collision, the directions of motion of both particles are reversed and the speed of  $P$  is halved.
- (i) Find, in terms of  $u$  and  $k$ , the speed of  $Q$  after the collision. Hence write down the range of possible values of  $k$ . [4]
- (ii) Calculate the magnitude of the impulse which  $Q$  exerts on  $P$ . [2]
- (iii) Given that  $k = \frac{1}{2}$ , calculate the coefficient of restitution between  $P$  and  $Q$ . [3]

3

6 (i)

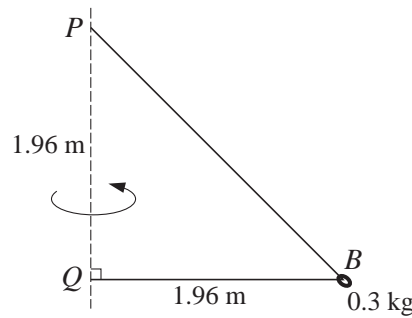


Fig. 1

One end of a light inextensible string is attached to a point  $P$ . The other end is attached to a point  $Q$ , 1.96 m vertically below  $P$ . A small smooth bead  $B$ , of mass 0.3 kg, is threaded on the string and moves in a horizontal circle with centre  $Q$  and radius 1.96 m.  $B$  rotates about  $Q$  with constant angular speed  $\omega$  rad  $s^{-1}$  (see Fig. 1).

(a) Show that the tension in the string is 4.16 N, correct to 3 significant figures. [2]

(b) Calculate  $\omega$ . [3]

(ii)

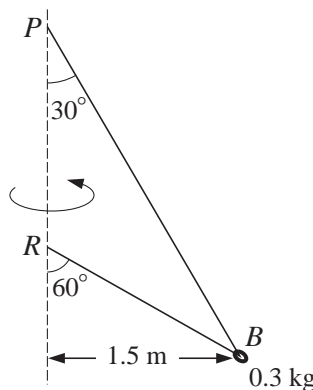


Fig. 2

The lower part of the string is now attached to a point  $R$ , vertically below  $P$ .  $PB$  makes an angle  $30^\circ$  with the vertical and  $RB$  makes an angle  $60^\circ$  with the vertical. The bead  $B$  now moves in a horizontal circle of radius 1.5 m with constant speed  $v$  m  $s^{-1}$  (see Fig. 2).

(a) Calculate the tension in the string. [3]

(b) Calculate  $v$ . [3]

7 A missile is projected from a point  $O$  on horizontal ground with speed 175 m  $s^{-1}$  at an angle of elevation  $\theta$ . The horizontal lower surface of a cloud is 650 m above the ground.

(i) Find the value of  $\theta$  for which the missile just reaches the cloud. [3]

It is given that  $\theta = 55^\circ$ .

(ii) Find the length of time for which the missile is above the lower surface of the cloud. [5]

(iii) Find the speed of the missile at the instant it enters the cloud. [4]

- 8 (i) A uniform semicircular lamina has radius 4 cm. Show that the distance from its centre to its centre of mass is 1.70 cm, correct to 3 significant figures. [2]

(ii)

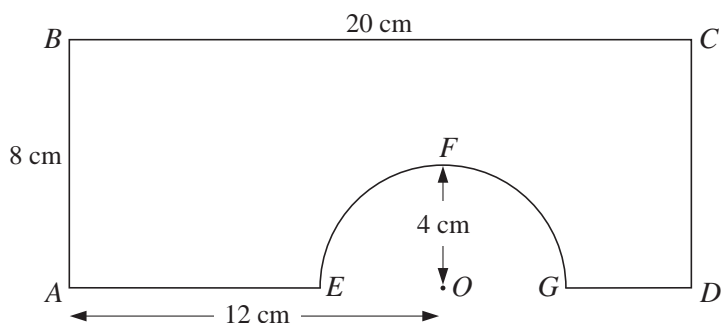


Fig. 1

A model bridge is made from a uniform rectangular board,  $ABCD$ , with a semicircular section,  $EFG$ , removed.  $O$  is the mid-point of  $EG$ .  $AB = 8$  cm,  $BC = 20$  cm,  $AO = 12$  cm and the radius of the semicircle is 4 cm (see Fig. 1).

- (a) Show that the distance from  $AB$  to the centre of mass of the model is 9.63 cm, correct to 3 significant figures. [5]

- (b) Calculate the distance from  $AD$  to the centre of mass of the model. [4]

(iii)

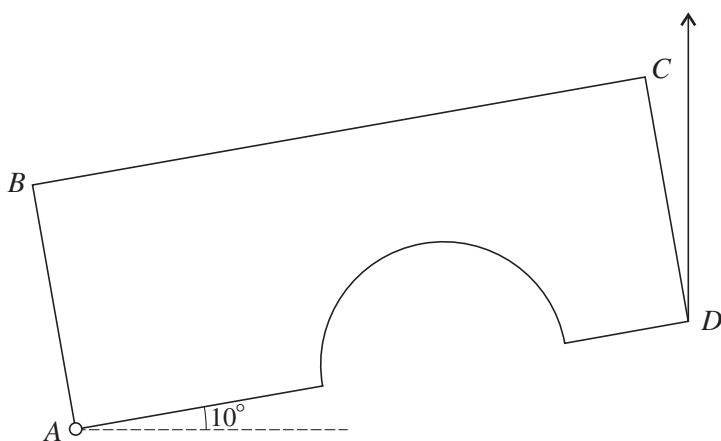


Fig. 2

The model bridge is smoothly pivoted at  $A$  and is supported in equilibrium by a vertical wire attached to  $D$ . The weight of the model is 15 N and  $AD$  makes an angle of  $10^\circ$  with the horizontal (see Fig. 2). Calculate the tension in the wire. [5]

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