

**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.**

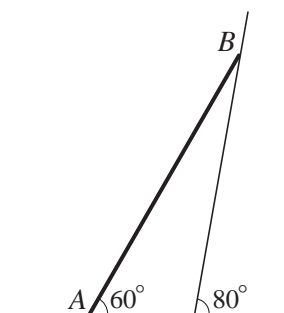
This document consists of 4 printed pages.

- 1 A ball is projected with speed 12 m s^{-1} at an angle of elevation of 55° 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 m s^{-1} . The plane makes an angle of 30° 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 N and length 1.6 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° to the horizontal. The rod is inclined at 60° to the horizontal (see diagram). Calculate the magnitude of the force acting on the rod at B . [6]

- 4 A car of mass 1200 kg has a maximum speed of 30 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 m s^{-1} on a horizontal road. [3]

(iii) The car climbs a hill, which is inclined at an angle of 10° to the horizontal, at a constant speed of 15 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]

6 (i)

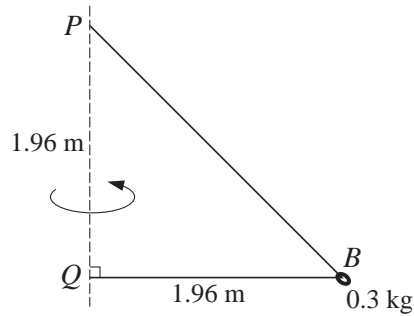


Fig. 1

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 ω 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 ω . [3]

(ii)

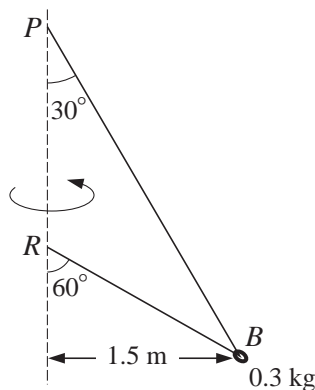


Fig. 2

The lower part of the string is now attached to a point R , vertically below P . PB makes an angle 30° with the vertical and RB makes an angle 60° 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 θ . The horizontal lower surface of a cloud is 650 m above the ground.

(i) Find the value of θ 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)

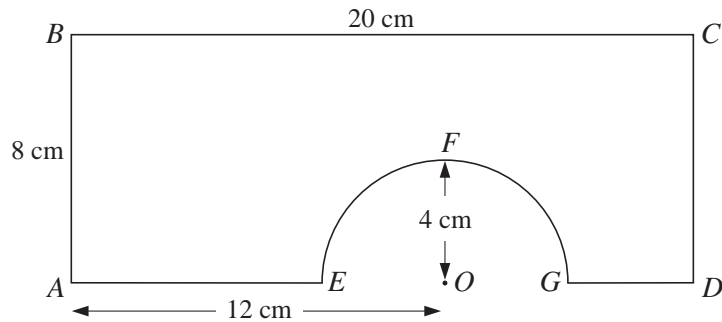


Fig. 1

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)

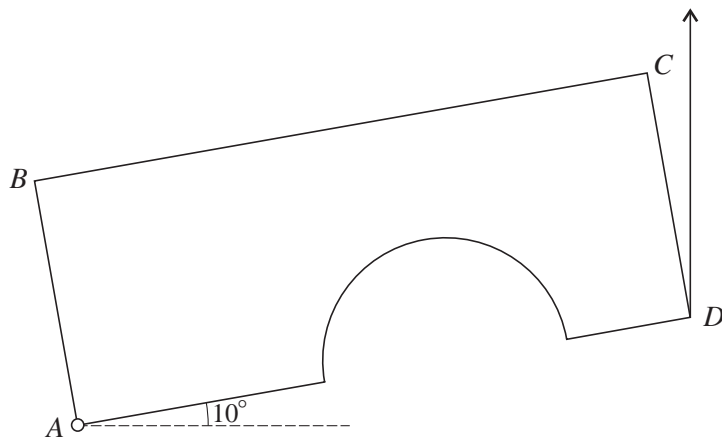


Fig. 2

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° with the horizontal (see Fig. 2). Calculate the tension in the wire. [5]