



ADVANCED GCE
MATHEMATICS
Mechanics 2

4729

Candidates answer on the Answer Booklet

OCR Supplied Materials:

- 8 page Answer Booklet
- List of Formulae (MF1)

Other Materials Required:

None

Monday 11 January 2010
Morning

Duration: 1 hour 30 minutes



INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- 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.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- This document consists of **4** pages. Any blank pages are indicated.

2

- 1 Find the average power exerted by a climber of mass 75 kg when climbing a vertical distance of 40 m in 2 minutes. [3]

- 2 A small sphere of mass 0.2 kg is dropped from rest at a height of 3 m above horizontal ground. It falls vertically, hits the ground and rebounds vertically upwards, coming to instantaneous rest at a height of 1.8 m above the ground.
 - (i) Calculate the magnitude of the impulse which the ground exerts on the sphere. [5]
 - (ii) Calculate the coefficient of restitution between the sphere and the ground. [2]

3

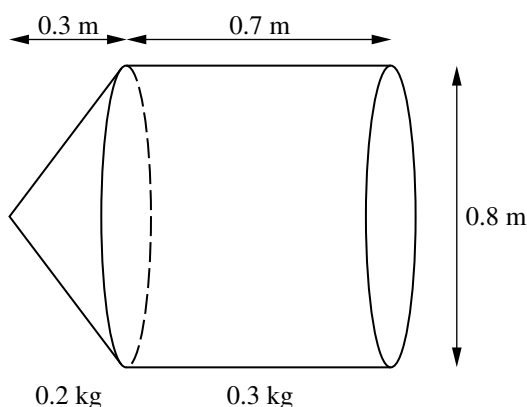


Fig. 1

A uniform conical shell has mass 0.2 kg, height 0.3 m and base diameter 0.8 m. A uniform hollow cylinder has mass 0.3 kg, length 0.7 m and diameter 0.8 m. The conical shell is attached to the cylinder, with the circumference of its base coinciding with one end of the cylinder (see Fig. 1).

- (i) Show that the distance of the centre of mass of the combined object from the vertex of the conical shell is 0.47 m. [4]

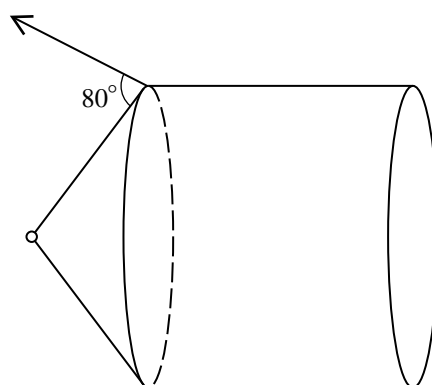


Fig. 2

The combined object is freely suspended from its vertex and is held with its axis horizontal. This is achieved by means of a wire attached to a point on the circumference of the base of the conical shell. The wire makes an angle of 80° with the slant edge of the conical shell (see Fig. 2).

- (ii) Calculate the tension in the wire. [4]

3

- 4 A car of mass 700 kg is moving along a horizontal road against a constant resistance to motion of 400 N. At an instant when the car is travelling at 12 m s^{-1} its acceleration is 0.5 m s^{-2} .

(i) Find the driving force of the car at this instant. [2]

(ii) Find the power at this instant. [2]

The maximum steady speed of the car on a horizontal road is 35 m s^{-1} .

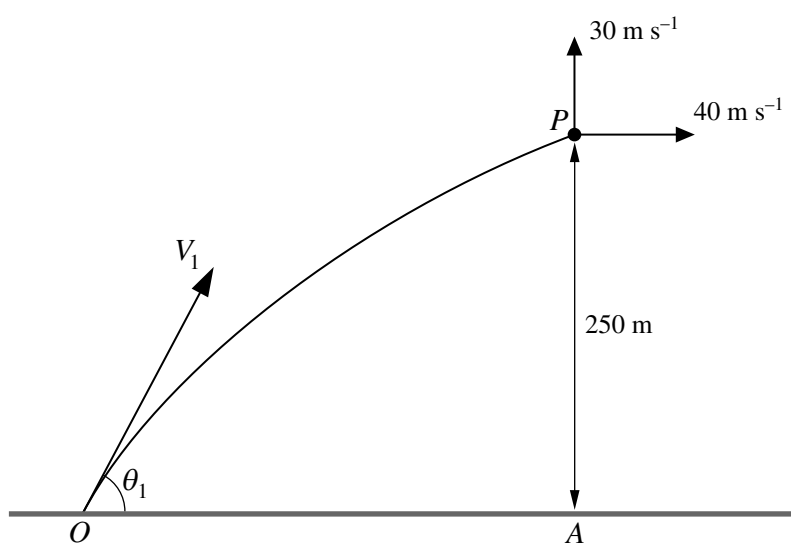
(iii) Find the maximum power of the car. [2]

The car now moves at maximum power against the same resistance up a slope of constant angle θ° to the horizontal. The maximum steady speed up the slope is 12 m s^{-1} .

(iv) Find θ . [4]

- 5 Two spheres of the same radius with masses 2 kg and 3 kg are moving directly towards each other on a smooth horizontal plane with speeds 8 m s^{-1} and 4 m s^{-1} respectively. The spheres collide and the kinetic energy lost is 81 J. Calculate the speed and direction of motion of each sphere after the collision. [12]

6



A particle P is projected with speed $V_1 \text{ m s}^{-1}$ at an angle of elevation θ_1 from a point O on horizontal ground. When P is vertically above a point A on the ground its height is 250 m and its velocity components are 40 m s^{-1} horizontally and 30 m s^{-1} vertically upwards (see diagram).

(i) Show that $V_1 = 86.0$ and $\theta_1 = 62.3^\circ$, correct to 3 significant figures. [5]

At the instant when P is vertically above A , a second particle Q is projected from O with speed $V_2 \text{ m s}^{-1}$ at an angle of elevation θ_2 . P and Q hit the ground at the same time and at the same place.

(ii) Calculate the total time of flight of P and the total time of flight of Q . [4]

(iii) Calculate the range of the particles and hence calculate V_2 and θ_2 . [8]

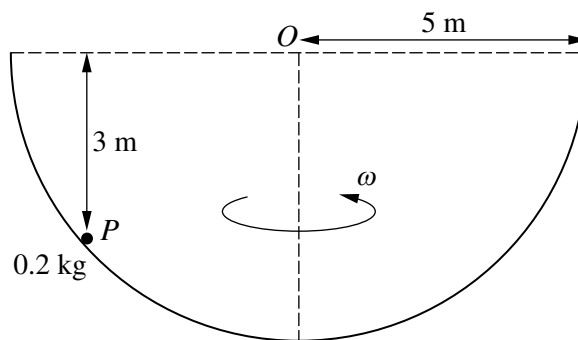


Fig. 1

A particle P of mass 0.2 kg is moving on the smooth inner surface of a fixed hollow hemisphere which has centre O and radius 5 m . P moves with constant angular speed ω in a horizontal circle at a vertical distance of 3 m below the level of O (see Fig. 1).

(i) Calculate the magnitude of the force exerted by the hemisphere on P . [3]

(ii) Calculate ω . [4]

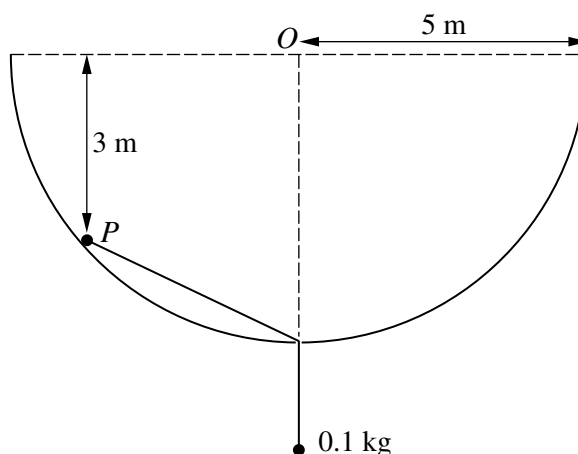


Fig. 2

A light inextensible string is now attached to P . The string passes through a small smooth hole at the lowest point of the hemisphere and a particle of mass 0.1 kg hangs in equilibrium at the end of the string. P moves in the same horizontal circle as before (see Fig. 2).

(iii) Calculate the new angular speed of P . [8]



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