

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 15 June 2009
Afternoon

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.

- 1 A boy on a sledge slides down a straight track of length 180 m which descends a vertical distance of 40 m. The combined mass of the boy and the sledge is 75 kg. The initial speed is 3 m s^{-1} and the final speed is 12 m s^{-1} . The magnitude, $R \text{ N}$, of the resistance to motion is constant. By considering the change in energy, calculate R . [5]

- 2 A car of mass 1100 kg has maximum power of 44 000 W. The resistive forces have constant magnitude 1400 N.

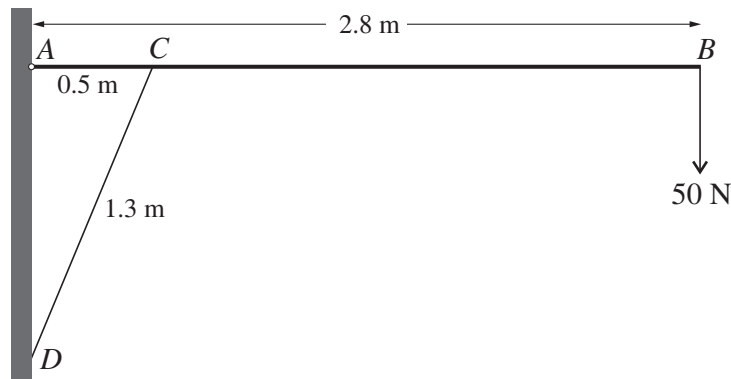
- (i) Calculate the maximum steady speed of the car on the level. [2]

The car is moving on a hill of constant inclination α to the horizontal, where $\sin \alpha = 0.05$.

- (ii) Calculate the maximum steady speed of the car when ascending the hill. [3]

- (iii) Calculate the acceleration of the car when it is descending the hill at a speed of 10 m s^{-1} working at half the maximum power. [3]

3



A uniform beam AB has weight 70 N and length 2.8 m. The beam is freely hinged to a wall at A and is supported in a horizontal position by a strut CD of length 1.3 m. One end of the strut is attached to the beam at C , 0.5 m from A , and the other end is attached to the wall at D , vertically below A . The strut exerts a force on the beam in the direction DC . The beam carries a load of weight 50 N at its end B (see diagram).

- (i) Calculate the magnitude of the force exerted by the strut on the beam. [4]

- (ii) Calculate the magnitude of the force acting on the beam at A . [6]

- 4 A light inextensible string of length 0.6 m has one end fixed to a point A on a smooth horizontal plane. The other end of the string is attached to a particle B , of mass 0.4 kg, which rotates about A with constant angular speed 2 rad s^{-1} on the surface of the plane.

- (i) Calculate the tension in the string. [2]

A particle P of mass 0.1 kg is attached to the mid-point of the string. The line APB is straight and rotation continues at 2 rad s^{-1} .

- (ii) Calculate the tension in the section of the string AP . [4]

- (iii) Calculate the total kinetic energy of the system. [5]

5 (i)

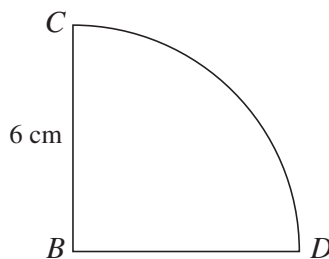


Fig. 1

Fig. 1 shows a uniform lamina BCD in the shape of a quarter circle of radius 6 cm. Show that the distance of the centre of mass of the lamina from B is 3.60 cm, correct to 3 significant figures.

[2]

A uniform rectangular lamina $ABDE$ has dimensions $AB = 12$ cm and $AE = 6$ cm. A single plane object is formed by attaching the rectangular lamina to the lamina BCD along BD (see Fig. 2). The mass of $ABDE$ is 3 kg and the mass of BCD is 2 kg.

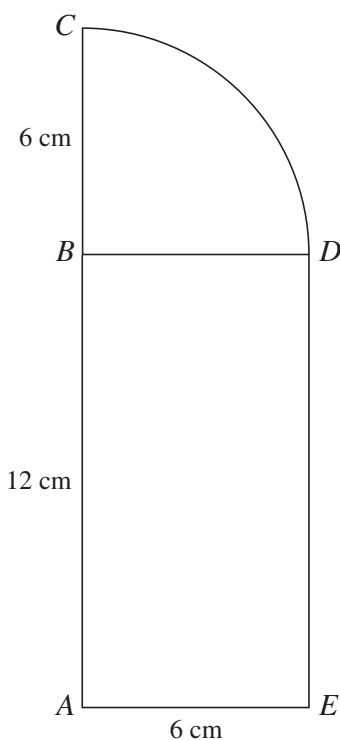


Fig. 2

(ii) Taking x - and y -axes along AE and AB respectively, find the coordinates of the centre of mass of the object.

[7]

The object is freely suspended at C and rests in equilibrium.

(iii) Calculate the angle that AC makes with the vertical.

[2]

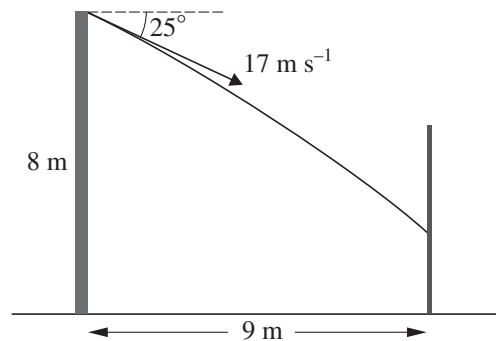
- 6 Two uniform spheres, A and B , have the same radius. The mass of A is 0.4 kg and the mass of B is 0.2 kg . The spheres A and B are travelling in the same direction in a straight line on a smooth horizontal surface, A with speed 5 m s^{-1} , and B with speed $v\text{ m s}^{-1}$, where $v < 5$. A collides directly with B and the impulse between them has magnitude 0.9 N s . Immediately after the collision, the speed of B is 6 m s^{-1} .

(i) Calculate v . [3]

B subsequently collides directly with a stationary sphere C of mass 0.1 kg and the same radius as A and B . The coefficient of restitution between B and C is 0.6 .

(ii) Determine whether there will be a further collision between A and B . [10]

7



A ball is projected with an initial speed of 17 m s^{-1} at an angle of 25° below the horizontal from a point on the top of a vertical wall. The point of projection is 8 m above horizontal ground. The ball hits a vertical fence which is at a horizontal distance of 9 m from the wall (see diagram).

(i) Calculate the height above the ground of the point where the ball hits the fence. [5]

(ii) Calculate the direction of motion of the ball immediately before it hits the fence. [5]

(iii) It is given that 30% of the kinetic energy of the ball is lost when it hits the fence. Calculate the speed of the ball immediately after it hits the fence. [4]

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