



Question 1 continued

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Handwriting practice lines consisting of 28 horizontal lines.

(Total 4 marks)

Q1

3

Turn over



N 2 6 1 1 5 A 0 3 2 4

Question 2 continued

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(Total 6 marks)

Q2

Small box for marking.



3.

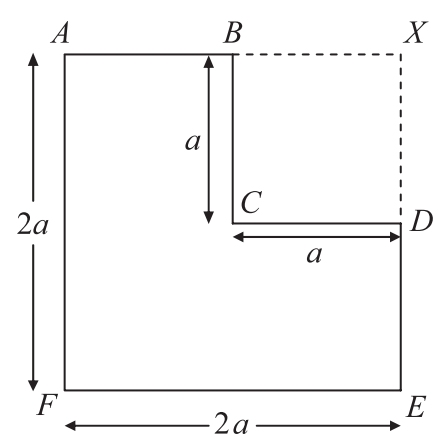


Figure 1

A uniform lamina $ABCDEF$ is formed by taking a uniform sheet of card in the form of a square $AXEF$, of side $2a$, and removing the square $BXDC$ of side a , where B and D are the mid-points of AX and XE respectively, as shown in Figure 1.

(a) Find the distance of the centre of mass of the lamina from AF . (4)

The lamina is freely suspended from A and hangs in equilibrium.

(b) Find, in degrees to one decimal place, the angle which AF makes with the vertical. (4)

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Question 3 continued

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(Total 8 marks)

Q3



4.

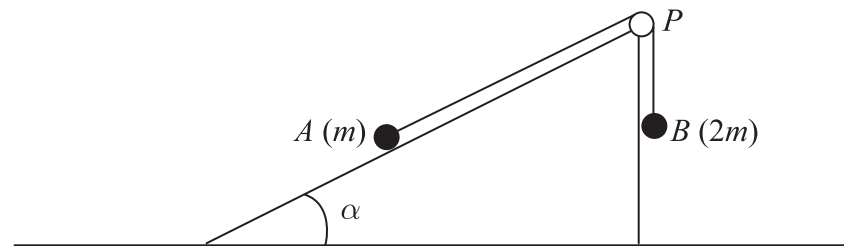


Figure 2

Two particles A and B , of mass m and $2m$ respectively, are attached to the ends of a light inextensible string. The particle A lies on a rough plane inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The string passes over a small light smooth pulley P fixed at the top of the plane. The particle B hangs freely below P , as shown in Figure 2. The particles are released from rest with the string taut and the section of the string from A to P parallel to a line of greatest slope of the plane. The coefficient of friction between A and the plane is $\frac{5}{8}$. When each particle has moved a distance h , B has not reached the ground and A has not reached P .

- (a) Find an expression for the potential energy lost by the system when each particle has moved a distance h . (2)

When each particle has moved a distance h , they are moving with speed v . Using the work-energy principle,

- (b) find an expression for v^2 , giving your answer in the form kgh , where k is a number. (5)

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5.

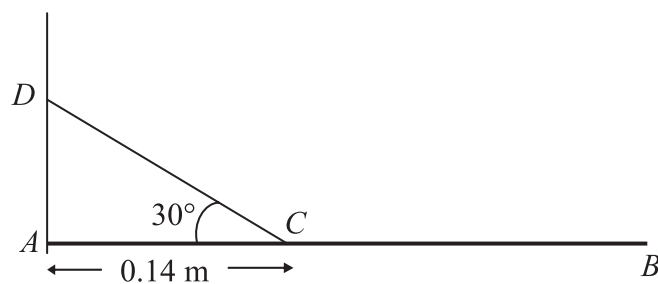


Figure 3

A uniform beam *AB* of mass 2 kg is freely hinged at one end *A* to a vertical wall. The beam is held in equilibrium in a horizontal position by a rope which is attached to a point *C* on the beam, where $AC = 0.14$ m. The rope is attached to the point *D* on the wall vertically above *A*, where $\angle ACD = 30^\circ$, as shown in Figure 3. The beam is modelled as a uniform rod and the rope as a light inextensible string. The tension in the rope is 63 N.

Find

- (a) the length of *AB*, (4)
- (b) the magnitude of the resultant reaction of the hinge on the beam at *A*. (5)

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Question 5 continued

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(Total 9 marks)

Q5

11

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N 2 6 1 1 5 A 0 1 1 2 4

6.

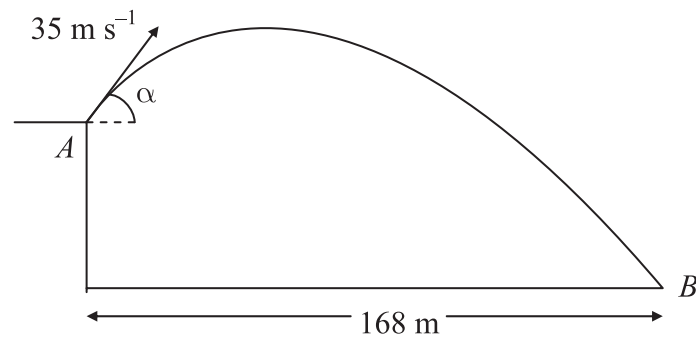


Figure 4

A golf ball P is projected with speed 35 m s^{-1} from a point A on a cliff above horizontal ground. The angle of projection is α to the horizontal, where $\tan \alpha = \frac{4}{3}$. The ball moves freely under gravity and hits the ground at the point B , as shown in Figure 4.

- (a) Find the greatest height of P above the level of A . (3)

The horizontal distance from A to B is 168 m.

- (b) Find the height of A above the ground. (6)

By considering energy, or otherwise,

- (c) find the speed of P as it hits the ground at B . (3)

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Question 6 continued

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Q6

(Total 12 marks)



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7. Two small spheres P and Q of equal radius have masses m and $5m$ respectively. They lie on a smooth horizontal table. Sphere P is moving with speed u when it collides directly with sphere Q which is at rest. The coefficient of restitution between the spheres is e , where $e > \frac{1}{5}$.

(a) (i) Show that the speed of P immediately after the collision is $\frac{u}{6}(5e - 1)$.

(ii) Find an expression for the speed of Q immediately after the collision, giving your answer in the form λu , where λ is in terms of e .

(6)

Three small spheres A , B and C of equal radius lie at rest in a straight line on a smooth horizontal table, with B between A and C . The spheres A and C each have mass $5m$, and the mass of B is m . Sphere B is projected towards C with speed u . The coefficient of restitution between each pair of spheres is $\frac{4}{5}$.

(b) Show that, after B and C have collided, there is a collision between B and A .

(3)

(c) Determine whether, after B and A have collided, there is a further collision between B and C .

(4)



Question 7 continued

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Question 7 continued

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(Total 13 marks)

Q7



8. A particle P moves on the x -axis. At time t seconds the velocity of P is v m s⁻¹ in the direction of x increasing, where v is given by

$$v = \begin{cases} 8t - \frac{3}{2}t^2, & 0 \leq t \leq 4, \\ 16 - 2t, & t > 4. \end{cases}$$

When $t = 0$, P is at the origin O .

Find

- (a) the greatest speed of P in the interval $0 \leq t \leq 4$, (4)
- (b) the distance of P from O when $t = 4$, (3)
- (c) the time at which P is instantaneously at rest for $t > 4$, (1)
- (d) the total distance travelled by P in the first 10 s of its motion. (8)

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