

3. A truck of mass of 300 kg moves along a straight horizontal road with a constant speed of 10 m s^{-1} . The resistance to motion of the truck has magnitude 120 N.

(a) Find the rate at which the engine of the truck is working.

(2)

On another occasion the truck moves at a constant speed up a hill inclined at θ to the horizontal, where $\sin \theta = \frac{1}{14}$. The resistance to motion of the truck from non-gravitational forces remains of magnitude 120 N. The rate at which the engine works is the same as in part (a).

(b) Find the speed of the truck.

(4)



5.

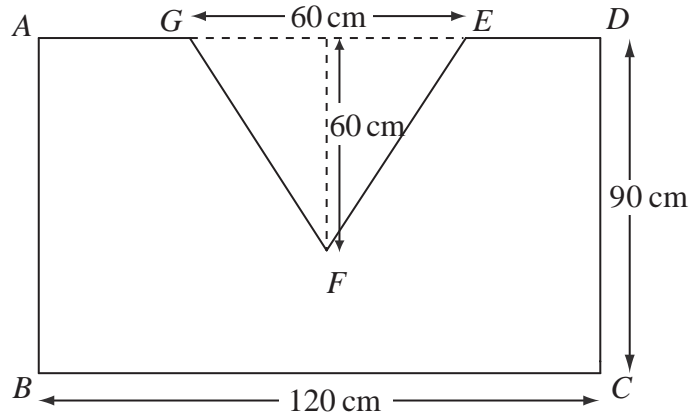


Figure 2

A shop sign $ABCDEFG$ is modelled as a uniform lamina, as illustrated in Figure 2. $ABCD$ is a rectangle with $BC = 120$ cm and $DC = 90$ cm. The shape EFG is an isosceles triangle with $EG = 60$ cm and height 60 cm. The mid-point of AD and the mid-point of EG coincide.

- (a) Find the distance of the centre of mass of the sign from the side AD . (5)

The sign is freely suspended from A and hangs at rest.

- (b) Find the size of the angle between AB and the vertical. (4)



Question 5 continued

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6.

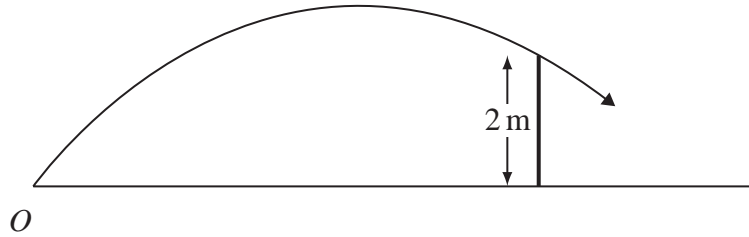


Figure 3

A child playing cricket on horizontal ground hits the ball towards a fence 10 m away. The ball moves in a vertical plane which is perpendicular to the fence. The ball just passes over the top of the fence, which is 2 m above the ground, as shown in Figure 3.

The ball is modelled as a particle projected with initial speed $u \text{ m s}^{-1}$ from point O on the ground at an angle α to the ground.

- (a) By writing down expressions for the horizontal and vertical distances, from O of the ball t seconds after it was hit, show that

$$2 = 10 \tan \alpha - \frac{50g}{u^2 \cos^2 \alpha}. \quad (6)$$

Given that $\alpha = 45^\circ$,

- (b) find the speed of the ball as it passes over the fence. (6)



7.

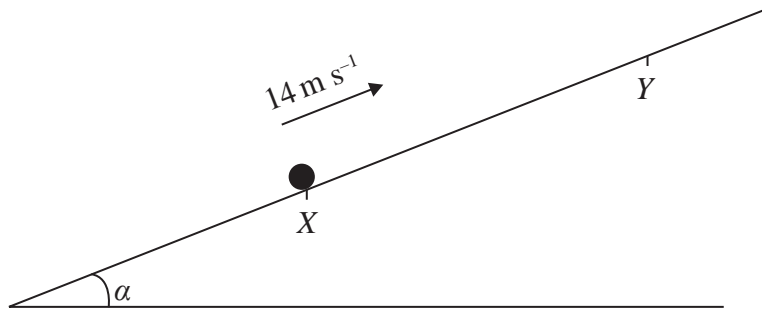


Figure 4

A particle P of mass 2 kg is projected up a rough plane with initial speed 14 m s^{-1} , from a point X on the plane, as shown in Figure 4. The particle moves up the plane along the line of greatest slope through X and comes to instantaneous rest at the point Y . The plane is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{7}{24}$. The coefficient of friction between the particle and the plane is $\frac{1}{8}$.

- (a) Use the work-energy principle to show that $XY = 25\text{ m}$. (7)

After reaching Y , the particle P slides back down the plane.

- (b) Find the speed of P as it passes through X . (4)



Question 7 continued

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8. Particles A , B and C of masses $4m$, $3m$ and m respectively, lie at rest in a straight line on a smooth horizontal plane with B between A and C . Particles A and B are projected towards each other with speeds $u \text{ m s}^{-1}$ and $v \text{ m s}^{-1}$ respectively, and collide directly.

As a result of the collision, A is brought to rest and B rebounds with speed $kv \text{ m s}^{-1}$. The coefficient of restitution between A and B is $\frac{3}{4}$.

(a) Show that $u = 3v$. (6)

(b) Find the value of k . (2)

Immediately after the collision between A and B , particle C is projected with speed $2v \text{ m s}^{-1}$ towards B so that B and C collide directly.

(c) Show that there is no further collision between A and B . (4)



Question 8 continued

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