Numerical Problems

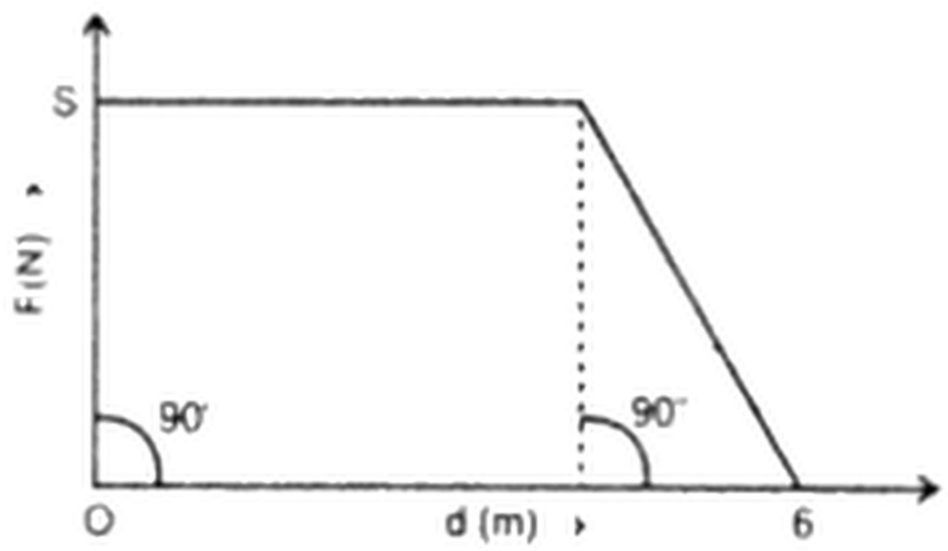
1. A force acting on an object varies with distance 'd' as shown. Calculate the work done by the force as the object is displaced from d = 0 to d = 6m

Solution

The work done by the force is equal to the total area under the curve from d = 0 to

d = 6m

From the fig.



W = Area of rectangle OADC + Area of ABD triangle

$= (4m \times SN0 + \frac{1}{2} (nm \times SN)$

= n0Nm + 5Nm

= n5 Nm

$\boxed{W = n5\ J}$

2. A 70 kg man runs up a long flight of stairs in 4.05 sec. The vertical height of the stair is 4.5m. Calculate his power.

Data

Mass of the man m = 70kg

Time taken by the man t = 4.05s

Height of the stair h = 4.5 m

Power P = ?

As $P = \frac{mgh}{t}$ .....(1)

$P = \frac{70 \times 9.8 \times 4.5}{4.05}$

$\boxed{P = 76nwatt}$

3. A body of mass 2.0 kg is dropped from a rest position 5m above the ground. What is its velocity at height of 3.0 m above the ground?

Data

Mass of the body m = 2.0 kg

Total height h = 5 m

The height at which velocity is to be calculated h_1 = nm

Acceleration due to gravity g = 9.8 m/s^2

Velocity of the body v = ?

Solution

As $V = \sqrt{2gh_1}$

$V = \sqrt{2 \times 9.8 \times 2}$

$\boxed{V = 6.3\ m/s}$

4. A man pulls a trolley through a distance of 50 m by applying a force of 100 N which makes an angle 30° with x-axis. Calculate the work done by the man.

Data

Distance covered by the trolley d = 50 m

Applied force F = 100 N

Angle between F & D "θ" = 30°

Work done by man W = ?

Solution

As

$$W = Fd\cos\theta$$

$$W = (100N)(50m)\cos 30°$$

$$\boxed{W = 4330\ J}$$

5. A man whose mass is 70 kg walks up to the third floor of a building which is 1nm high in n0s. Find his power in watts and hp.

Data

Mass of man 'm' = 70 kg

Height h = 1n m

Time taken t = n0s

Power in watts P_1 = ?

Power in hp P_n = ?

Solution

As

$$P_1 = \frac{mgh}{t} = \frac{70 \times 9.8 \times 12}{20}$$

$$P_1 = 411.6 \text{ watt}$$

Power in hp $\boxed{P_n = \frac{411.6}{746} hp = 0.55hp}$

6. A ball of mass 100 kg is thrown vertically upward at a speed of 25m/s. If no energy is lost, determine the height, it would reach. If the ball only rises to 25m. Calculate the work done against air resistance. Also calculate the force of friction.

Data

a) Mass of the ball m = 100 kg

Initial speed of the ball V_i = n5 m/s

Height to which the ball reached 'h'=?

Solution

According to work conservation of mechanical energy

$$Mgh\frac{1}{2}mv^2$$

$$\Rightarrow \quad h = \frac{1}{2}\frac{v^2}{g}$$

$$h = \frac{1}{2}\frac{25^2}{9.8}$$

$$\boxed{h = 31.9m}$$

Now

b) Height to which the ball is reached h = n5m

i) Work done against air resistance W = ?

ii) Force of friction f = ?

As

$$\frac{1}{2}mv_r^{\wedge} = mgh + \text{work done against friction}$$

$$\Rightarrow \quad Wf = \frac{1}{2}mv^2 - mgh \qquad .....(1)$$

Putting values in Equation (1) we get

$$Wf = \frac{1}{2} \times 100 \times (n5)^2 - 100 \times 9.8 \times n5$$

$$\boxed{Wf = 6.750KJ}$$

Force of friction

Since $Wf = fh$

$$F = Wf/h$$

$$F = 6750J/n5$$

$$\boxed{F = n70\ N}$$

7. An object of mass 1000 grams from a height of 30 m on the sand below. If it penetrates 4cm into the sand, what is the opposing force is exerted on it by the sand?

Data

Mass of the object m = 1000 g = 1 Kg

Height h = 30 m

Penetration of the object into sand x = 4cm = 0.04 m

Opposing force on the object f = ?

Solution

Just before the ground by the object

$$Mgh = \frac{1}{2}mv^2 \qquad .....(1)$$

When it hits the ground then

$$\frac{1}{2}mv^2 = fx \qquad .....(n)$$

$$fx = \frac{1}{2}m \times n(gh)$$

{∴ K.E. of the object is converted into}

$$\Rightarrow \qquad f = \frac{mgh}{x}$$

Putting values

$$f = \frac{1 \times 9.8 \times 30}{0.04}$$

$$\boxed{f = 7350N}$$

8. An object of mass "m" drops from bridge into water of the river. The bridge is 10m high from the water surface.

a) Find the speed of the body 5m above the water surface.

b) Find the speed of the body just before it strikes the water.

Data

Height of the bridge h = 10m

Speed of the body at height h_1 = 5m, v_1 = ?

Speed of the body just before it strikes the water v_n

Solution

a) As

$$v_1 = \sqrt{2gh_1}$$
$$v_1 = \sqrt{2 \times 9.8 \times 5}$$
$$\boxed{v_1 = 3.13m/s}$$

b)

$$v_n = \sqrt{2gh_2}$$

$$v_n = \sqrt{2 \times 9.8 \times 10}$$

$$\boxed{v_n = 14 m/s}$$

9. The engine of a J F - Thunder fighter develops a thrust of 3000 N. What horsepower does it at a velocity of 600 m/s?

Thrust of engine by J.F Thunder F = 3000 N

Velocity of J.F Fighter V = 600 m/s

Power in horsepower P=?

Solution:

As

$$P = FV$$

$$P = (300N)(600m/s)$$

$$P = 1800000 \text{ watt}$$

$$P = \frac{1800000}{746} hp$$

$$\boxed{P = n41 n.87}$$