Numerical Problems

6.1. A man has pulled a cart through 35 m applying a force of 300 N. Find the work done by the man. (10500 J)

Solution: Distance = S = 35 m

Force = F = 300 N

Work done = W = ?

W = F x S

W = 300 x 35

W = 10500 J

6.2. A block weighing 20 N is lifted 6 m vertically upward. Calculate the potential energy stored in it. (120 J)

Solution: Weight of the block = W = 20 N

Height = h = 6 m

Potential energy = P. E. = ?

P.E. = mgh

We know that w = mg

P.E. = (mg) x h

Thus, P.E. = (2 x 10) x 6

P.E. = 120 J

6.3. A car weighing 12 k N has speed of 20 ms – 1. Find its kinetic energy.

(240 kJ)

Solution: Weight of the car = w = 12kN = 12 x 1000 N = 12000 N

Speed of the car = v= 20 ms^{-1}

Kinetic energy = K.E. = ?

$$K.E. = \frac{1}{2} m v^2$$

$$W = mg \quad \text{or} \quad m = \frac{w}{g}$$

$$m = \frac{12000}{10} = 1200 \text{ kg}$$

Thus $K.E. = \frac{1}{2} \times 1200 \times (20)^2$

$= 600 \times 400 = 240000$ J

K.E. = 240 kJ

6.4. A 500 g stone is thrown up with a velocity of 15ms^{-1}. Find its

(i) P.E. at its maximum height

(ii) K.E. when it hits the ground

(56.25 J, 56.25 J)

Solution: Mass of stone = m = 500 g = $\frac{500}{1000}$ kg = 0.5 kg

Velocity = v = 15 ms^{-1}

(i) Potential energy = P.E. = ?

(ii) Kinetic energy = K.E. = ?

(i) Loss of K.E. = Gain in P.E.

$$\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 = mgh$$

As velocity of the stone at maximum height become zero, therefore, $v_f = 0$

$$\frac{1}{2} \times 0.5 \times (0) - \frac{1}{2} \times 0.5 \times (15)^2 = mgh$$

$$\frac{1}{2} \times 0.5 \times 225 = mgh$$

$$-56.25 = mgh$$

$$mgh = -56.25 J$$

Since energy is always positive, therefore

P.E. = 56.25 J

(ii) K.E. = $\frac{1}{2} m v^2$

K.E. = $\frac{1}{2} \times 0.5 \times (15)^2$

$= \frac{1}{2} \times 0.5 \times 225$

= 56.25 J

6.5. On reaching the top of a slope 6 m high from its bottom, a cyclist has a speed of 1.5 ms^{-1}. Find the kinetic energy and the potential energy of the cyclist. The mass of the cyclist and his bicycle is 40 kg. (45 J, 2400 J)

Solution: Height of the slope = h = 6 m

Speed of the cyclist = v = 1.5 ms^{-1}

Mass of cyclist and the bicycle = m = 40 kg

(i) Kinetic energy = K.E. = ?

(ii) Potential energy = P.E. = ?

(i) $K.E. = \frac{1}{2} m v^2$

$K.E = \frac{1}{2} \times 40 \times (1.5)^2$

$K.E = \frac{1}{2} \times 40 \times 2.25 = 45 \text{ J}$

(ii) $P.E = mgh$

$P.E = 40 \times 10 \times 6 = 2400 \text{ J}$

6.6. A motor boat moves at a steady speed of 4 ms^{-1}. Water resistance acting on it is 4000 N. Calculate the power of its engine.

(16 kW)

Solution: Speed of the boat = $v = 4ms^{-1}$

Force = F = 4000 N

Power = P = ?

$P = F v$

$P = 4000 \times 4$

$P = 16000 \text{ W}$

$P = 16 \times 10^3 \text{ W}$

$P = 16 \text{ kW}$

6.7. A man pulls a block with a force of 300 N through 50 m in 60 s. Find the power used by him to pull the block.

(250 W)

Solution: Force = F = 300 N

Distance = S = 50m

Time = t = 60 s

Power = P = ?

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{w}{t} = \frac{F \times S}{t}$$

$$P = \frac{300 \times 50}{60} = 5 \times 50 = 250 \text{ W}$$

6.8 A 50 kg man moved 25 steps up in 20 seconds. Find his power, if each step is 16 cm high.

(100 W)



Solution:

Mass = m = 50 kg

Total height = h = 25 x 16 = 400 cm = $\frac{400}{100}$ m = 4 m

Time = t = 20 s

Power = P = ?

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{w}{t} = \frac{mgh}{t}$$

$$P = \frac{50 \times 10 \times 4}{20}$$

$$P = 100 \text{ W}$$

6.9. Calculate the power of a pump which can lift 200 kg of water through a height of 6 m in 10 seconds.

(1200 watts)

Solution: Mass = m = 200 kg

Height = h = 6m

Power = P = ?

$$\text{Power} = \frac{\text{work}}{\text{time}} = \frac{w}{t} = \frac{mgh}{t}$$

$$P = \frac{200 \times 10 \times 6}{10}$$

$$P = 1200 \text{ W}$$

6.10. An electric motor of 1hp is used to run water pump. The water pump takes 10 minutes to fill an overhead tank. The tank has a capacity of 800 liters and height of 15 m. Find the actual work done by the electric motor to fill the tank. Also find the efficiency of the system. (Density of water = 1000 kgm^{-3})

(Mass of 1 liter of water = 1 kg) (447600 J, 26.8 %)

Solution: Power = P = 1 hp = 746 W

Time = t = 10 min = 10 x 60 s = 600 s

Capacity/volume = V = 800 liters

Height = h = 15 m

(i) Work done = W = ?

(ii) Efficiency = E = ?

(i) Power = $\frac{\textbf{work}}{\textbf{time}}$

$$P = \frac{\mathbf{W}}{\mathbf{t}}$$

Or $W = P \times t$

$W = 746 \times 600$

$W = 447600$ J

Since the work done by electric pump to fill the tank is 447600 J. It is equal to input.

Hence input = actual work doe = W = 447600 J

(ii) Output = P.E = mgh

Since 1 litre = 1kg, therefore 800 litres = 800 kg

Output = P.E = 800 x 10 x15 = 120000J

$$\% \text{ Efficiency} = \frac{\text{Output}}{\text{Input}} \times 100$$

$$\% \text{ Efficiency} = \frac{120000}{447600} \times 100$$

Efficiency = 26. 8 %

ClassNotes