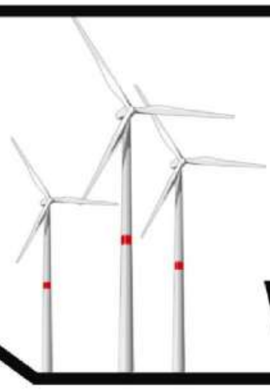

UNIT 6
WORK AND ENERGY

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. (GRW 2013)

Given Data

Force applied = F = 300 N

Distance moved by cart = S = 35 m

Required

Work done by the man = W =?

Solution

As we know that

W = F x S

By putting the values, we have

W = 300 x 35

W = 10500 J

Result

Work done by the man = W = 10500 J

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

Given Data

Weight of the block = W = 20 N

Distance moved vertically upward = h = 6 m

Required

Potential energy of the block = P.E = ?

Solution

As we know that

W = F x S

By putting the values, we have

W = 20 x 6

W = 120 J

Result

Potential energy of the block = P.E = 120 J

6.3 A car weighing 12 kN has speed of 20 ms-1. Find its kinetic energy stored in it. (LHR 2015)

Given Data

Weight of car = w = 12 kN

Speed of car = v = 20 ms-1

Required

Kinetic energy stored in car = K.E = ?

Solution

As we know that

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

By putting the values, we have

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

$K.E. = \frac{1}{2} \times 1200 \times 400$

$K.E. = 240000\ J$

$K.E. = 240\ kJ$

Result

Kinetic energy stored in car = K.E = 240 kJ

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

i) P.E. at its maximum height

ii) K.E. when it hits the ground

Given Data

Mass of the stone = m = 500 g = 0.5 kg

Velocity of the stone = v = 15 ms^{-1}

Required

P.E. at its maximum height = P.E. = ?

K.E. when it hits the ground = K.E. = ?

Solution

As we know that

Potential energy at maximum height = kinetic energy while throwing

Potential energy at maximum height = $\frac{1}{2} mv^2$

By putting the values, we have

Potential energy at maximum height = $\frac{1}{2} \times 0.5 \times (15)^2$

Potential energy at maximum height = $\frac{1}{2} \times 0.5 \times 225$

Potential energy at maximum height = 56.25 J

Also we know that

Kinetic energy while hitting the ground = Potential energy at maximum height

As Potential energy at maximum height = 56.25 J

So Kinetic energy while hitting the ground = 56.25 J

Result

P.E. at its maximum height = P.E. = 56.56 J

K.E. when it hits the ground = K.E. = 56.56 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.

Given Data

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

Height of slope = h = 6 m

Mass of cyclist and bicycle = m = 40 kg

Required

Kinetic energy of the cyclist = K.E. = ?

Potential energy of the cyclist = P.E = ?

Solution

As we know that

$P.E. = mgh$

By putting the values, we have

$P.E. = 40 \times 10 \times 6$

$P.E. = 2400\ J$

Also we know that

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

By putting the values, we have

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

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

K.E. = 45 J

Result

Kinetic energy of the cyclist = K.E. = 45 J
Potential energy of the cyclist = P.E = 2400 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.

Given Data

Speed of the motor boat = v = 4 ms^{-1}
Water resistance acting on boat = 4000 N

Required

Power of the engine of motor boat = P = ?

Solution

As we know that

$$P = \frac{W}{t}$$
$$= \frac{FS}{t}$$
$$= F\left(\frac{S}{t}\right)$$
$$P = F \times v$$

By putting the values, we have

$$P = 4000 \times 4$$
$$P = 16000 \text{ W}$$
$$P = 16 \text{ kW}$$

Result

Power of the engine of motor boat = P = 16 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. (LHR 2015)

Given Data

Force applied on block = F = 300 N
Distance covered by the block = S = 50 m
Time taken = t = 60 s

Required

Power used to pull the block = P = ?

Solution

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{3000 \times 50}{60}$$
$$P = \frac{150000}{60}$$
$$P = 250 \text{ W}$$

Result

Power used to pull the block = P = 250 W

6.8 A 50 kg man moved 25 steps up in 20 seconds. Find his power, if each step is 16 cm high. (GRW 2014)

Given Data

Mass of man = m = 50 kg

Height of each step = h = 16 cm = 0.16 m
Number of steps = n = 25
Time taken = t = 20 s

Required

Power of the man = P = ?

Solution

Since

F = w
= mg
= (50) (10)
= 500 N

Height reached by man = h = 0.16 × 25
= 4 m

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{500 \times 4}{20}$$

$$P = \frac{2000}{20}$$

P = 100 W

Result

Power of the man = P = 100 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. (LHR 2013, GRW 2013, 2014)

Given Data

Mass of the water = m = 200 kg
Height attained = h = 6 m
Time taken = t = 10 s

Required

Power of the pump = P = ?

Solution

Since

F = w
= mg
= 200 × 10
= 2000 N

As we know that

$$P = \frac{W}{t} = \frac{F \times S}{t}$$

By putting the values, we have

$$P = \frac{2000 \times 6}{10}$$

$$P = \frac{12000}{10}$$

P = 1200 W

Result

Power of the pump = P = 1200 W

6.10 An electric motor of 1 hp 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.

Given Data

Power of the motor = P = 1 hp
Time taken by pump = t = 10 mins = 600 s
Capacity of the tank = v = 800 liters
Height of the tank = h = 15 m

Required

Work done by the motor = W = ?
Efficiency of the system = ?

Solution

As we know that

$$P = \frac{W}{t} \qquad \text{So} \qquad W = P \times t$$

By putting the values, we have

W = 1 hp x 600s

Or W = 746 w x 600s = 447600 J

Now Output = W = mgh

By putting the values, we have

Output = 800 x 10 x 15
Output = 120000 J

We also know that

$$\% \text{ Efficiency} = \frac{\text{Required form of output}}{\text{Total input energy}} \times 100$$

By putting the values, we have

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

% Efficiency = 0.268 x 100

So, % Efficiency = 26.8%

Result

Work done by the motor = W = 447600 J
Efficiency of the system = 26.8%