

| Chapter | 4 Work, Energy and Power | Class | 1 <sup>st</sup> Year | Subject | Physics |
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## Give Short Answers of the Following Questions

1. Why is electrical power required at all when the elevator is descending? Why should there be a limit on the number of passengers in this case?

### Ans. Importance of electrical power during descent

Electrical power is required to control the descent speed and stop the elevator from free-falling. Otherwise object become in state of weightlessness.

#### Limits on the number of passengers

By limiting the number of passengers, the kinetic energy of the descending elevator is kept within the design limits of the braking system, ensuring a safe and controlled descent.

If the elevator is overloaded, the braking system may be unable to dissipate the excess kinetic energy. So due to over speeding, the accident may happen.

2. A body is being raised to a height H from surface of Earth. What is the sign of work done by both? Justify.

### Ans. The two main forces acting on the body are:

The upward force applied to lift the body and downward force of gravity

Work done is given by the product of force and displacement.

$$W = \vec{F} \cdot \vec{d}$$

$$W = Fd\cos\theta$$

Work done by Upwards force is positive, since the force and displacement are in the same direction:

$$W = Fh\cos 0^\circ = Fh$$

Work done by Downward force (gravity) is negative, since the force and displacement are in opposite directions:

$$W = Fh\cos 180^\circ = -Fh = -mgh \quad (\because F = mg)$$

3. A body falls towards the Earth in air. Will its total mechanical energy be conserved during fall? Justify.

### Ans. When an object fall towards Earth, then

#### For non-resistive medium

Loss in P.E = gain in K.E.

total mechanical energy remains conserved

#### For resistive medium

Loss in P.E. = gain in K.E. + work done against friction.

For resistive medium, a part of mechanical energy is converted into heat energy to perform work against friction. So total mechanical energy does not remain conserved

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|---------|--------------------------|-------|----------------------|---------|---------|
|---------|--------------------------|-------|----------------------|---------|---------|

- 4. Calculate power of a crane in kilowatt which lifts a mass of 1000 kg to a height of 100 m in 20 second.**

**Ans. Data:**  $m = 1000\text{kg}$   
 $h = 100\text{m}$   
 $t = 20\text{m}$

$P \text{ (kW)} = ?$

**Calculation:** As the power is equal to time rate of doing work. So,

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

$$P = \frac{mgh}{t} \quad (\because W = mgh - 0 = mgh)$$

$$P = \frac{1000 \times 9.8 \times 100}{20}$$

$$P = 49000\text{watt}$$

$$P = \frac{49000}{1000}\text{kW}$$

$$P = 49\text{kW}$$

- 5. A trolley of mass 1500 kg carrying sand bags of 500 kg is moving uniformly with a speed of 40 km h<sup>-1</sup> on a frictionless track. After some time, sand starts leaking out of whole sand bags on the road at a rate of 0.05 kg s<sup>-1</sup>. What is the speed of the trolley after entire sand bags are empty?**

**Ans.** Initial velocity =  $40 \text{ km h}^{-1} = \frac{40 \times 1000}{3600} \text{ms}^{-1} = 11.11 \text{ ms}^{-1}$

Initial mass =  $1500 \text{ kg} + 500 \text{ kg} = 2000 \text{ kg}$

Initial momentum =  $2000 \text{ kg } 11.11 \text{ ms}^{-1} = 22220 \text{ kg ms}^{-1}$

Since, no external force acts on the system so the momentum is conserved.

i.e., Initial momentum = final momentum

$$22220 = 1500 \times \text{Final velocity}$$

$$\text{Final velocity} = \frac{22220}{1500} = 14.8 \text{ ms}^{-1}$$

$$\text{Final velocity} = 53.32 \text{ km h}^{-1}$$

- 6. Give absolute and gravitational units of work on M.K S & C.G.S systems.**

**Ans.** The absolute and gravitational units of work in MKS and CGS systems:

$$(\because F = ma \text{ and } W = Fd)$$

**Absolute Units:**

**MKS:** joule (J) =  $\text{N m} = \text{kg m}^2 \text{ s}^{-2}$

**CGS:** Erg (erg) =  $\text{dyne cm} = \text{g cm}^2 \text{ s}^{-2}$

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|---------|--------------------------|-------|----------------------|---------|---------|
|---------|--------------------------|-------|----------------------|---------|---------|

And  $1 \text{ joule (J)} = 10^7 \text{ erg (erg)}$

**Gravitational Units:**

**MKS:** kilogram – meter (kg m) or kilogram – force meter (kg fm)

**CGS:** gram- centimeter (g cm) or gram – force centimeter (g fcm)

And  $1 \text{ kilogram – meter (kg m)} = 9.80665 \text{ joule (J)} \text{ (approx.)}$

- 7. A body dropped from a height of H reaches the ground with a speed of  $(1.2\sqrt{gH})$ . Calculate work done b air friction.**

**Ans.** potential energy at height H is:

Initial potential energy (PE) = mgH

Kinetic energy just before hitting the ground:

Kinetic energy (KE) =  $\frac{1}{2} m v^2$

As  $\text{loss of P.E} = \text{Pain in K.E} + \text{Work done against friction}$

So, work done by air friction

$$(P.E)_{\text{int}} = K.E + W_f$$

$$W_f = (P.E)_{\text{int}} - K.E$$

$$W_f = mgH - \frac{1}{2} m (1.2\sqrt{gH})^2$$

$$W_f = mgH - \frac{1}{2} m (1.44gH)$$

$$W_f = mgH - 0.72mgH$$

$$W_f = 0.28 mgH$$

This is the work done by air friction, opposing the motion of the body.

- 8. A bicycle has a K.E. of 150 J. what K.E. would the bicycle have if it had?**

**(i) Same mass but has speed double?**

**(ii) Three times mass and was moving with one half of the speed?**

**Ans.** (i) As kinetic energy of body is  $K.E = \frac{1}{2} m v^2 = 150 \text{ J}$

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

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

$$(K.E)' = 4 \left( \frac{1}{2} m v^2 \right)$$

$$(K.E)' = 4 (K.E) \quad \text{so K.E. become four times}$$

$$(K.E)' = 4(150) = 600 \text{ J}$$

(ii) As kinetic energy of body is  $K.E = \frac{1}{2} m v^2$

| Chapter | 4 Work, Energy and Power | Class | 1 <sup>st</sup> Year | Subject | Physics |
|---------|--------------------------|-------|----------------------|---------|---------|
|---------|--------------------------|-------|----------------------|---------|---------|

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

$$(K.E)' = \frac{1}{2} (3m) \left(\frac{v}{2}\right)^2 \quad (\because m' = 3m, v' = \frac{v}{2})$$

$$(K.E)' = \frac{1}{2} (3m) \frac{v^2}{4}$$

$$(K.E)' = \frac{3}{4} \left(\frac{1}{2} m v^2\right)$$

$$(K.E)' = \frac{3}{4} (K.E) \text{ so K.E. become } 3/4 \text{ times}$$

$$(K.E)' = \frac{3}{4} (150) = 112.5J$$

**9. What will be the effect on K.E. of the body having mass  $m$ , moving with velocity  $v$  when its momentum becomes double? Justify.**

**Ans.** As kinetic energy of body is  $(K.E)' = \frac{1}{2} m v^2$

Multiply and divide by  $m$

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

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

$$K.E = \frac{p^2}{2m} \quad \because p = mv \text{ so } p^2 = (mv)^2$$

As momentum is double  $p' = 2p$

$$K.E' = \frac{p'^2}{2m}$$

$$K.E' = \frac{(2p)^2}{2m} \quad (\because p' = 2p)$$

$$K.E' = 4 \left(\frac{p^2}{2m}\right)$$

$$K.E' = 4(K.E)$$

**10. Does the international space-station have gravitation P.E. or Kinetic energy or both? Explain.**

**Ans.** International space-station has both kinetic and potential energies. But kinetic energy is much more significant as compare to its potential energy due to its large value.

**Kinetic Energy:**

International space-station has kinetic energy due to its orbital motion around the Earth.

**Gravitational Potential Energy:**

As gravitational potential energy is due to position of object in gravitational field. So, space-station in earth's gravitational field has gravitational potential energy.