Chapter # 04 (Work and Energy)
Important Short Questions

1. Define work done. Write its formula and unit.

Ans:

Work done: -

The product of magnitude of displacement and component of force in the direction of the displacement is called work done.

$$w = \vec{F}.\vec{d}$$

$$w = Fd\cos\theta$$

- Its SI unit is **Joule** that is equal to **Nm**. And its dimension is **$[ML^2T^{-2}]$**
- It is a scalar quantity.

2. What is positive and negative work done?

Ans:

Positive Work	Negative Work
• When a body falls freely under the action of gravity, force of gravity and displacement are in same direction ($\theta=0^0$). Then work done will be positive. • If $\theta < 90^0$, Work will be positive.	• When a body moves against gravity, force of gravity and displacement are opposite to each other ($\theta = 180^0$). Then work done will be negative. • If **$270^0 > \theta > 90^0$**, work done will be negative.

3. Define energy and watt.

Ans: Energy:

The ability of a body to do work is called energy.

Watt: The power of body will be one watt if t does 1J work in one second.

$$1W = \frac{1J}{1s}$$

4. Define conservative field. Give one example.

Ans: Conservative field:

The field in which work is independent of the path follower is called conservative field.

OR

The field, in which work done along a closed path is zero is called conservative field.

Examples:

- Gravitational field
- Electric field

5. Differentiate between conservative and non-conservative forces. Give examples.

Ans:

Conservative forces	Non-conservative forces
• The force that does zero work in closed path is called conservative force. • For example, (i) Gravitational force (ii) Elastic spring force (iii) Electric force	• The force that does not do zero work in a closed path is called non-conservative force. • For example, (i) Frictional force (ii) Air resistance

6. Define power, Write its formula and unit.

Ans: The rate of doing work is called power.

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

Average Power: The ration between total work done and total time is called average power.

$$P_{av} = \frac{\Delta w}{\Delta t}$$

Instantaneous Power: The limiting value of $\frac{\Delta w}{\Delta t}$ as time Δt approaches to zero is called instantaneous power.

$$P_{ins} = Lim_{\Delta t \to 0} \frac{\Delta w}{\Delta t}$$

- Its SI unit is **Watt** that is equal to $\mathbf{Js^{-1}}$**.** And its dimension is $\mathbf{[ML^2T^{-3}]}$
- It is a scalar quantity.

7. Prove that P = F.V

Ans: Proof: -

Let $\vec{F}$ is the constant force acting on a moving body and $\vec{v}$ is constant velocity of the body. Then the power delivered to the body at any instant is given by

$$P = Lim_{\Delta t \to 0} \frac{\Delta w}{\Delta t}$$

$$P = Lim_{\Delta t \to 0} \frac{\vec{F}.\Delta\vec{d}}{\Delta t} \qquad [\Delta w = \vec{F}.\Delta\vec{d}]$$

$$P = \vec{F}.\left(Lim_{\Delta t \to 0} \frac{\Delta\vec{d}}{\Delta t} \right) \qquad [Lim_{\Delta t \to 0} \frac{\Delta\vec{d}}{\Delta t} = \vec{v}]$$

$$P = \vec{F}.\vec{v}$$

8. Define KWH, show that 1Kwh=3.6MJ

Ans: The commercial unit of electrical energy is **kilowatt-hour**.

Kilowatt-hour: -

The work done in one hour by an agency whose power is one kilowatt is called one kilowatt-hour.

$$1\ kWh = 1000\ W \times 3600\ sec$$

$$1\ kWh = 3600000\ J$$

$$1\ kWh = 3.6 \times 10^6\ J$$

$$\mathbf{1\ kWh = 3.6\ MJ}$$

9. Define K.E and P.E. Write down their formulae.

Kinetic Energy	Potential Energy
• The energy possessed by the body due to its motion is called kinetic energy. • For example, running water has K.E. $K.E = \frac{1}{2}mv^2$	• The energy possessed by the body due to its position is called Potential energy. • For example, Water stored in a dam has P.E. $P.E = mgh$

10. Differentiate between gravitational P.E and Elastic P.E.

Ans:

Gravitational P.E.	Elastic P.E.
• The energy possessed by the body due to its height is called gravitational P.E. **P.E = mgh**	• The energy stored in a compressed or stretched string is called elastic P.E. $\mathbf{P.E = \frac{1}{2}kx^2}$

11. Define work energy principle, Write its mathematical form.

Ans: Work-Energy Principle: -

Work done on a body is equal to the change in its kinetic energy.

Proof:

The work done on the body is

$$\text{Work done} = Fd \quad \text{---------- (i)}$$

According to equation of motion

$$2ad = v_f^2 - v_i^2$$

$$d = \frac{1}{2a}\left(v_f^2 - v_i^2\right) \quad \text{---------- (ii)}$$

According to Newton's 2nd law of motion

$$F = ma \quad \text{---------- (iii)}$$

By putting equations (ii) and (iii) in (i), we get

$$\text{Work done} = ma \times \frac{1}{2a}\left(v_f^2 - v_i^2\right) = \frac{1}{2}m\left(v_f^2 - v_i^2\right)$$

$$\text{Work done} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Work done = final K.E – initial K.E

Work done = Change in K.E

12. Define absolute P.E. Write its formula.

Ans: Absolute P.E:

The absolute P.E of an object at a certain position is the work done by gravitational force in displacing the object from that position to infinity where the force of gravity becomes zero.

$$\mathbf{U_g = -\frac{GMm}{R}}$$

13. What is escape velocity? Write its value and mathematical form.

Ans: Escape velocity

The initial velocity of a body with which it goes out of the earth's gravitational field is called escape velocity.

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

$$v_{esc} = \sqrt{2gR}$$

As, $g = 9.81\ ms^{-2}$ and $R = 6.4 \times 10^6\ m$

Then,

$$v_{esc} = \sqrt{2 \times 9.81 \times 6.4 \times 10^6}$$

$$v_{esc} = 11.2 \times 10^3 \text{ ms}^{-1}$$

$$\mathbf{v_{esc} = 11.2 \text{ kms}^{-1}}$$

14. Differentiate between Geyser and aquifer.

Ans:

Geyser	Aquifer
• Geyser is a hot spring, which out steam and hot water in air. • They are present usually in volcanic areas.	• Aquifer is a rock layer holding water, which allows water to percolate through it with pressure. • Aquifer permeable rock which can contain or transmit ground water.

15. State law of conservation of energy. Give one example of energy conversion in our daily life.

Ans: Law of conservation of energy:

Energy neither created not destroyed. It can be converted from one form into another, but the total energy remains constant.

Conversion of Mechanical Energy: -

The K.E and P.E are the different forms of the energies. The total mechanical energy of the body is equal to the sum of K.E and P.E.

P.E may change into K.E, Similarly K.E may also be converted into P.E but the total energy remains constant.

Mathematically, we can write.

Total energy = K.E + P.E

16. How electrical energy can be obtained by using tides?

Ans: Electrical energy is obtained from tides.

Explanation:

Gravitational force of the moon produces tides in the sea. The tides raise the water in the sea roughly twice a day. water at high tide can be trapped in a basin by constructing a dam. Dam is filled at high tide. Then, water is released in a controlled way at low tide to derive the turbines. The dam is filled again for next high tide and the fall of water also derive the turbines and turbines run generators. This process is used to generate the electricity from tides.

17. What is geothermal energy?

Ans: Geo-thermal energy:

"The heat energy that is extracted from inside the Earth in the form of hot water or steam is called geothermal energy."

Process of Geothermal Energy Generation: -

(i) Radioactive decay
(ii) Residual heat of Earth
(iii) Compression of materials
(iv) Through bacterial action in the absence of air

18. What is meant by solar constant?

Ans: Solar Constant:

"Solar constant at normal incidence outside the earth's atmosphere per second per unit area is about **1.4 kW/m²** which is called solar constant.

19. How can we obtain the energy from biomass?

Ans: Energy from biomass:

The energy from all the organic materials including crop residue, natural vegetable trees, animal dung and sewage is called biomass energy.

There are many methods used for the conversion of biomass into fuels:

i. Direct Combustion
ii. Fermentation

20. Write sources of energies which are renewable and non-renewable.

Ans:

Renewable Energy Source	Non-renewable Energy Source
• Such energy from a source which does not deplete when used is called renewable energy source. • **For example,** (i) Hydroelectric (ii) Wind (iii) Geothermal (iv) Sunlight	• Such energy from a source which deplete when used is called non- renewable energy source. • **For example,** (i) Coal (ii) Natural Gas (iii) Oil (iv)

Exercise Short Questions

1- A person holds hold a bag of groceries while standing still, talking to a friend. A car is stationary with its engine running. From the stand point of work, how are these two situations similar?

Ans: In both cases work done is zero.

Reason: -

As the person and the car both are at rest. So the displacement is zero.

$$\text{Work done} = FdCos\theta$$
$$W = F\,(0)\,Cos\theta$$
$$W = 0$$

So, the word done is zero.

2- Calculate the work done in kilo joules in lifting a mass of 10 kg (at a steady velocity) through a vertical height of 10m.

Ans:

Given Data: -

$m = 10kg$
$h = 10\ m$
$W = ?$

Calculations: -

As the work done is in the form of P.E.

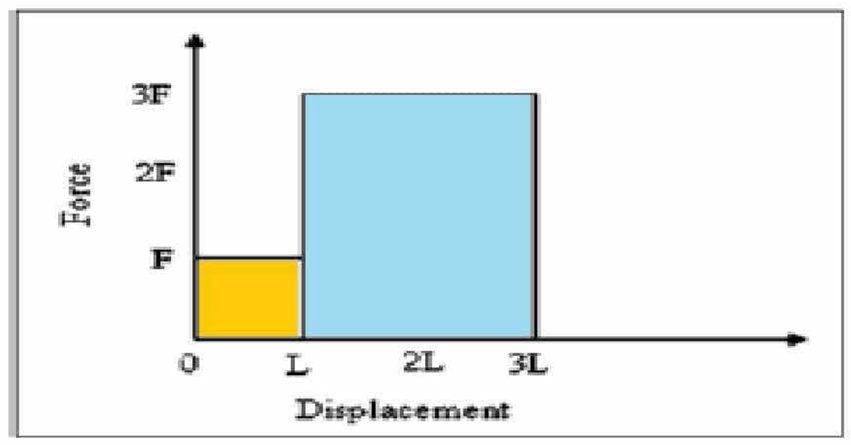
$$W = mgh$$
$$W = 10 \times 9.8 \times 10$$
$$W = 0.980\ J$$

3- A Force F acts through a distance L. the force is then increased to 3F, and then acts through a further distance of 2L. Draw the work diagram to scale.

Ans: Force displacement graph: -

As area under the force displacement graph is equal to the work done by the body. So,

$$W = (F)(L) + (3F)(2L)$$
$$W = FL + 6FL$$
$$W = 7FL$$



4- In which case is work done? When a 50kg of books is lifted through 50cm, or when a 50kg crate is pushed through 2m across the floor with a force of 50N?

Ans: Case I: -

$$\text{Mass} = m_1 = 50\ kg$$
$$\text{Height} = h = 50\ cm = 0.50\ m$$
$$W_1 = ?$$
$$W_1 = m_1gh$$
$$W_1 = 50 \times 9.8 \times 0.5$$
$$W_1 = 245\ J$$

Case II: -

$$\text{Mass} = m = 50\ kg$$
$$\text{Distance} = d = 2m$$
$$\text{Force} = F = 50\ N$$
$$W_2 = Fd$$
$$W_2 = 50 \times 2$$
$$W_2 = 100J$$

Result: The work done is greater in case I.

5- An object has 1J of potential energy. Explain what does it mean?

Ans: An object having one joule P.E means that body has a capacity to do a work of one joule.
For example, if an object is lifted up ad one joule of work is done in doing so then this work done will be stored in the body in the form of P.E. When the same object i.e. having P.E of 1J, is allowed to fall it will do one joule work.

6- A ball of mass m is held at a height h_1 above a table. The table top is at height h_2 above the floor. One student says that ball has potential energy mgh_1, but another says that it is $mg(h_1 + h_2)$. Who is correct?

Ans: Both of them are correct.

Reason: -

Since P.E is always with respect to some reference point. Therefore, we can say that first student has measure P.E with respect to table top.

P.E with **respect to table top** = mgh_1

And the 2nd student measure P.E with respect to floor.

P.E with **respect to floor** = $mg(h_1 + h_2)$

7- When a rocket re-enters the atmosphere, its nose cone becomes very hot. Where does this heat energy come from?

Ans: Source of Heat energy: -

When the rocket re-enters the atmosphere, then some of its K.E is used in doing work done against friction with dust particles and air, which is converted into heat. Due to this heat energy, its nose cone becomes very hot.

8- What sort of energy is in the following?

(a) Compressed spring.

(b) Water in high dam.

(c) A moving car.

Ans: (a) A compressed spring has **Elastic P.E.**

(b) Water in the high dam has **gravitational P.E.**

(c) A moving car has **Kinetic Energy.**

9- A girl drops a cup from a certain height, which breaks into pieces. What energy changes are involved?

Ans: Energy Changes: -

A cup thrown from certain height losses its gravitational P.E and gain its K.E. When it strikes the ground then a part of this K.E is used to break the cup and rest of the energy converts into sound energy and heat energy.

10- A body uses a catapult to thrown a stone which accidently smashes a green-house window. List the possible energy changes?

Ans: Possible Energy Changes: -

The following energy changes occur,

1) When the boy throws the stone the elastic P.E into K.E.
2) When stone hits the window, a part of K.E used to break the window into pieces.
3) Rest of energy converted into heat and sound.

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