13. Work and Energy

Work: The product of displacement and force in the direction of displacement of a body is called work. i.e. work = Displacement × Force in the direction of displacement.

The unit of work is Joule in m.k.s. system and erg in C.G..S. system.

$$1 \text{ Joule} = 10^7 \text{ erg}$$

Energy: The capacity of a body to do work is called energy. i.e. Energy possessed by a body = Total work that the body can do

The m.k.s. unit of energy is Joule.

Joule: When a body moves through a distance of 1 m under the force of 1 N in the direction of force, then work done by the body is said to be 1J.

Different forms of energy:

(i) **Kinetic energy:** The energy possessed by a body due to its motion is called kinetic energy. i.e. KE = ½ mv^2. Here m is mass and v is velocity of the body.

(ii) **Potential energy:** The energy possessed by a body due to its position is called P.E. Potential energy = mgh

(iii) **Mechanical energy:** The energy possessed by a body due to position or motion is called mechanical energy. i.e. Mechanical energy = PE + KE

(iv) **Thermal energy:** The energy which gives us sensation of warmth is called thermal energy.

(v) **Light energy:** The energy which helps us see things is called light energy.

(vi) **Electrical energy:** The energy due to moving charges is called electrical energy.

(vii) **Nuclear energy:** The energy released in nuclear reactions by conversion of mass into energy is called nuclear energy.

Power: The time rate of doing work is called power. i.e. power = work done/time

The SI unit of power is **Watt**. It is also measured in horse power, 1 HP = 746 watt

Watt: If one Jule of work is done by a body in one second, then power of a body is said to be one watt.

Build your understanding

- When you try to push a wall you do not do any work as distance moved by the body is zero.
- When no force is applied on the body and the body is either at rest or moving with constant velocity then no work is done.
- If force and displacement are perpendicular to each other then work done by force is zero. e.g. A person carrying a load on his head and moving on level road does no work against gravity.

Since no component of force is there in the direction of force of gravity.

- Energy can neither be created nor destroyed but it can be converted from one form to another form.

✔ Maximise Your Marks

- Remember that Kilowatt hour is a unit of energy. Power is measured in watt or kilo watt.
- 1 k watt = 1000 watt, 1 kwh = 3.6×10^6 Joule
- Calculate the energy spent in converting 100 g of ice into water at 0ºC.

$$Q = mL$$
$$m = 100 \text{ g}$$
$$= 100 \times 80 \text{ cal}$$
$\{\because L$ = Latent heat of ice
$$= 80 \text{ cal/g}\}$$
$$= 100 \times 80 \times 4.18 \text{ J}$$
$(\because 1 \text{ cal} = 4.18 \text{ Joule})$
$$= 33440 \text{ Joule.}$$

★ Stretch Yourself

1. Does work done depend on the path?
2. A ball of mass 0.5 kg has 100 J of kinetic energy. What is the velocity of the ball?
3. State law of conservation of energy.
4. Why road accidents at high speed are worse than accidents at low speed?
5. In which of the following situations work is done?
   (a) A person is climbing up a staircase.
   (b) A satellite revolving around the earth in closed circular orbit.
   (c) Two teams play a tug of war and both pull with equal force.
   (d) A person is standing with heavy load on his head.

? Test Yourself

1. What type of energy is possessed by water stored in a dam?
2. Vishrut is moving with speed 10 m/s in circular path of radius 10 m. What work is doen by vishrut to complete one revolution?
3. What will be the percentage increase in kinetic energy of a body if its velocity is doubled?
4. Alok climbs up a staircase in 5 minutes, Vishrut takes only 3 minutes in going up the same staircase. The weight of Alok and vishrut is equal, which one will spend more power?
5. Calculate the work done in lifting a 5 kg mass through a height of 2 m from the ground. ($g = 9.8 \text{ ms}^{-2}$)