Chapter 10 Work and Energy

Work

Work done in moving an object is equal to the product of force and displacement of body in the direction of force.

$$Work = Force \times Displacement$$

$$\boxed{W = F \times d}$$

Work is a scalar quantity.

Unit of work is Newton meter or **Joule**.

1 joule

$$W = F \times d \quad if \ f = 1 \ and \ d = 1$$

$$then \ \ W = 1 \times 1$$

$$\boxed{W = 1 \ joule}$$

When a force of 1 Newton moves a body through a distance of 1 meter in its own direction, then the work done is 1 Joule.

Energy

The capacity of doing work is known as energy.

Energy is a scalar quantity.

Unit: The SI unit of energy is Joule (J) and its bigger unit is kilo joule (kJ).

1 kJ = 1000 J

Forms of Energy

Main forms of energy are:

(i) Kinetic energy
(ii) Potential energy
(iii) Heat energy
(iv) Chemical energy
(v) Electrical energy
(vi) Light energy

Sum of kinetic energy & potential energy of a body is called mechanical energy.

Mechanical energy

The energy controlled by a body on account of its motion or position is called mechanical energy.

Kinetic Energy

The energy of a body due to its motion is called kinetic energy.

Examples of kinetic energy

- Running water
- Flowing wind
- A moving car
- Flying aircraft

Formula for Kinetic Energy

If an object of mass 'm' moving with uniform velocity 'u', it is displaced through a distance 's'. Constant force 'F' acts on it in the direction of displacement. Its velocity changes from 'u' to 'v'. Then acceleration is 'a'.

$$Work\ done, \qquad W = F \times d \qquad \ldots(i)$$

$$and \qquad F = ma \qquad \ldots(ii)$$

According to third equation of motion, relationship between u, v, s and a is as follows

$$v^2 - u^2 = 2ad$$

$$So, \qquad d = \frac{v^2 - u^2}{2a} \qquad \ldots.(iii)$$

Now putting the value of F and s from (ii) and (iii) in equation (i),

$$W = ma \times \frac{v^2 - u^2}{2a}$$

$$= \frac{m}{2} \times v^2 - u^2$$

$$= \frac{1}{2}m(v^2 - u^2)$$

$$\boxed{W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2}$$

$If\ u = 0\ (when\ body\ starts\ moving\ from\ rest)$

$$W = \frac{1}{2}mv^2$$

$$\boxed{E_K = \frac{1}{2}mv^2}$$

Potential Energy

The energy of a body due to its position is known as potential energy.

Examples:

a) **Water kept in dam:** It can rotate turbine to generate electricity due to its position above the ground.
b) **Bent string of bow:** Potential energy due to change of its shape (Deformation) released in the form of kinetic energy while shooting an arrow.