Work and Energy

- **Condition for scientifically work to be done**

  - There must be a displacement
  - Displacement of an object must be in the direction of applied force

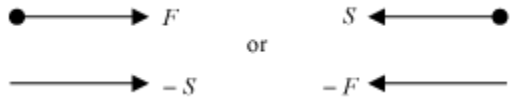
- **Work done** by a constant force is defined as Work = Force × Displacement [along the direction of force]

  $W = F \times s$ [Unit – Joule, 1 J = 1 N-m]

- Work done against gravity = Weight × Height = mgh

- **Condition for the Negative Work done**

  Force and displacement must be in opposite direction



- **Conditions for no work done**

  - No displacement (e.g. a boy pushes the wall)
  - Displacement occurs perpendicularly to the applied force(e.g. in case of circular motion, there is no work done by the centripetal force)

- **Energy** : Capacity to do work is called energy.
- There are various form of energy e.g. heat energy, mechanical energy, nuclear energy, light energy etc.

- **Mechanical Energy:** It is caused by the motion or the position and configuration of the object.

- **Kinetic energy:** A body possesses kinetic energy by virtue of its motion.

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

- **Proof**

  $v^2 - u^2 = 2as$

$$s = \frac{v^2 - u^2}{2a}$$

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

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

$$= \frac{1}{2}mv^2 \left[\text{when u } = 0\right]$$

The kinetic energy of the wind is used in windmills to generate electricity.

Relationship between kinetic energy and momentum

K.E. =12pm2p2 =2mK=2mK (where K =Kinetic energy)

- **Potential energy:** A body possesses potential energy by virtue of its configuration or position.
- **Gravitational potential energy**

PE = *mgh* [*h* = height of object from the earth surface]

- **Elastic potential energy**

$\mathrm{U} = \frac{1}{2}\mathrm{kx}^2$ [Where x = compression or elongation in the spring]

- **Law of conservation of energy**

  - The total amount of energy in a system always remains constant.

$$\mathrm{mgh} + \frac{1}{2}\mathrm{mv}^2 = \text{constant}$$

Power: It is defined as rate of doing work.

$$\mathrm{P} = \frac{\mathrm{W}}{t}\left(\text{Unit - Watt, } 1\mathrm{W} = \frac{1\mathrm{J}}{1\mathrm{s}}\right)$$

1Horse Power = 746Watts

For electric appliances,

power = voltage × current

Energy consumed in time *t* = Power × time.

Power is also defined as the product of force and average speed.

$P = F \times v$

- The commercial unit of energy is kilowatt-hour (kWh).
  $1\text{kWh} = 3.6 \times 10^6\ \text{J}$

- The amount of electrical energy consumed in our house is expressed in terms of 'units', where

  1 unit = 1kWh