Energy and Power

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

    1. **There must be a displacement**
    2. Displacement must be along the direction of applied force

        - **When is no work done?**

1. **No displacement [No work is done in circular path]**
2. Displacement occurs perpendicularly to the applied force

    Work = Force × Displacement [along force direction]

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

- Work-Energy Relationship:
    - The ability to do work is called energy.
    - Energy of the body is equal to the amount of work it can do when its energy is released.
    - A Body possessing energy is only capable of doing work.

- **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**

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

- **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)

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

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

Power: It is defined as rate of doing work.

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

1 Horse Power = 746 Watts

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.

$P = F \times v$