

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

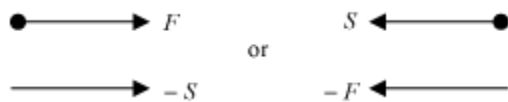
- **Work done** by a constant force is defined as Work = Force \times Displacement [along the direction of force]

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

- Work done against gravity = Weight \times 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**

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

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

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

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

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

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

Relationship between kinetic energy and momentum

K.E. = $\frac{1}{2}mv^2 = 2mK$ (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**

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

- **Law of conservation of energy**

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

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

Power: It is defined as rate of doing work.

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

1Horse Power = 746Watts

For electric appliances,

power = voltage \times current

Energy consumed in time t = Power \times 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

$1 \text{ unit} = 1 \text{ kWh}$
