

# 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

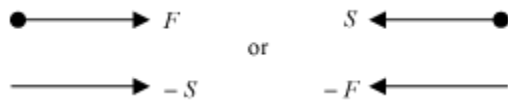
- **Work done** by a constant force is defined as Work = Force × Displacement [along the direction of force]

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

- 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**

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

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

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

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

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

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

### Relationship between kinetic energy and momentum

$$\text{K.E.} = \frac{1}{2}mv^2 = \frac{1}{2}m \times \frac{p^2}{m} = \frac{1}{2}p^2 \text{ (where } K = \text{Kinetic energy)}$$

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

$$PE = mgh \text{ [ } h = \text{ height of object from the earth surface ]}$$

- **Elastic potential energy**

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

- **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.

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

$$1 \text{Horse Power} = 746 \text{Watts}$$

For electric appliances,

$$\text{power} = \text{voltage} \times \text{current}$$

Energy consumed in time  $t = \text{Power} \times \text{time}$ .

**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

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