2. 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: Unit – Joule

- **Kinetic energy** (because of motion): It depends on the mass and the speed of the body. Kinetic energy = $\frac{1}{2}mv^2$
- **Potential energy** (Because of position and shape of the body). Potential energy = mgh [gravitational potential energy; h = height, g = acceleration due to gravity]
- **Mechanical energy**: A body is said to have mechanical energy if it possesses either kinetic energy or potential energy or both.
- **Various forms of energy are** Chemical energy, Sound energy, Light energy, heat energy, magnetic energy, and muscular energy.
- Grease and other lubricating substances are used to minimize the energy loss due to the friction.
- **Energy Chain:** The sun's energy reaches us through a series of conversions which is called energy chain i.e the interconversion of energy from one form to various other forms.
- **Conservation of energy:** It states that energy cannot be created or destroyed. It can only be transformed from one form to another.

- **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**

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

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

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

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

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

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

Relationship between kinetic energy and momentum

K.E. =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**

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

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

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

Power: It is defined as rate of doing work.

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

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).

  $1kWh = 3.6 \times 10^6$ J

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

1 unit = 1kWh