Law of Conservation of Energy.

(1) **Law of conservation of energy**

For a body or an isolated system by work-energy theorem we have

$$K_2 - K_1 = \int \vec{F}.d\vec{r} \qquad .....(i)$$

But according to definition of potential energy in a conservative field

$$U_2 - U_1 = -\int \vec{F}.d\vec{r} \qquad .....(ii)$$

So from equation (i) and (ii) we have

$$K_2 - K_1 = -(U_2 - U_1)$$

or $\quad K_2 + U_2 = K_1 + U_1$

i.e. $\quad$ K + U = constant.

For an isolated system or body in presence of conservative forces the sum of kinetic and potential energies at any point remains constant throughout the motion. It does not depends upon time. This is known as the law of conservation of mechanical energy.

$\Delta(K + U) = \Delta E = 0$ $\qquad$ [As E is constant in a conservative field]

$\therefore \quad \Delta K + \Delta U = 0$

i.e. if the kinetic energy of the body increases its potential energy will decrease by an equal amount and vice-versa.

(2) **Law of conservation of total energy :** If some non-conservative force like friction is also acting on the particle, the mechanical energy is no more constant. It changes by the amount of work done by the frictional force.

$\Delta(K + U) = \Delta E = W_f$ $\qquad$ [Where W_f is the work done against friction]

The lost energy is transformed into heat and the heat energy developed is exactly equal to loss in mechanical energy.

We can, therefore, write $\Delta E + Q = 0$ $\qquad$ [where Q is the heat produced]

This shows that if the forces are conservative and non-conservative both, it is not the mechanical energy alone which is conserved, but it is the total energy, may be heat, light, sound or mechanical etc., which is conserved.

In other words : “Energy may be transformed from one kind to another but it cannot be created or destroyed. The total energy in an isolated system is constant". This is the law of conservation of energy.