1.) $W = \int \vec{F} \cdot d\vec{r}$

2.) $W = \vec{F} \cdot \Delta\vec{r}$ [const. force]

3.) $W = F \Delta r \cos\theta$ [const. force]

Work done by variable force :-

$$\boxed{W = \int_{x_1}^{x_2} F_x \, dx + \int_{y_1}^{y_2} F_y \, dy + \int_{z_1}^{z_2} F_z \, dz}$$

$$K.E. = \frac{1}{2} mv^2 = \frac{p^2}{2m}$$

Work - Energy Theorem

$$\boxed{W_{\text{all the force}} = \Delta K.E.}$$

Potential Energy

$$\boxed{\Delta U_{system} = -W_{icf}}$$

Spring P.E. $\Rightarrow \boxed{\frac{1}{2} K x^2}$

$$\boxed{F_x = -\frac{dU}{dx}}$$

$$\vec{F} = \left[-\frac{\delta U}{\delta x}\hat{i} - \frac{\delta U}{\delta y}\hat{j} - \frac{\delta U}{\delta z}\hat{k} \right]$$

Conservation of Mechanical Energy

$$\boxed{W_{ext} + W_{incf} = \Delta M.E.}$$

If external & internal non-conservative forces are zero. Then,

$$\boxed{\Delta M.E = 0}$$

i.e., $\boxed{K.E_i + U_i = K.E_f + U_f}$

Power

$$\boxed{P = \frac{dW}{dt} = \vec{F} \cdot \vec{v}}$$

$$\boxed{P = \frac{\Delta K.E.}{t}}$$