Electric potential

Electric Potential Energy

$W = \vec{F} \cdot d\vec{s} = q_0 \vec{E} \cdot d\vec{s}$

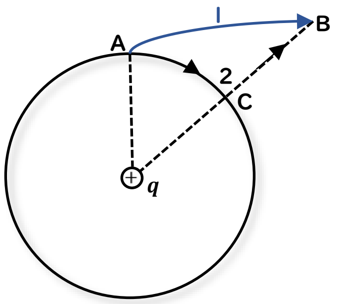
$\Rightarrow \boxed{\Delta U = U_B - U_A = -\int_A^B \vec{E} \cdot d\vec{s}}$

energy is conservative $\Rightarrow q_0 \oint \vec{E} \cdot d\vec{s} = 0$

Electric Potential

$$\boxed{\Delta V = \frac{\Delta U}{q_0} = -\int_A^B \vec{E} \cdot d\vec{s}}$$

V of a point charge



$V_B - V_A = \Delta V_1 = \Delta V_2$

$= -\int_A^B \vec{E} \cdot d\vec{s} = -\left(\int_A^C \vec{E} \cdot d\vec{s} + \int_C^B \vec{E} \cdot d\vec{s}\right) = -(0 + \int_{r_A}^{r_B} k_e \frac{q}{r^2} d\vec{r})$

$= k_e q(\frac{1}{r_B} - \frac{1}{r_A})$

choose $V = 0$ at $r_A = \infty$

$\Rightarrow \boxed{V = k_e \frac{q}{r}}$

for $V = k_e \frac{q}{r}$ and $E_r = k_e \frac{q}{r^2}$, we can find $\boxed{E_r = -\frac{dV}{dr}}$

Potential Energy of Multiple Charges

$$U_{AB} = q_A V_B = q_A \left(k_e \frac{q_B}{r_{AB}}\right) = k_e \frac{q_A q_B}{r_{AB}} \Rightarrow \boxed{U = \sum_{i,j} k_e \frac{q_i q_j}{r_{ij}}}$$