Electric Potential 301

1] Prove that, $N/C = V/m$ (1)

Proof: $N/C = V/m$

R.H.S

$$= \frac{V}{m}$$

$$= \frac{J/C}{m} \quad \left[\because 1V = \frac{1J}{1C}\right]$$

$$= \frac{J}{Cm}$$

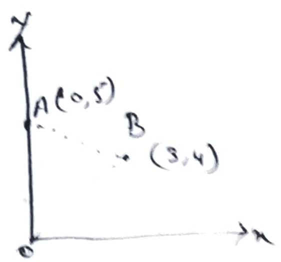
$$= \frac{Nm}{Cm} \quad [\because 1J = Nm]$$

$$= \frac{N}{C}$$

$\therefore$ R.H.S = L.H.S

2] **Soln:** Work done is zero because electric potential at all points of the circle are is same $\left[V = \frac{q}{4\pi\epsilon_0 r}\right]$

3) **Soln:**



Given,

$q = +5\mu C$

$= +5 \times 10^{-6} C$

$\therefore$ Potential at A (0, 5m)

$$V_1 = \frac{kq}{r} = \frac{9 \times 10^9 \times 5 \times 10^{-6}}{5}$$

$$V_1 = 9 \times 10^3 V$$

∴ Potential at B (3m, 4m)

$$V_2 = \frac{kQ}{r} = \frac{9\times10^9 \times 5\times10^{-6}}{5}$$

$$\Rightarrow V_2 = 9\times10^3\ V$$

charge of $e^- = -1.6\times10^{-19}\ C$

$$W = e\,(V_2 - V_1)$$

$$= -1.6\times10^{-16}\,(9\times10^3 - 9\times10^3)$$

$$= -1.6\times10^{-16}\times 0$$

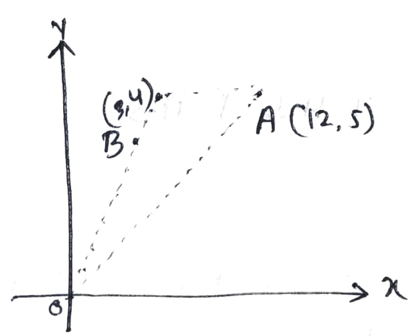
$$= 0$$

4) Soln:

Given,

$q = +8\ \mu C$

$= +8\times10^{-6}\ C$



∴ Potential at A (12, 5)

$$V_1 = \frac{kq}{r} = \frac{9\times10^9\times8\times10^{-6}}{\sqrt{144+25}}$$

$$= \frac{9\times10^9\times8\times10^{-6}}{13}$$

$$\therefore V_1 = 5.53\times10^3\ V$$

∴ Potential at B (3,4)

$$V_2 = \frac{kq}{r} = \frac{9\times10^9\times8\times10^{-6}}{5}$$

$$V_2 = 14.4\times10^3\ V$$

c are of e = 2 × 10^-9

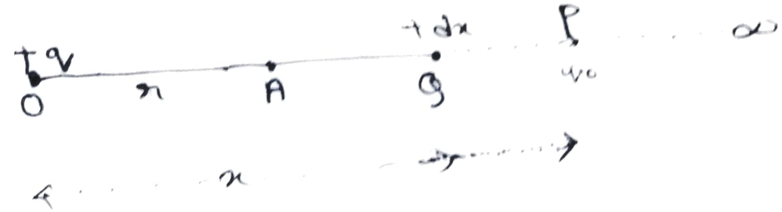
$\therefore W_{A \to B} = -2 \times 10^{-9} [14.4 \times 10^{3} - 5.53 \times 10^{3}]$

$= -2 \times 10^{-9} [14.4 - 5.53] \times 10^{3}$

$= -2 \times 10^{-9} \times 8.87 \times 10^{3}$

$= -17.74 \times 10^{-6}$ J

5] Soln:



Let a point charge $+q$ at O, due to which electrical potential at A ($OA = r$) is

$$V_A = \frac{W_{\infty \to A}}{q_0} \quad \text{--- (1)}$$

[where $W_{\infty \to A}$ is the amount of work done in bringing $+q_0$ from $\infty \to A$]

Let $OP = x$ $[r < x < \infty]$

So, repulsive force between $+q_0$ at P and $+q$ at O is

$$F_P = \frac{1}{4\pi\epsilon_0} \cdot \frac{q q_0}{x^2} \quad \text{..... (1B)}$$

Let $\vec{PQ} = \vec{dx}$ (P & Q are very much closer to each other)

Amount of work done in moving $+q_0$ from P to Q

$$dW_{P \to Q} = \vec{F_P} \cdot \vec{PQ}$$

$$= \vec{F_P} \cdot \vec{dx} \cos 180^\circ$$ [$\because$ $\vec{F_P}$ & $\vec{dx}$ are in opp. dirn]

$$= -\frac{1}{4\pi\epsilon_0}\frac{q q_0}{x^2}\,dx \cdots\cdots (iii)$$

$$\therefore W_{\infty \to A} = \int dW_{p \to q}$$

$$= \int_{\infty}^{r} -\frac{1}{4\pi\epsilon_0}\frac{q q_0}{x^2}\,dx$$

$$= -\frac{1}{4\pi\epsilon_0} q q_0 \int_{\infty}^{r} \frac{dx}{x^2}$$

$$= -\frac{1}{4\pi\epsilon_0} q q_0 \left[-\frac{1}{x}\right]_{\infty}^{r}$$

$$\Rightarrow \frac{W_{\infty - A}}{q_0} = \frac{1}{4\pi\epsilon_0} q \left[\frac{1}{r} - \frac{1}{\infty}\right]$$

$$\therefore \boxed{V_A = \frac{1}{4\pi\epsilon_0}\frac{q}{r}} \quad (iv)$$