1. Prove that, ~~N/C~~ $N/C = V/m$

R.H.S. $= \frac{V}{m}$ $\left[\because V = \frac{J}{C}\right]$.

~~$\therefore V = \frac{J}{C}$~~

R.H.S $= \frac{J/C}{m}$

$= \frac{J}{mC}$ $[J = Nm]$.

$= \frac{Nm}{mC}$

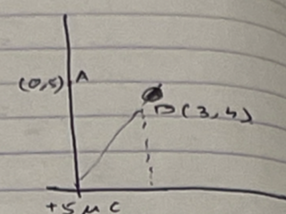
$= \frac{N}{C}$

$=$ ~~R.H.S~~ L.H.S

3. A point charge of + 5 μC is placed at the origin of coordinate coordinate system. An electron is to be moved from (0, 5 m) to (3 m, 4 m). Find the work done.

Solution :-

Given, the charge $q_0 = +5 \mu C$
$= 5 \times 10^{-6} C$



The charge of the electron
$q_1 = 1.6 \times 10^{-19} C$

We know,
$W_{A \to B} = q_1 (V_B - V_A)$

The potential at the point A (0, 5 m)

$$V_A = K \frac{q_0}{r_0}$$
$$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{\sqrt{0^2 + 5^2}}$$
$$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{\sqrt{25}}$$
$$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{5}$$
$$= 9 \times 10^3 \text{ V}$$

The potential at the point B (3 m, 4 m).

$$V_B = K \frac{q_0}{r_B}$$
$$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{\sqrt{9 + 16}}$$
$$= 9 \times 10^9 \times \frac{5 \times 10^{-6}}{\sqrt{25}}$$
$$= \frac{9 \times 10^9 \times 5 \times 10^{-6}}{5} = 9 \times 10^3 \text{ V}$$

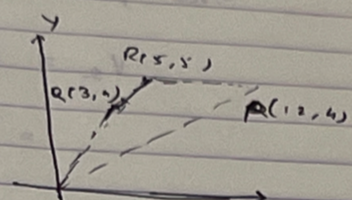
$$\therefore W_{A \to B} = q_1 [V_B - V_A]$$
$$= 1.6 \times 10^{-6} (9 \times 10^3 - 9 \times 10^3)$$
$$= 1.6 \times 10^{-6} \times 0$$
$$= 0$$

4. A point charge of $+8\,\mu C$ is placed at the origin of a co ordinate system. An electron another charge of the $-2\,nC$ is to be moved from $(12\,m, 5\,m)$ to $(3\,m, 4\,m)$ via $(5\,m, 5\,m)$. Find the work done.

Solution :-

The charge, $q = 8\,\mu C$

$= 8 \times 10^{-6} C$



~~$Q \rightarrow (12\,m, 5\,m)$~~

~~The potential at the point Q (12, 4) is~~

~~$V = \frac{Kq}{r^2}$~~

~~$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{}$~~

And the charge, $q_1 = -2\,\mu C$

$= -2 \times 10^{-9} C$

$P\,(12\,m, 5\,m)$
$Q\,(3\,m, 4\,m)$
$R\,(5\,m, 5\,m)$

The potential at the point $P(12\,m, 5$

$$V_P = K \frac{q}{r_P}$$

$$= 9 \times 10^9 \times \frac{8 \times 10^{-6}}{\sqrt{12^2 + 5^2}}$$

$$= 9 \times 10^9 \times \frac{8 \times 10^{-6}}{\sqrt{144 + 25}}$$

$$= 9 \times 10^9 \times \frac{8 \times 10^{-6}}{\sqrt{169}}$$

$$= 9 \times 10^9 \times \frac{8 \times 10^{-6}}{13}$$

$= 5.53 \times 10^3 \text{ V}$

The potential at the point Q (3, 4)

$$V_Q = \frac{k q}{r_Q}$$

$$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{\sqrt{3^2 + 4^2}}$$

$$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{\sqrt{9 + 16}}$$

$$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{\sqrt{25}}$$

$$= \frac{9 \times 10^9 \times 8 \times 10^{-6}}{5}$$

$$= 14.4 \times 10^3 \text{ V}$$

The work done from

$$W_{P \to Q} = q_1 [V_Q - V_P]$$

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

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

$$= (-2 \times 10^{-9}) (8.9 \times 10^3)$$

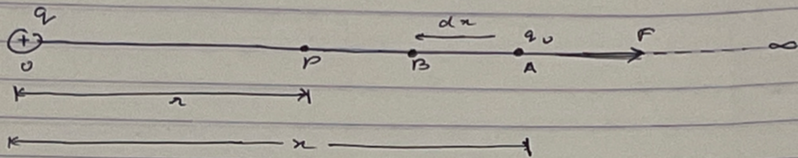
$$= -17.8 \times 10^{-6} \text{ J}$$

Q.5 Find an expression for the electric potential due to a point charge

Ans:-

- Electric potential due to a point charge.

We consider,
+ve point charge q placed at origin O.
To calculate,
its electric potential at a point P at dist. r from it.
By defination,
"the electric potential at point P will be equal to the amount of work done in bringing a unit +ve charge from infinity to the point P."



We suppose,
a test charge q_0 is placed at point A at the dist. x from O. By Coulomb's law, the electrostatic force acting on the charge q_0 is

$$F = \frac{1}{4\pi\epsilon_0} \frac{q \cdot q_0}{x^2}.$$

The force $\vec{F}$ acts away from the charge q.
The small work done in moving the test charge q_0 from A to B through small disp. $\vec{dx}$ against the electrostatic force is

$$dW = \vec{F} \cdot \vec{dx}$$
$$= F\,dx \cos 180^\circ$$
$$= -F\,dx.$$

The total work done in moving the charge q_0 from infinity to the point P will be

$$W = \int dW$$

$$= -\int_{\infty}^{r} F\,dx$$

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

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

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

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

$$= \frac{1}{4\pi\epsilon_0} \frac{q q_0}{r}$$

∴ The work done in moving a unit test charge from infinity to the point P, or the electric potential at point P is

$$V = \frac{W}{q_0}.$$

or $$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}.$$

$$\therefore V \propto \frac{1}{r}.$$