1/0 P

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Electric Potential:

→ Paper - 01

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

Soln: $RHS = \frac{V}{m}$

$= \frac{J}{C\,m}$

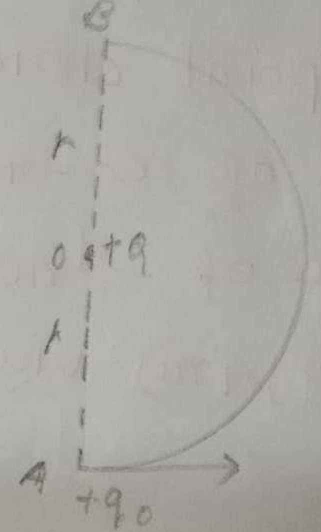
$= \frac{N \times m}{C \times m}$

$= \frac{N}{C}$

$= L.H.S$

Proved

2. Calculate the workdone in moving a test charge $+q_0$ along a semi circular arc, with a source charge $+Q$ at the centre of the arc.



Soln: $V_A = \frac{1}{4\pi\epsilon_0}\frac{Q}{r}$

$V_B = \frac{1}{4\pi\epsilon_0}\frac{Q}{r}$

$W_{A\to B} = +q_0\left[V_B - V_A\right]$

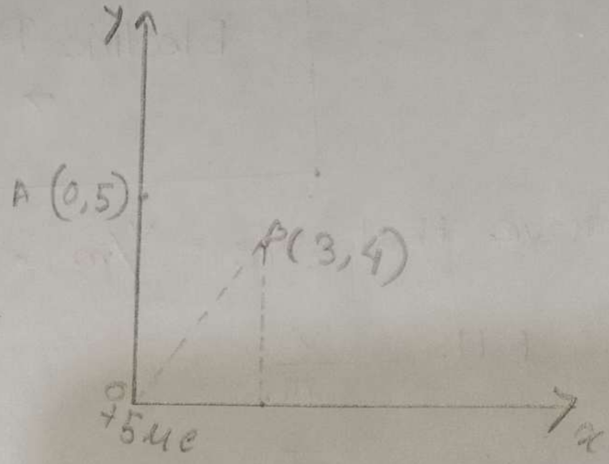
$= +q\left[\frac{1}{4\pi\epsilon_0}\frac{Q}{r} - \frac{1}{4\pi\epsilon_0}\frac{Q}{r}\right]$

$= +q.0$

$= 0$

3. A point charge of $+5\,\mu C$ is placed at the origin of co-ordinate system. An electron is to be moved from $(0, 5\,m)$ to $(3\,m, 4\,m)$. Find the work done.

Solⁿ:



$q = +5\ \mu C$

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

$q_e = -1.6 \times 10^{-19}\ C$

$V_A = \frac{1}{4\pi\epsilon_0} \frac{5 \times 10^{-6}}{5}$

$= 9 \times 10^{9} \times 10^{-6}$

$= 9 \times 10^{3}$

$V_B = \frac{1}{4\pi\epsilon_0} \frac{5 \times 10^{-6}}{5}$

$= 9 \times 10^{3}$

$W_{A \to B} = q_e \left[V_B - V_A \right]$

$= -1.6 \times 10^{-19} \left[9 \times 10^{3} - 9 \times 10^{3} \right]$

$= -1.6 \times 10^{-19} \times 0$

$= 0$

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$V_B = \frac{1}{4\pi}$

$= 9 \times$

$= \frac{7}{}$

$= 1$

$W_{A \to}$

5) Fi

a poi

Soln:

—— X ——

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

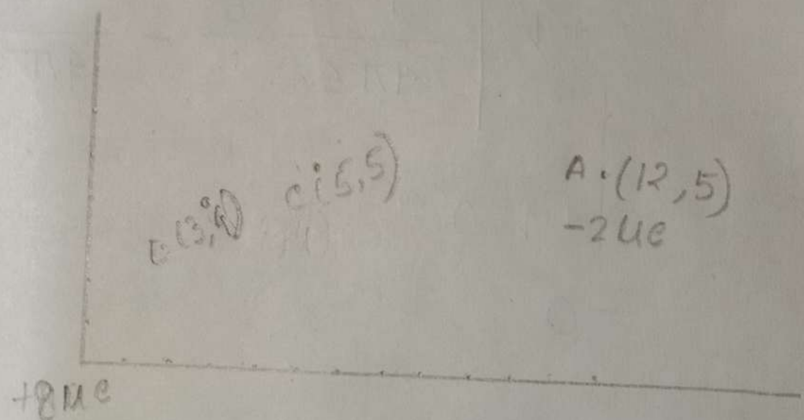
Soln:

$q = +8\,\mu C$

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

$q = -2\,nC$

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



$W_{A \to C \to B} = W_{A \to B}$

$$V_A = \frac{1}{4\pi\epsilon_0}\frac{Q}{r_A} = 9 \times 10^9 \times \frac{8 \times 10^{-6}}{13}$$

$$= \frac{72}{13} \times 10^3 = 5.53 \times 10^3 \text{ Volt}$$

$$V_B = \frac{1}{4\pi\epsilon_0}\frac{q}{r_B}$$

$$= 9\times10^9 \times \frac{8\times10^{-6}}{5}$$

$$= \frac{72}{5}\times10^3$$

$$= 14.4\times10^3 \text{ volt}$$

$$W_{A\to B} = q\left[V_B - V_A\right]$$

$$= -2\times10^{-9}\left[14.4\times10^3 - 5.53\times10^3\right] \text{J}$$

$$= -2\times10^{-9}\times8.9\times10^3$$

$$= -17.8\times10^{-6}$$

$$= -1.78\times10^{-5} \text{ J}$$

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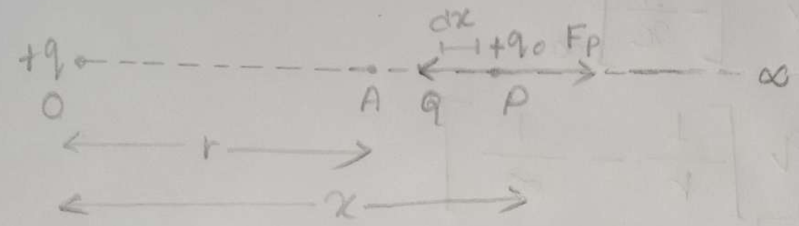
5) Find an expression for the electric potential due to a point charge.

Soln:



Let a point charge $+q$ is placed at a point O, due to which electric potential at A =

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

$OA = r$

Let $OP = x$

Let the test charge $+q_0$ be placed moved from infinity toward A.

When $+q_0$ is placed at P, then the repulsive force on $+q_0$ due to $+q$ is

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

Let $\vec{PQ} = dx$

Amount of workdone in bringing $+q_0$ from P to Q is $dW_{P\to Q} = \vec{F_P} \cdot \vec{PQ} = \vec{F_P} \cdot \vec{dx}$

$$= F_P \, dx \cos 180^\circ$$

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

Now, workdone in bringing a charge from ∞ to A is-

$$W_{\infty \to A} = \int dW$$

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

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

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

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

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

——— X ———