① Ans:-

$$\frac{\text{Volt}}{\text{meter}} = \frac{\text{Newton}}{\text{coulomb}}$$

$$LHS = \frac{\text{Volt (V)}}{\text{meter (m)}}$$

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

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

$$= \frac{N.m}{C.m} \quad [\because 1J = N/m]$$

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

$$= RHS$$

$$\therefore \frac{V}{m} = \frac{N}{C}$$

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② Ans:- Test charge $+q_0$ is moving along a semi circular arc

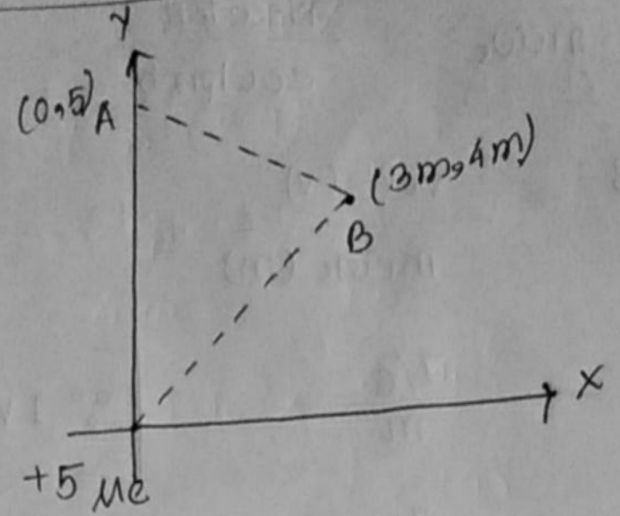
$$\Delta V = V_f - V_i$$

$$= 0 \quad [\because \text{It is a equipotential surface}]$$

$$\therefore W = q_0(V_f - V_i)$$

$$= q_0 \times 0 = 0$$

3 Ans:-



Given $q = +5\,\mu C$

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

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)

$$V_2 = \frac{kq}{r} = \frac{9 \times 10^{9} \times 5 \times 10^{-6}}{\sqrt{9+16}}$$

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

$$V_2 = 9 \times 10^{3} V$$

charge of $e = -1.6 \times 10^{-19} C$

$\therefore W_{A \to B} = e (V_2 - V_1)$

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

$= 0$

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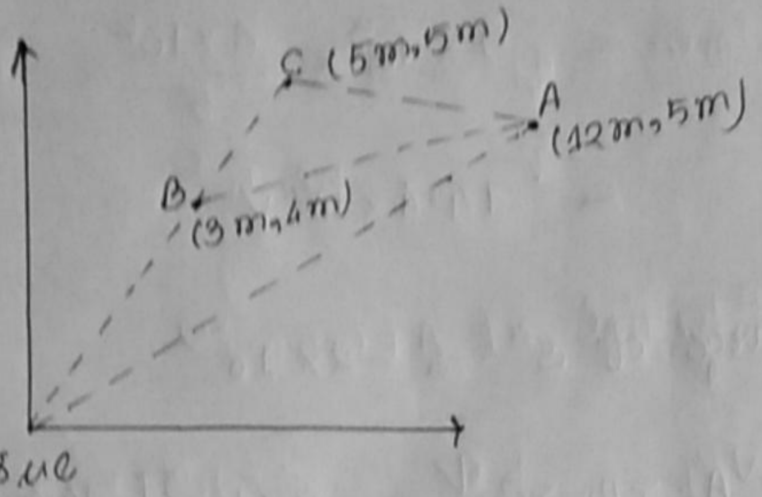
(4) Ans:-



Given, $q = 8 \mu C$

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

Let A (12m, 5m), B (3m, 4m), C = (5m, 5m)

Electric potential at A (12m, 5m)

$$V_A = \frac{1}{4\pi\epsilon_0} \times \frac{q}{r_A}$$

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

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

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

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

Potential at B (3,4)

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

$$= 9\times10^{9} \times \frac{8\times10^{-6}}{\sqrt{3^2+4^2}}$$

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

$$= 14.4\times10^{3} V$$

Charge of e^- $= -2\times10^{-9}$

$$W_{A\rightarrow B\rightarrow C} = -2\times10^{-9}\left[14.4\times10^{3} - 5.53\times10^{3}\right]$$

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

$$= -2\times8.87\times10^{-6}$$

$$= -17.74\times10^{-6} J$$

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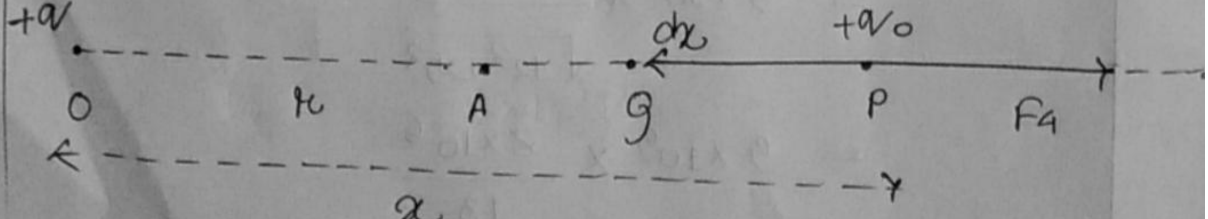
(5) Ans:-



Let a point charge at o due to which

electric potential at A (OA = r) is

$$V_A = \frac{W_{\infty \to A}}{q_0} \quad \text{———} \quad (I)$$ [where $W_{\infty \to A}$ is the amount of workdone in bringing $+q_0$ from ∞ to A]

Let $OP = x$ ($r < x < \infty$)

So repulsive force b/w $+q_0$ at P and $+q$ at O is

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

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

Amount of workdone moving $+q_0$ from P to Q against repulsion is

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

$$= \vec{F_P} \cdot \vec{dx}$$

$$= F_P . dx \cos 180^\circ$$ [$\because$ F_P & dx are in opposite dirn]

$$\Rightarrow dW_{P \to Q} = -\frac{1}{4\pi\epsilon_0} \frac{q q_0}{x^2} \quad \text{———} \quad (III)$$

$$\therefore W_{\infty \to A} = \int dW_{P \to Q} = \int_{\infty}^{r} -\frac{1}{4\pi\epsilon_0} \frac{q q_0}{x^2} dx$$

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

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

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

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

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