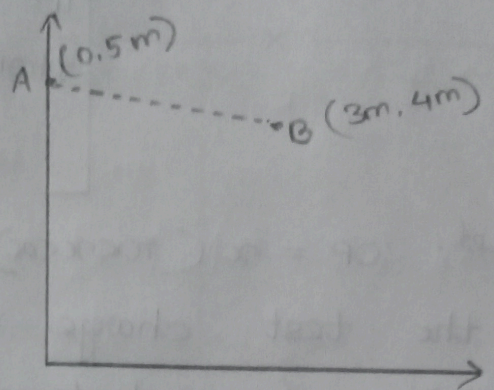
ELECTRIC POTENTIAL : PAPER : 1

3. no. Ans :



We have,

$$W_{A\to B} = q_0 (V_B - V_A) \to (i)$$

where,

$$q_0 = 1.6\times10^{-19}\ C$$

$$q = 5\times10^{-6}\ C$$

$$\therefore V_A = 9\times10^9 \frac{q}{r_A} = 9\times10^9 \times \frac{5\times10^{-6} C}{5}$$

$$= 9\times10^3\ C$$

$$V_B = 9\times10^9 \frac{q}{r_A} = 9\times10^9\times\frac{5\times10^{-6} C}{5}$$

$$= 9\times10^3\ C$$

$$W_{A\to B} = q_0 (V_B - V_A)$$

$$= 1.6\times10^{-19}(9\times10^3\ C - 9\times10^3\ C)$$

$$= 0$$

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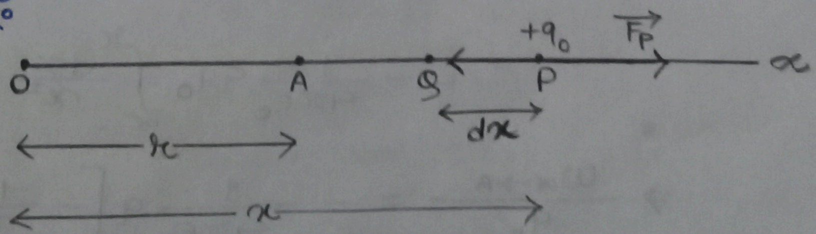
5. Ans :



Let the point charge +q be at O.

Let, OA = r

By definition of electric potential at A,

$V_A = \frac{W_{\infty \to A}}{q_0} \longrightarrow$ (i) [where $W_{\infty \to A}$ is the amount of workdone in moving +q from ∞ to A]

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

Let the test charge $+q_0$ at P.

$\therefore$ Repulsion force between +q and $+q_0$ is

$$F_P = \frac{1}{4\pi\epsilon_0} \frac{q q_0}{x^2} \text{ [towards right]} \rightarrow \text{(ii)}$$

Let, $\vec{PQ} = P\vec{dx}$

$\therefore$ One workdone in bringing $+q_0$ from P to Q.

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

$$= F_P \cdot dx \cdot \cos 180^\circ \quad [\because \vec{F_P} \text{ and } \vec{dx} \text{ are in opposite direction.}$$

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

$$W_{\infty \to A} = \int dW_{P \to Q}$$

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

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

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

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

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

This is the required expression for electric potential due to a point charge.

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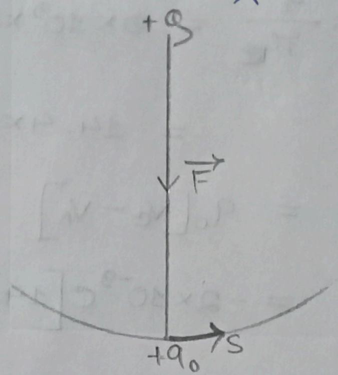
2. Ans:



As the force on the test charge and displacement are perpendicular to each other. So, the workdone in moving the test charge is 0.

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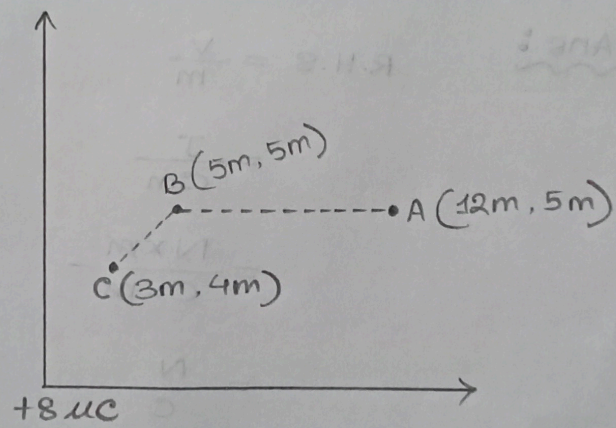
4. Ans:



Given,

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

$q_0 = -2 \times 10^{-9}$ C

A → (12m, 5m)

B → (5m, 5m)

C → (3m, 4m)

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

$= q_0 [V_C - V_A] \longrightarrow$ (i)

$$V_A = 9\times10^9 \times \frac{q}{r_A} = 9\times10^9\times\frac{8\times10^{-6}\,C}{13}$$

$$= 5.54\times10^3\,C.$$

$$V_C = 9\times10^9\times\frac{q}{r_C} = 9\times10^9\times\frac{8\times10^{-6}C}{5}$$

$$= 14.4\times10^3 C$$

$$\therefore\ W_{A\to C} = q_0[V_C - V_A]$$

$$= -2\times10^{-9}C[14.4\times10^3C - 5.54\times10^3C]$$

$$= -2\times10^{-9}C[(14.4-5.54)\times10^3C]$$

$$= -2\times10^{-9}C\times 8.86\times10^3C$$

$$= -17.72\times10^{-6}C$$

$$= -1.772\times10^{-5}C$$

———— x ————

1. Ans:

$$R.H.S = \frac{V}{m}$$

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

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

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

$$= L.H.S$$

$\therefore$ Proved.

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