Solutions

1. $$RHS = \frac{V}{m} = \frac{J}{Cm} = \frac{N\cancel{m}}{C\cancel{m}}$$
$$= \frac{N}{C}$$
$$= LHS$$

2. $$W_{A\rightarrow B} = q_0[V_B - V_A]$$

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

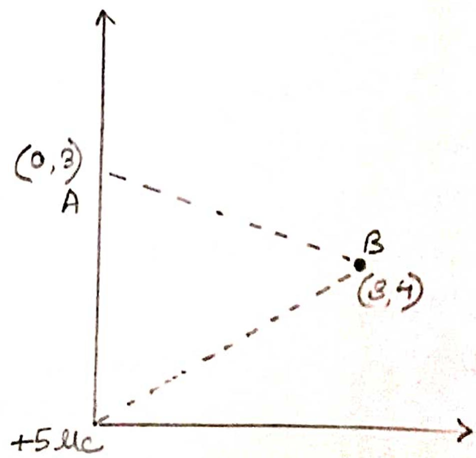
$$V_B = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

$$\therefore W_{A\rightarrow B} = q_0\left[\frac{1}{4\pi\epsilon_0}\frac{q}{r} - \frac{1}{4\pi\epsilon_0}\frac{q}{r}\right]$$
$$= q_0 k \times 0$$
$$= 0$$

3. $$q_0 = -1.6 \times 10^{-19} C$$
$$q = +5 \times 10^{-6} C$$

$$W_{A\rightarrow B} = q_0[V_B - V_A]$$

$$V_A = 9\times10^9 \frac{5\times10^{-6}}{OA}$$



$$= 9\times 10^{9}\,\frac{5\times10^{-6}}{5}$$

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

$$= 9\times10^{3}\,V$$

$$V_B = 9\times10^{9}\,\frac{3\times10^{-6}}{\sqrt{25}}$$

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

$$= 9\times10^{3}\,V$$

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

$$= -1.6\times10^{-19}\left[9-9\right]10^{3}$$

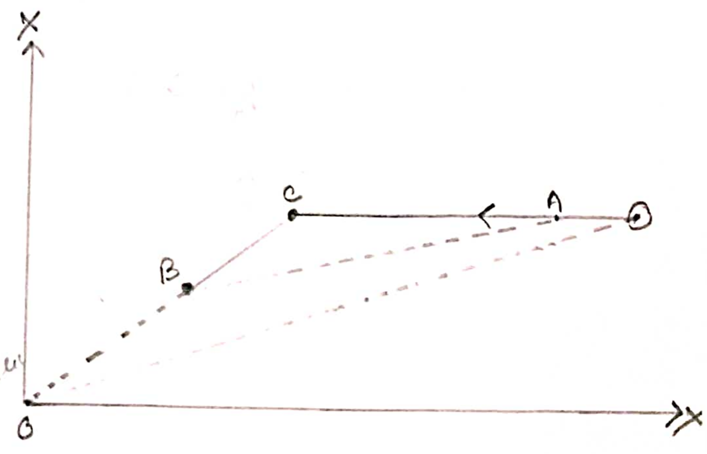
$$= -1.6\times10^{-19}\times 0$$

$$= 0$$

4. $A \longrightarrow (12m, 5m)$

$B \longrightarrow (3m, 4m)$

$C \longrightarrow (5m, 5m)$



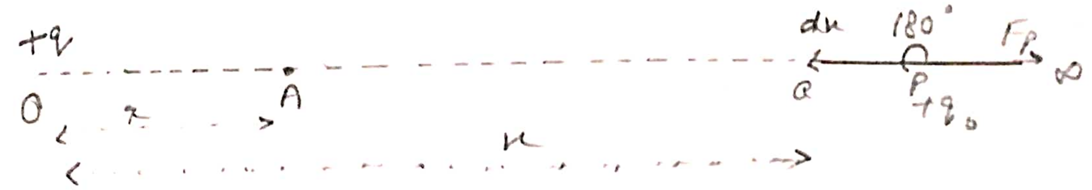
$q_0 = 8\times10^{-6}$

$q = -2\times10^{-9}$

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

$$= q_0\left[V_B - V_A\right]$$

5.



Let a point charge '+q' be at O due to which potential at A (OA = x) is

$$V_A = \frac{W_{\infty \to A}}{+q_0} \quad \text{(workdone in bringing } +q_0 \text{ from } \infty \text{ to A)} \text{ — (I)}$$

Let

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

Let $+q_0$ be moved from ∞ to A when '$+q_0$' is at P, the repulsive force acting on q_0 due to q is

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

Let $\vec{PQ} = \vec{dr}$

W_0 in moving from q_0 from P to Q is

$$dW_{P \to Q} = F_P \cdot PQ \cos 180°$$

$$= F_P \, dr \cos 180°$$

$$= -\frac{1}{4\pi\epsilon_0} \frac{q_0 q \, dr}{r^2} \text{ — (III)}$$

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

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

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

$$V_A = 9\times10^9 \frac{-2\times10^{-9}}{\sqrt{169}}$$

$$= 9\times10^9 \frac{-2\times10^{-9}}{13}$$

$$= \frac{-18\times1}{13}$$

$$= \frac{-18}{13} V$$

$$V_B = \frac{-2\times10^{-9}}{\sqrt{25}} 9\times10^9$$

$$= \frac{-18\times10^0}{5}$$

$$= \frac{-18}{5} V$$

$$W_{A\to B} = 8\times10^{-6}\left[-\frac{18}{5}+\frac{18}{13}\right]$$

$$= 8\times10^{-6}\left(\frac{-18\times13+18\times5}{65}\right)$$

$$= 8\times10^{-6}\left(\frac{-234+90}{65}\right)$$

$$= 8\times10^{-6}\left(\frac{-144}{65}\right)$$

$$= 8\times10^{-6} \quad (-2.22)$$

$$= -17.7\times10^{-6} J$$

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

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

$$= \frac{q}{4\pi\epsilon_0}\left[\frac{1}{x} - 0\right]$$

$$V_A = \frac{q}{4\pi\epsilon_0} \frac{q}{x} \quad \text{—— (IV)}$$