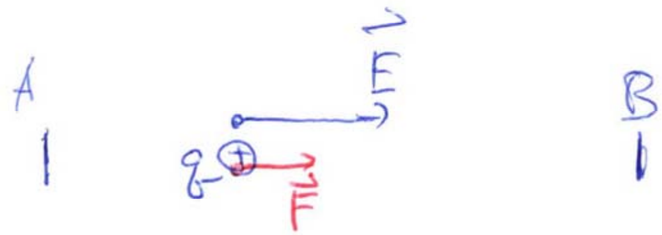
Solutions to Sample Problem Set 03

SP 3.1



(a) $\vec{F} = q\vec{E}$ $\qquad q = 20.0\ \mu C$

$\therefore$ The magnitude of $\vec{F}$ is:

$F = |q|E = (20.0\,\mu C)\cdot(250\ N/C)$

$= (20\times10^{-6}\ C)(250\ N/C)$

$F = \boxed{5\times10^{-3}\ N}$ $\qquad$ Direction: to the right.

(b) $\because$ $\vec{E}$ is uniform

$\therefore$ $\vec{F}$ is a constant force

$\therefore W = \vec{F}\cdot\vec{d} = Fd\cos(0^\circ) = Fd = |q|Ed$

force & Displacement are in the same direction

$\therefore W = |q| E d$

This makes sense because the electric force does positive work on the charge q when it moves from A to B.

$$\therefore W = |q| E d$$
$$= (20 \times 10^{-6}\ C) \cdot (250\ N/C) \cdot (0.12\ m)$$
$$= \boxed{6 \times 10^{-4}\ (J)}$$

(C)

$$\Delta U = -W = \boxed{-6 \times 10^{-4}\ J}$$

~~(d)~~ The positive work done on the positive charge results in a decrease in potential energy of the charge. Thus, we have the minus sign here.

Part (d):

The potential difference between *A* and *B* is $V_{AB} = V_A - V_B$. There are *two methods* for solving this part of the problem.

[Method 1]:

We have learned that

$$E = \frac{V_{AB}}{d}.$$

Thus,

$$V_{AB} = Ed = (250\text{ N/C})\cdot(0.12\text{ m}) = 30\ (\text{V}).$$

The potential difference between *A* and *B* is $\boxed{V_{AB} = 30\ (\text{V}).}$

[Method 2]:

The work done by the electric force is related to the potential difference by:

$$W = qV_{AB} = q(V_A - V_B).$$

Thus,

$$V_{AB} = \frac{W}{q}.$$

From Part (b) of this problem, we have already obtained that

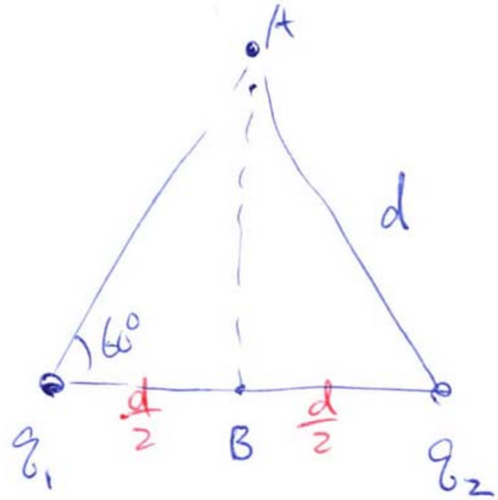
$$W = 6\times10^{-4}\text{ J}.$$

Therefore,

$$V_{AB} = \frac{W}{q} = \frac{6\times10^{-4}\text{ J}}{20\times10^{-6}\text{ C}} = 30\ (\text{V}).$$

The potential difference between *A* and *B* is $\boxed{V_{AB} = 30\ (\text{V}).}$

SP 3.2



(a) $V_A = V_{A,1} + V_{A,2}$

$$= k_e \frac{q_1}{d} + k_e \frac{q_2}{d}$$

$$= \left(\frac{k_e}{d}\right)(q_1 + q_2)$$

$$= \frac{9\times10^{9}\ \frac{N\cdot m^2}{C^2}}{6\times10^{-2}\ m} \cdot (-22.5 + 40.5)\times10^{-6}\ C$$

$$\boxed{V_A \approx 2.70\times10^{6}\ V}$$

(b) $V_B = V_{B,1} + V_{B,2} = k_e \frac{q_1}{\left(\frac{d}{2}\right)} + k_e \frac{q_2}{\left(\frac{d}{2}\right)}$

$$= \frac{k_e}{(d/2)}(q_1 + q_2) = 2\cdot \frac{k_e}{d}(q_1 + q_2)$$

$$= \boxed{2\ V_A} = 2\cdot(2.70\times10^{-6}\ V)$$

$$\boxed{V_B = 5.40\times10^{-6}\ V}$$