Assignment - 1

A1. $q_A = +8\mu C$

$q_B = -5\mu$

$r = 10cm$

$\Rightarrow .1m$

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$$

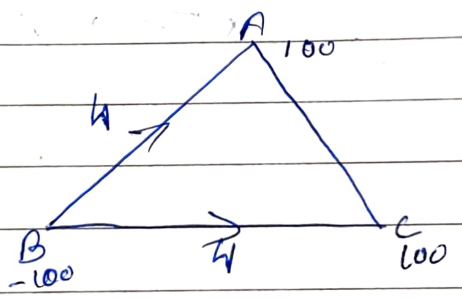
$$= \frac{9\times10^9 \times 8\times10^{-6} \times -5\times10^{-6}}{(0.1)^2}$$

$$= \frac{9\times 40\times 10^{-3}}{(0.1)^2}$$

$$\Rightarrow \frac{360\times10^{-3}}{0.01}$$

$$\Rightarrow -36\ N$$

A2.



$$F_{BC} = \frac{9\times10^9 \times 100\times10^{-6}\times100^{-6}}{4\times4}$$

$$= 9\times10^9\times25\times10^{-6}\times25\times10^{-6}$$

$$= 5625\times10^{-3}$$

$$= 5.625\ N$$

classmate

Date

Page

A4. Since negative charges are fixed net force on them will always be zero and they will be in equilibrium.

A5. The electric field at O due to charges at A and B are cancel out ~~ben~~ because both charges are equal and same sign ~~A~~ at A and B. Thus only charge at C will contribute the field at O.

The field O is $E = \frac{1}{4\pi\epsilon_0} \frac{(-2q/3)}{R^2} = -\frac{q}{6\pi\epsilon_0 R^2}$ along negative x axis.

Potential energy $U = \frac{1}{4\pi\epsilon_0}\left[\frac{(q^2/9)}{AB} + \frac{(-2q^2/9)}{BC} + \frac{(-2q^2/9)}{AC}\right]$

$= \frac{1}{4\pi\epsilon_0}\left[\frac{(q^2/9)}{2R} + \frac{(-2q^2/9)}{2R(\sqrt{3}/2)} + \frac{(-2q^2/9)}{2R(1/2)}\right] \neq 0$

The force between ~~ta~~ charges at B and C is F

$= \frac{1}{4\pi\epsilon_0} \frac{(q/3)(-2q/3)}{BC^2} = -\frac{1}{4\pi\epsilon_0} \frac{2q^2}{9(2R\sin 60)^2}$

$= \frac{1}{4\pi\epsilon_0} \frac{2q^2}{9(4R^2 \times 3/4)}$

$|F| = \frac{q^2}{54\pi\epsilon_0 R^2}$

Potential O at $V = \frac{1}{4\pi\epsilon_0}\left[\frac{(q/3)}{OA} + \frac{(q/3)}{OB} + \frac{(-2q/3)}{OC}\right]$

$= \frac{1}{4\pi\epsilon_0}\left[\frac{(q/3)}{R} + \frac{(q/3)}{R} + \frac{(-2q/3)}{R}\right] = 0$

A6. Let the two charges be q_1 and q_2

$$q_1 + q_2 = q$$

$$F = \frac{K q_1 q_2}{a^2}$$

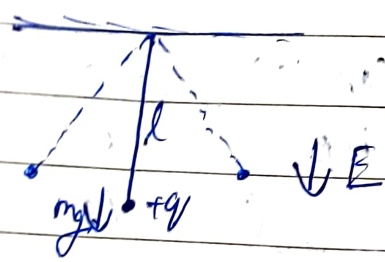
The force b/t them will be maximum only when $q_1 = q_2$

$$q_1 + q_2 = q$$

$$q_1 = \frac{q}{2}$$

$$q_1 = q_2 = \frac{q}{2}$$

A7.



We know,

$$T = 2\pi \sqrt{\frac{L}{a_{net}}}$$

Also, net force $= mg + qE$

Now,

$\cancel{M a_{net} = \frac{mg + qE}{M}}$ $\quad m a_{net} = mg + qE$

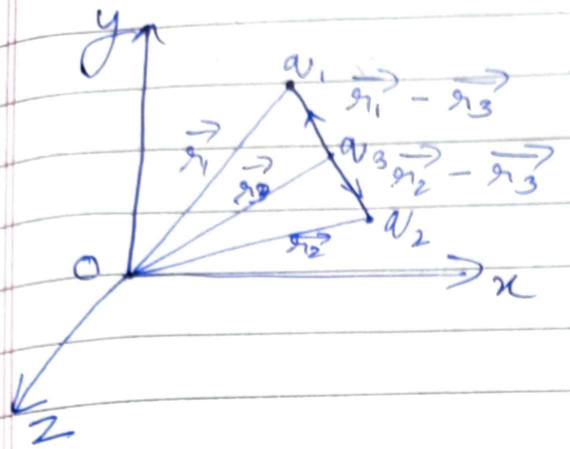
$$a_{net} = \frac{mg + qE}{m}$$

So, $T = 2\pi \sqrt{\frac{L}{g + \frac{qE}{m}}}$

$\Rightarrow T = 2\pi \sqrt{\frac{Lm}{g + qE}}$ = Time Period.

~~Time Period = 2π~~

A8.



Now, for the equilibrium of q_3.

$$\Rightarrow \frac{+q_2 q_3 (\vec{r_2} - \vec{r_3})}{|\vec{r_2} - \vec{r_3}|^3} + \frac{q_1 q_3 (\vec{r_1} - \vec{r_3})}{|\vec{r_1} - \vec{r_3}|^3} = 0$$

$$\text{or } \frac{q_2}{|\vec{r_2} - \vec{r_3}|} = \frac{q_1}{|\vec{r_1} - \vec{r_3}|^2} \left(\because \frac{\vec{r_2} - \vec{r_3}}{|\vec{r_2} - \vec{r_3}|} = \frac{\vec{r_1} - \vec{r_3}}{|\vec{r_1} - \vec{r_3}|} \right.$$

$$\Rightarrow \sqrt{q_2} (\vec{r_1} - \vec{r_3}) = \sqrt{q_1} (\vec{r_3} - \vec{r_2})$$

$$\Rightarrow r_3 = \frac{\sqrt{q_2}\, \vec{r_1} + \sqrt{q_2}\, \vec{r}_2}{\sqrt{q_1} + \sqrt{q_2}}$$

Also for the equilibrium of q_1,

$$\frac{q_3 (\vec{r_3} - \vec{r_1})}{|\vec{r_3} - \vec{r_1}|^3} + \frac{q_2 (\vec{r_2} - \vec{r_1})}{|\vec{r_2} - \vec{r_1}|^3} = 0$$

$$\Rightarrow q_3 = \frac{-q_2}{|\vec{r_2} - \vec{r_1}|} \quad |\vec{r_1} - \vec{r_3}|$$

Subsituting the of $\vec{r_3}$ we get,

$$q_3 = \frac{-q_1 q_2}{(\sqrt{q_1} + \sqrt{q_2})^2}$$

A10. Since there are ~~twelve~~ 12 ~~charges~~ equal charges placed symmetrically on 12 side of a 12 sided polygon, the charges will cancel each others, therefore, charge at the centre will be equal to zero.