NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Assignment – 01

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Course No.	: PHY 108
Course Title	: General Physics-II
Section	: 4
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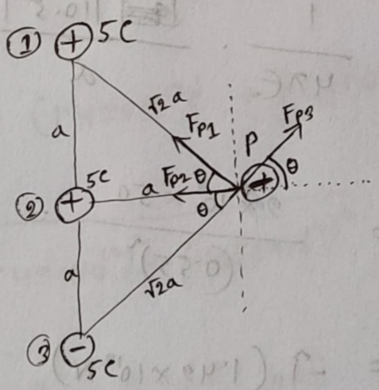
Ans. to the ques. no. 01

a)

The force of attraction or repulsion between two charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|q_1 q_2|}{r^2} \quad \text{(Coulomb's Law)}$$

b)



$\theta = 45°$

Forces on charge P: $\vec{F}_{P1}$, $\vec{F}_{P2}$, $\vec{F}_{P3}$

$$\therefore \vec{F}_{Pnet} = \vec{F}_{P1} + \vec{F}_{P2} + \vec{F}_{P3}$$

$$\therefore F_{p1} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|10.5|}{(\sqrt{2}a)^2}$$

$$= \frac{9\times10^9 \times 50}{2\times(0.55)^2} = 7.44\times10^{11}\ N$$

$$\therefore F_{p1x} = F_{p1}\cos 45^\circ = 7.44\times10^{11} \times \cos 45^\circ$$

$$= 5.26\times10^{11}\ N \quad (\text{Left})$$

$$\therefore F_{p1y} = F_{p1}\sin 45^\circ = 7.44\times10^{11} \times \sin 45^\circ$$

$$= 5.26\times10^{11}\ N \quad (\text{up})$$

$$\therefore \vec{F}_{p1} = -\hat{i}\,(5.26\times10^{11}\ N) + \hat{j}\,(5.26\times10^{11}\ N)$$

Now,

$$F_{p2} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|10.5|}{a^2}$$

$$= \frac{9\times10^9\times50}{(0.55)^2} = 1.49\times10^{12}\ N \quad (\text{Left})$$

$$\therefore \vec{F}_{p2} = -\hat{i}\,(1.49\times10^{12}\ N)$$

Again,

$$F_{p3} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|10.5|}{2a^2}$$

$$= \frac{9\times10^9\times50}{2\cdot(0.55)^2} = 7.44\times10^{11}\ N$$

$$\therefore F_{P3x} = F_{P3}\cos 45^\circ = 7.44\times10^{11}\times\cos45^\circ$$

$$= 5.26\times10^{11}\,N\ (\text{Right})$$

$$\therefore F_{P3y} = F_{P3}\sin 45^\circ = 7.44\times10^{11}\times\sin45^\circ$$

$$= 5.26\times10^{11}\,N\ (\text{Up})$$

$$\therefore \vec{F}_{P3} = \hat{i}\,(5.26\times10^{11}\,N) + \hat{j}\,(5.26\times10^{11}\,N)$$

Hence,

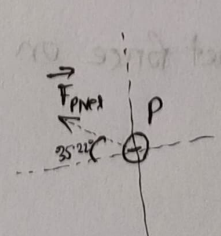
$$\vec{F}_{Pnet} = \vec{F}_{P1} + \vec{F}_{P2} + \vec{F}_{P3}$$

$$= -\hat{i}\,(5.26\times10^{11}\,N) + \hat{j}\,(5.26\times10^{11}\,N) - \hat{i}\,(1.49\times10^{12}\,N) + \hat{i}\,(5.26\times10^{11}\,N) + \hat{j}\,(5.26\times10^{11}\,N)$$

$$= -\hat{i}\,(1.49\times10^{12}\,N) + \hat{j}\,(1.052\times10^{12}\,N)$$

$$\therefore |\vec{F}_{Pnet}| = \sqrt{(1.49\times10^{12})^2 + (1.052\times10^{12})^2} = 1.82\times10^{12}\,N$$

$$\therefore \theta = \tan^{-1}\left(\frac{1.052\times10^{12}}{1.49\times10^{12}}\right) = 35.22^\circ$$



Ans. to the ques. no, 02

Forces on M: $\vec{F}_{MA}$, $\vec{F}_{MB}$

$\therefore$ Net force, $\vec{F}_{M_{net}} = \vec{F}_{MA} + \vec{F}_{MB}$

Now,

$$F_{MA} = \frac{1}{4\pi\epsilon_0} \cdot \frac{12 \times C1}{(L+0.0001)^2}$$

$$= \frac{9\times10^9 \times 12}{(L+0.001)^2} \text{ (Left)}$$

$$\vec{F}_{MA} = -\hat{i} \cdot F_{MA}$$

Again,

$$F_{MB} = \frac{1}{4\pi\epsilon_0} \cdot \frac{12\times 31}{L^2}$$

$$= \frac{9\times10^9 \times 6}{L^2} \text{ (Right)}$$

$$\therefore \vec{F}_{MB} = \hat{i} \cdot F_{MB}$$

Given that net force on M is zero.

$$\therefore \vec{F}_{Mnet} = 0$$

$$\Rightarrow \vec{F}_{MA} + \vec{F}_{MB} = 0$$

$$\Rightarrow -\hat{i} \cdot F_{MA} + \hat{i} \cdot F_{MB} = 0$$

$$\Rightarrow \hat{i} \cdot F_{MB} = \hat{i} \cdot F_{MA}$$

$$\Rightarrow \frac{9 \times 10^9 \times 6}{L^2} = \frac{9 \times 10^9 \times 12}{(L + 0.001)^2}$$

$$\Rightarrow \frac{1}{L^2} = \frac{2}{L^2 + 0.002L + 0.000001}$$

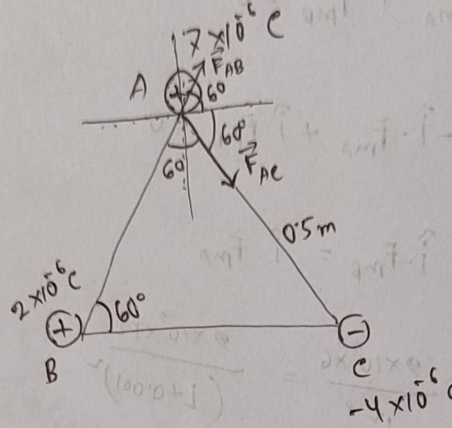
$$\Rightarrow L^2 - 0.002L - 0.000001 = 0$$

$\therefore L = 0.0024, \ -0.0004$ (distance cannot be negative.)

$\therefore L = 0.0024 \, m$

Ans

Ans. to the ques. no. 03



Forces on A: $\vec{F}_{AB}$ & $\vec{F}_{AC}$

$$\vec{F}_{Anet} = \vec{F}_{AB} + \vec{F}_{AC}$$

Now,

$$F_{AB} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|7\times10^{-6} \times 2\times10^{-6}|}{(0.5)^2}$$

$$= 0.504 \text{ N}$$

$\therefore F_{ABx} = F_{AB} \cos 60° = 0.504 \times \cos 60°$

$= 0.252$ N (Right)

$\therefore F_{ABy} = F_{AB} \sin 60° = 0.504 \times \sin 60°$

$= 0.436$ N (Up)

$$\therefore \vec{F}_{AB} = \hat{i}\,(0.252 \text{ N}) + \hat{j}\,(0.436 \text{ N})$$

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Again,

$$F_{AC} = \frac{1}{4\pi\epsilon_0} \cdot \frac{|7\times10^{-6} \times 4\times10^{-6}|}{(0.5)^2} = 1.008\,N$$

$\therefore F_{ACx} = F_{AC} \cos 60^\circ = 1.008 \times \cos 60^\circ$

$= 0.504\,N$ (Right)

$\therefore F_{ACy} = F_{AC} \sin 60^\circ = 1.008 \times \sin 60^\circ$

$= 0.873\,N$ (Down)

$\therefore \vec{F}_{AC} = \hat{i}\,(0.504\,N) - \hat{j}\,(0.873\,N)$

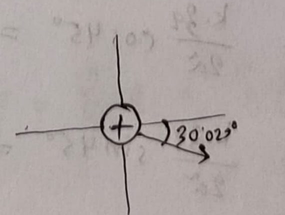
$\therefore \vec{F}_{Anet} = \vec{F}_{AB} + \vec{F}_{AC}$

$= \hat{i}\,(0.252\,N) + \hat{j}\,(0.436\,N) + \hat{i}\,(0.504\,N) - \hat{j}\,(0.873\,N)$

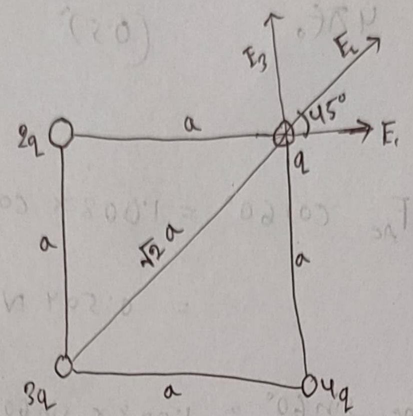
$= \hat{i}\,(0.756\,N) - \hat{j}\,(0.437\,N)$

$\therefore |\vec{F}_{Anet}| = \sqrt{(0.756)^2 + (0.437)^2} = 0.873\,N$

$\therefore \theta = \tan^{-1} \frac{0.437}{0.756} = 30.029^\circ$



Ans. to the ques. no. 04



a)

Electric Field on "q"

For 2q,

$$E_1 = \frac{1}{4\pi\epsilon_0} \cdot \frac{2q}{a^2} = \frac{k \cdot 2q}{a^2} \text{ (Right)}$$

$$\therefore \vec{E_1} = \hat{i}\left(\frac{k \cdot 2q}{a^2}\right)$$

For. 3q,

$$E_2 = \frac{1}{4\pi\epsilon_0} \cdot \frac{3q}{(\sqrt{2}a)^2} = \frac{k \cdot 3q}{2a^2}$$

$$E_{2x} = \frac{k \cdot 3q}{2a^2} \cos 45° = \cancel{\frac{k \cdot q}{\sqrt{2}a^2}} \text{ ~~(Right)~~ } \frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2} \text{ (Right)}$$

$$E_{2y} = \frac{k \cdot 3q}{2a^2} \sin 45° = \cancel{\frac{k \cdot q}{\sqrt{2}a^2}} \text{ ~~(Up)~~ } \frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2} \text{ (up)}$$

$$\cancel{\therefore \vec{E_2} = \hat{i}\left(\frac{k \cdot q}{\sqrt{2}a^2}\right) + \hat{j}\left(\frac{k \cdot q}{\sqrt{2}a^2}\right)}$$

$$\therefore \vec{E_2} = \hat{i}\left(\frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2}\right) + \hat{j}\left(\frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2}\right)$$

For $4q$,

$$E_3 = \frac{1}{4\pi\epsilon_0} \cdot \frac{4q}{a^2} = \frac{k \cdot 4q}{a^2} \quad (\text{up})$$

$$\therefore \vec{E}_3 = \hat{j}\left(\frac{k \cdot 4q}{a^2}\right)$$

$\therefore$ Net electric field,

$$\cancel{\vec{E} = \hat{i}\left(\frac{k \cdot 2q}{a^2}\right) + \hat{i}\left(\frac{k \cdot q}{\sqrt{2}a^2}\right) + \hat{j}\left(\frac{k \cdot q}{\sqrt{2}a^2}\right) + \hat{j}\left(\frac{k \cdot 4q}{a^2}\right)}$$

$$=$$

$$\vec{E} = \hat{i}\left(2 \cdot \frac{kq}{a^2}\right) + \hat{i}\left(\frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2}\right) + \hat{j}\left(\frac{3\sqrt{2}}{4} \cdot \frac{kq}{a^2}\right) + \hat{j}\left(4 \cdot \frac{kq}{a^2}\right)$$

$$= \hat{i}\left(3.06 \times \frac{kq}{a^2}\right) + \hat{j}\left(5.06 \times \frac{kq}{a^2}\right)$$

$\therefore$ Net electric field on 'q' is $\vec{E} = \hat{i}\left(3.06 \times \frac{kq}{a^2}\right) + \hat{j}\left(5.06 \times \frac{kq}{a^2}\right)$

b)

$\therefore$ Net resultant force on 'q' is

$$F = \vec{E} \cdot q = \hat{i}\left(3.06 \times \frac{kq^2}{a^2}\right) + \hat{j}\left(5.06 \times \frac{kq^2}{a^2}\right)$$

Ans