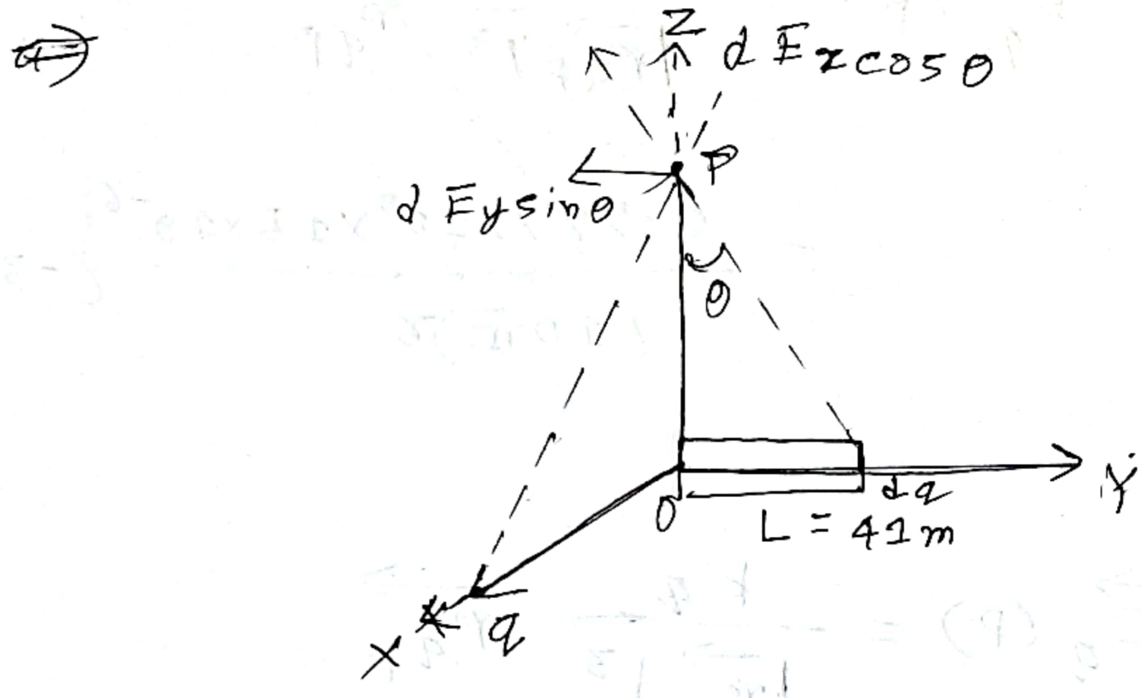
PHY112 - Section-04 ID: 19101077

Assignment-02

Date : ..................................

## G.A 2.21




a) Here,

$$\vec{r}_P = (0, 0, 20)$$

$$\vec{r}_q = (30, 0, 0)$$

So,

$$\vec{r}_{qP} = \vec{r}_P - \vec{r}_q$$

$$= (0, 0, 20) - (30, 0, 0)$$

$$= (-30, 0, 20)$$

$$= -30\hat{i} + 0\hat{j} + 20\hat{k}$$ (Ans)

$$_q(P) = \frac{kq}{|\vec{r}_{qp}|^3} \vec{r}_{qp}$$

$$\cancel{= \frac{8.987 \times 10^{9} \times 15 \times 10^{-6}}{(10\sqrt{13})^3} (-30\hat{i} + 0\hat{j}}$$

b) $$\vec{E}_q(P) = \frac{kq}{|\vec{r}_{qp}|^3} \vec{r}_{qp}$$

$$= \frac{8.987 \times 10^{9} \times 15 \times 10^{-6}}{(10\sqrt{13})^3} (-30\hat{i} + 0\hat{j} + 20\hat{k})$$

$$= -86.28\hat{i} + 0\hat{j} + 57.52\hat{k}$$

(Ans)

c) Here,

$$\vec{E}_x(P) = 0\ NC^{-1}$$

& $\vec{E}_y(P) = \dfrac{-k\,dq}{|\vec{r}_{qs}|^2}$

Let,

$$\frac{dq}{dy} = \lambda$$

$$\Rightarrow dq = \lambda dy$$

$$\cos\theta = \frac{z}{\sqrt{y^2+z^2}}$$

$$\sin\theta = \frac{y}{\sqrt{y^2+z^2}}$$

$$\Rightarrow \vec{E}_y(P) = \int \frac{-k\lambda\,dy}{y^2+z^2}\sin\theta$$

$$= \int \frac{-k\lambda y\,dy}{(y^2+z^2)^{3/2}}$$

$$= -k\lambda \int \frac{y}{(y^2+z^2)^{3/2}}\,dy$$

$$\therefore \vec{E}_y(P) = -k\lambda \left[\frac{-1}{\sqrt{y^2+z^2}}\right]_0^{41}$$

$$= -\overset{8.987}{9}\times10^9\times 4.4\times10^{-6}\left[\frac{-1}{\sqrt{(41)^2+(20)^2}} + \frac{1}{\sqrt{(20)^2+(0)^2}}\right]$$

$$\vec{E}_y(P) = -11103.751$$

Again,

$$\vec{E}_z(P) = \int \frac{k\lambda\, dy}{y^2+z^2} \cos\theta$$

$$= k\lambda z \int \frac{1}{(y^2+z^2)^{3/2}}\, dy$$

$$= k\lambda z \left[ \frac{y}{z^2(y^2 z^2)^{1/2}} \right]_0^{41}$$

$$= 8.987 \times 10^9 \times 44 \times 10^{-6} \times 20 \left[ \frac{41}{20^2\sqrt{41^2+20^2}} \right]$$

$$\therefore \vec{E}_z(P) = 17769.91045$$

d) $E_{net} = \vec{E}_q(P) + \vec{E}_{dq}(P)$

$$= (-86.28\hat{i} + 57.52\hat{k}) + (-11103.151\hat{j} + 17769.91\hat{k})$$

$$= -86.48\hat{i} ~~-11045.631\hat{k}~~ - 11103.151\hat{j} + 17827.43\hat{k}$$

(Ans)

~~Here,~~

$\cancel{k = 8.98 \times 10^{9}}$

$\cancel{q_1 = 5.3 \times 10^{-9} C,\ q_2 = 53 \times 10^{-}}$

## GA 2.2

Here,

$q_1 = 53 \times 10^{-9} C$ ; $r_1 (-27, -50)$

$q_2 = 53 \times 10^{-9} C$ ; $r_2 (39, -53)$

$q_3 = -106 \times 10^{-9} C$ ; $r_3 (61, 42)$

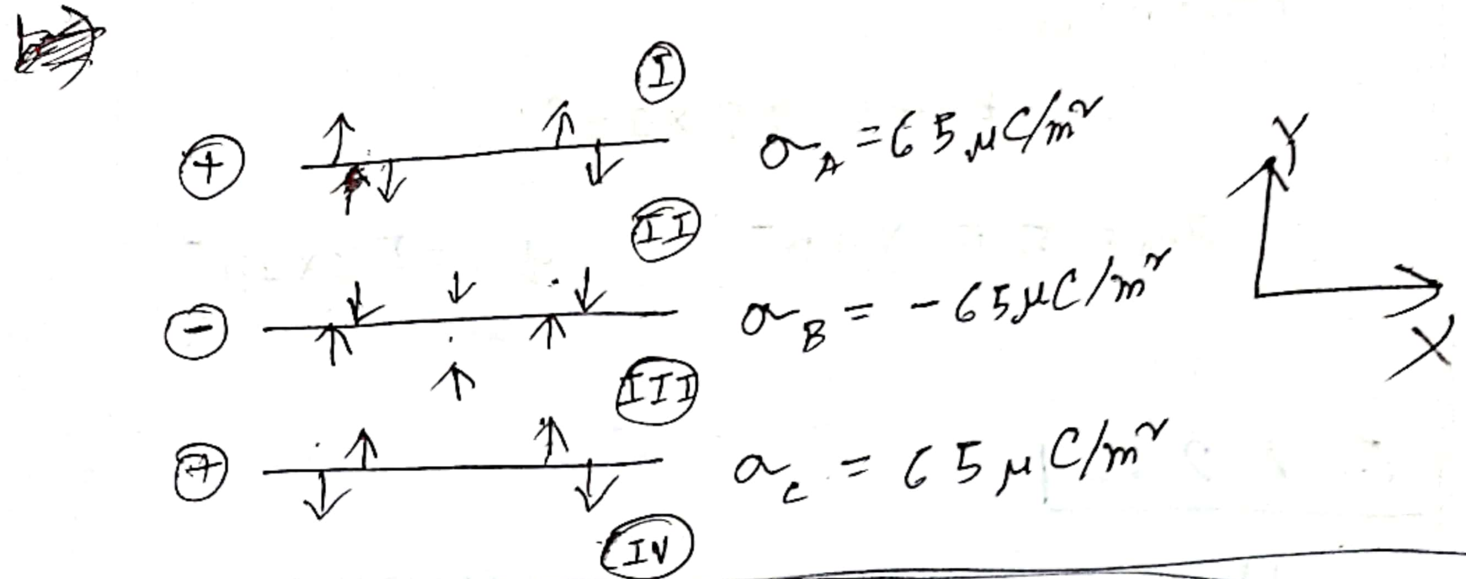
a) $\vec{P} = q_1 \vec{r}_1 + q_2 \vec{r}_2 + q_3 \vec{r}_3$

$= 53 \times 10^{-9} \begin{pmatrix} -27 \times 10^{-9} \\ -50 \times 10^{-9} \end{pmatrix} + 53 \times 10^{-9} \begin{pmatrix} 39 \times 10^{-9} \\ -53 \times 10^{-9} \end{pmatrix}$

$- 106 \times 10^{-9} \begin{pmatrix} 61 \times 10^{-9} \\ 42 \times 10^{-9} \end{pmatrix}$

$\therefore \vec{P} = \begin{pmatrix} -5.83 \times 10^{-15} \\ -9.911 \times 10^{-15} \end{pmatrix} Cm$

(Ans)




(b) In region. II,

$$\vec{E}_x\,(II) = 0$$

Here,

$\sigma_B = -65\,\mu C/m^2$

$$\therefore \vec{E}_Y(II) = \vec{E}\,(II) = \frac{\sigma_B}{2\times\epsilon_0}\,\hat{j}$$

$$= \frac{-65\times10^{-6}}{2\times8.854\times10^{-12}}$$

$$= -3670857.33 \ N/C$$

(Ans)

(c) $\vec{\tau} = \vec{P} \times \vec{F}(II)$

$$= (-5.89\times10^{-25}\hat{i} - 9.911\times10^{-25}\hat{j}) \times (-3670657.33\hat{j})$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -5.89\times10^{-25} & -9.911\times10^{-25} & 0 \\ 0 & -3670657.33 & 0 \end{vmatrix}$$

$\therefore |\tau| = 2.162\times10^{-8}$ Nm (Ans)

(d) For region III,

$$\vec{F}_x(III) = 0$$

$$\therefore \vec{E}_y(III) = \vec{E}(III) = \frac{\sigma_c}{2\epsilon_0}\hat{j}$$

$$= \frac{65\times10^{-6}}{2\times8.854\times10^{-12}}$$

$$= 3670657.33\hat{j}$$

(Ans)

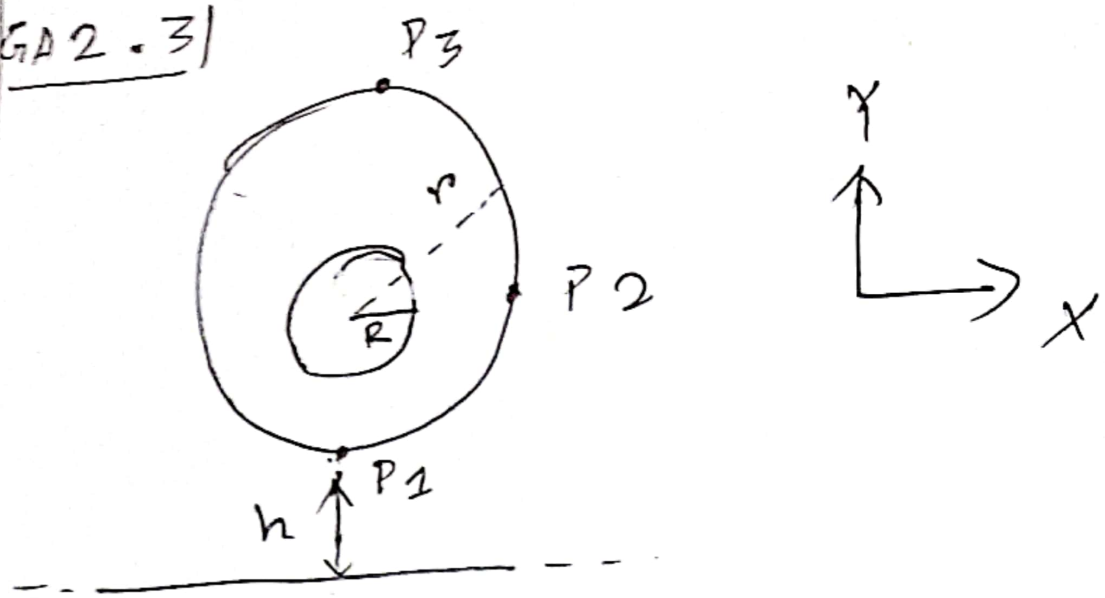
c) $\vec{\tau} = \vec{p} \times \vec{E}$ (III)

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -5.89\times10^{-15} & -9.911\times10^{-15} & 0 \\ 0 & -3270257.33 & 0 \end{vmatrix}$$

$$= -2.122\times10^{-8}\,\hat{k} \text{ Nm}$$

(Ans)

GA 2.31




a) $2 \cdot EA = \frac{q_{enc}}{\epsilon_0}$

$\Rightarrow 2EA = \frac{\sigma A}{\epsilon_0}$

$\Rightarrow E_{P_1} = \frac{\sigma}{2\epsilon_0}$

$\Rightarrow E_{P1} = \frac{21 \times 10^{-12}}{2 \times 8.854 \times 10^{-12}}$

$\Rightarrow E_{P_1} = 1.1859 \quad NC^{-1}$

$\therefore E_{P1} = E_{P_2} = 1.1859 \quad NC^{-1}$ (Ans)

(b) $\Phi = \frac{q_{uncleared}}{\epsilon_0} = \frac{0}{\epsilon_0} = 0 \; Nm^2/C$

(Ans)

c) $E A = \Phi = \frac{\rho\left(\frac{4}{3}\pi R^3\right)}{\epsilon_0}$

$\therefore \Phi = \frac{-43 \times 10^{-12}\left(\frac{4}{3}\pi (5.1)^3\right)}{8.854 \times 10^{-12}}$

$= -2698.535 \ Nm^2/C$

(Ans)

d) $E_{P_2} A = \Phi$

$\Rightarrow E_{P_2} = \frac{\Phi}{4\pi r^2}$

$\Rightarrow E_{P_2} = \frac{-2698.535}{4\pi (10.2)^2}$

$\Rightarrow E_2 = -2.064 \ NC^{-1}$

$|E_{P_2}| = |E_{P_3}| = 2.064 \ NC^{-1}$

(Ans)

e) $\Phi_{net} = -2698.535 + 0$

$= -2698.535 \ Nm^2/C$ (Ans)

f) $\vec{E}_{net,P_1} = \begin{pmatrix} 0 \\ -1.1859 \end{pmatrix} + \begin{pmatrix} 0 \\ +2.064 \end{pmatrix}$

$= \cancel{\begin{pmatrix} 0 \\ -3.2499 \end{pmatrix}} = \begin{pmatrix} 0 \\ 0.8781 \end{pmatrix} NC^{-1}$

g) $\vec{E}_{net,P_2} = \begin{pmatrix} 0 \\ -1.1859 \end{pmatrix} + \begin{pmatrix} -2.064 \\ 0 \end{pmatrix}$

$= \begin{pmatrix} -2.064 \\ -1.1859 \end{pmatrix} NC^{-1}$

h) $\vec{E}_{net,P_3} = \begin{pmatrix} 0 \\ -1.1859 \end{pmatrix} + \begin{pmatrix} 0 \\ -2.064 \end{pmatrix}$

$= \begin{pmatrix} 0 \\ -3.2499 \end{pmatrix} N/C$

(Ans)