NORTH SOUTH UNIVERSITY

Department of Mathematics & Physics

Assignment – 02

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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

Given that,

radius, $r = 3$ cm

$= 0.03$ m

distance from center to P, $x = 15$ cm

$= 0.15$ m

For a ring charge,

Net Electric field, $E = \frac{1}{4\pi\epsilon_0} \cdot \frac{x\lambda(2\pi r)}{(r^2+x^2)^{3/2}}$

$$= \frac{9\times10^9 \times 0.15 \times 2 \times \pi \times 0.03 \times \lambda}{\left((0.03)^2 + (0.15)^2\right)^{3/2}}$$

$$= 7.107 \times 10^{10} \lambda$$

$\therefore$ Net electric field is $7.107 \times 10^{10} \lambda$.

Ans. to the ques. no.02

For smaller ring charge,

$$\text{Electric field, } E_1 = \frac{1}{4\pi\epsilon_0} \cdot \frac{DQ}{(R^2+D^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ}{(R^2+(2R)^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ}{(5R^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ}{5^{3/2} \cdot R^3}$$

For larger ring charge,

$$\text{Electric field, } E_2 = \frac{1}{4\pi\epsilon_0} \cdot \frac{DQ'}{(R'^2+D^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ'}{((3R)^2+(2R)^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ'}{(13R^2)^{3/2}}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ'}{(13)^{3/2} \cdot R^3}$$

Now,

$$E_1 + E_2 = 0$$

$$\Rightarrow \quad E_2 = -E_1$$

$$\Rightarrow \quad \frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ'}{(13)^{3/2} \cdot R^3} = -\frac{1}{4\pi\epsilon_0} \cdot \frac{2RQ}{5^{3/2} \cdot R^3}$$

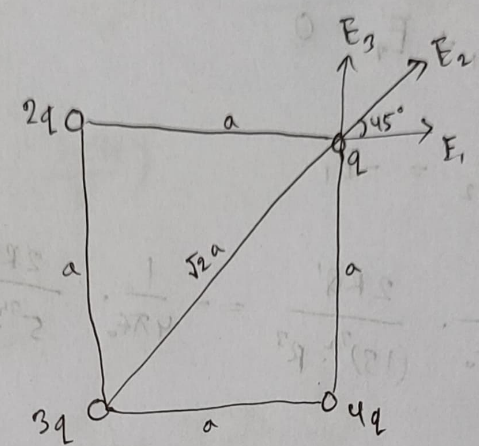
$$\Rightarrow \quad \frac{Q'}{(13)^{3/2}} = -\frac{Q}{(5)^{3/2}}$$

$$\Rightarrow \quad Q' = -\frac{(13)^{3/2}}{5^{3/2}} \cdot Q$$

$$\therefore Q' = -4.19Q$$

Therefore, the charge on larger ring will be, $-4.19Q$.

Ans. to the ques. no. 19



a)

Electric Field on "q"

For 2q,

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

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

For, 3q,

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

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

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

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

For, $4q$,

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

$$\therefore \vec{E_3} = \hat{j}\left(\frac{k \cdot 4q}{a^2}\right)$$

$\therefore$ Net electric field,

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

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

$\therefore$ 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

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

Ans

Ans. to the ques. no. 33

Given that,

Rod length, $L = 14$ cm

$= 0.14$ m

charge on rod, $Q = -7.50 \times 10^{-6}$ C

$\therefore$ radious, $R = \dfrac{L}{\pi}$ $[\because L = \pi R]$

$\therefore$ Electric field at the point O for the arc charge

$$E = \frac{1}{4\pi\epsilon_0} \cdot \frac{\lambda}{R} \cdot 2 \sin 90^\circ$$

$$= \cancel{\frac{2 \cdot \frac{Q}{L}}{4\pi\epsilon_0 \cdot R}}$$

$$= \cancel{\frac{Q}{2\pi\epsilon_0 RL}}$$

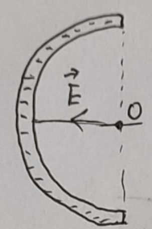
$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q}{RL} = \frac{1}{4\pi\epsilon_0} \cdot \frac{2Q\pi}{L^2}$$

$$= \frac{9 \times 10^9 \times 2 \times (-7.50 \times 10^{-6}) \times 3.1416}{(0.14)^2}$$

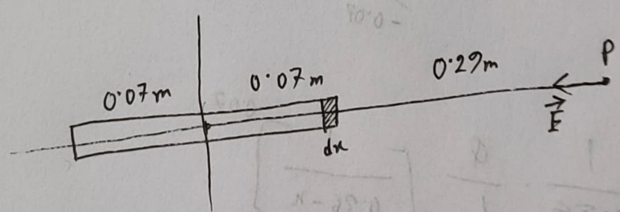
$$= -2.16 \times 10^7 \text{ N/C}$$

$\therefore \vec{E} = -\hat{i}\,(2.16 \times 10^{7}\ N/C)$

$\therefore$ The magnitude of the electric field is $(2.16 \times 10^{7}\ N/C)$ and the direction is $-x$-axis.



Ans. to the ques. no. 25



Here,

dx = line element

dq = diff. charge element

$= \lambda\, dx$

$= \dfrac{Q\,dx}{L}$

Rod length, $L = 14$ cm $= 0.14$ m

charge $Q = -22 \times 10^{-6}$ C

r = is the distance of point from dq

$= \cancel{(36-x)}\ (0.36 - x)$

$$\therefore dE = \frac{1}{4\pi\epsilon_0} \cdot \frac{dq}{r^2}$$ [diff. electric field at P due to dq]

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q\,dx}{L\,(0.36-x)^2}$$ [-x axis only]

$$\therefore E = \int dE$$

$$= \int_{x=-0.07}^{x=0.07} \frac{1}{4\pi\epsilon_0} \cdot \frac{Q\,dx}{L\,(0.36-x)^2}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{L} \int_{-0.07}^{0.07} \frac{dx}{(0.36-x)^2}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{L} \left[\frac{1}{0.36-x}\right]_{-0.07}^{0.07}$$

$$= \frac{1}{4\pi\epsilon_0} \cdot \frac{Q}{L} \left(\frac{1}{0.29} - \frac{1}{0.43}\right)$$

$$= \frac{9\times10^9 \times (-22\times10^{-6})}{0.14} \times \frac{1400}{1247}$$

$$= -1.59\times10^6 \text{ N/C}$$

Let,

$u = 0.36 - x$

$\therefore du = -dx$

$\therefore dx = -du$

$$\therefore \int \frac{dx}{(0.36-x)^2} = \int \frac{1}{u^2}\cdot(-du)$$

$$= -\int u^{-2}\,du$$

$$= -\left[\frac{u^{-1}}{-1}\right]$$

$$= \frac{1}{u}$$

$$= \frac{1}{0.36-x}$$

$\therefore \vec{E} = -\hat{i}\left(1.59 \times 10^{6} \ N/C\right)$

$\therefore$ The magnitude of the electric field is $\left(1.59 \times 10^{6} \ N/C\right)$ and direction is towards the rod ($-x$ axis).