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Assignment No # 01

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Question No #01.

What is the magnitude of the point charge that would create an electric field of 1.00 N/c at point 1.00m away?

Given data:

Electric field = E = 1.00 N/c

Distance = r = 1.00m

To Find:

Magnitude of charge |q| = ?

Formula:

$$\vec{E} = \frac{\vec{F}}{q_0}$$

$$E = \frac{KqQ}{r^2 Q}$$

$$E = \frac{Kq}{r^2}$$

$$\boxed{q = \frac{Er^2}{K}} \longrightarrow$$

Solution:

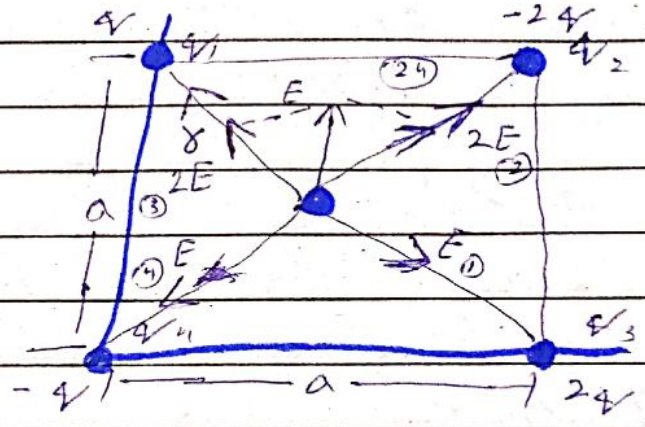
Date:

$$q = \frac{1\ N/C \times (1m)^2}{9 \times 10^9\ Nm^2 Kg^{-2}}$$

$$q = \frac{1}{9 \times 10^9}$$

$$\boxed{q = 1.11 \times 10^{-10}\ C}$$ Ans

Question No #02



Given data:

$q_1 = q = +10\ nC$

$q_2 = -2q = -20\ nC$

$q_3 = 2q = +20\ nC$

$q_4 = -q = -10\ nC$

$a = 5cm = \frac{5}{100} = 0.05m$

To Find:

Electric field at centre E = ?

Solution:

$$\text{diag} = \sqrt{2}\,a$$

$$\therefore \gamma = \frac{\sqrt{2}\,a}{2} = a$$

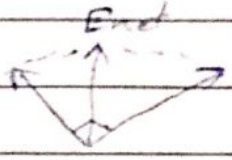
$$\gamma = \frac{a\sqrt{2}}{(\sqrt{2})^2}$$

$$\gamma = \frac{a}{\sqrt{2}}$$

Field magnitude due to 'q'

$$E = \frac{Kq}{\gamma^2} = \frac{9\times10^9 \times 10\times10^{-9}}{\left[5\times10^{-2}\,a/\sqrt{2}\right]^2}$$

$$\boxed{E = 7.2\times10^4\ N/C}$$



$$E_{net} = \sqrt{E^2 + E^2} \quad \therefore$$

$$= \sqrt{2E^2}$$

$$= \sqrt{2}\,E$$

$$E_{net} = \sqrt{2} \times 7.2\times10^4$$

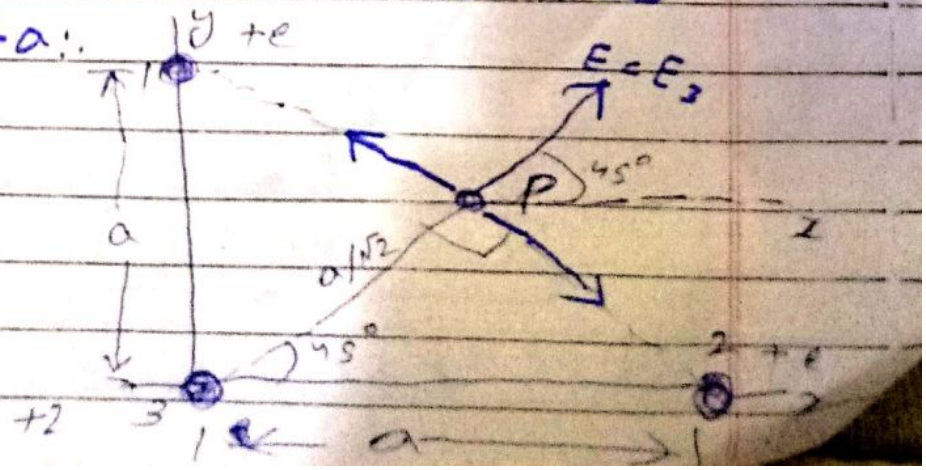
$$E_{net} = 1.02\times10^5\ N/C$$

In vector form (direction is upward)

$$\boxed{\vec{E} = (1.02\times10^5\ N/C)\,\hat{j}}$$

Question No #03

Given data:



Distance = a = 6.00 μm = 6.00×10^{-6} m

$q_1 = q_2 = +e$

$q_3 = +2e$ $\quad \therefore e = 1.6 \times 10^{-19}$ C

To Find:

a) Magnitude of net E.F = ?

b) Field of 45°

Formula:

$$E = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

$$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$$

Solution:

$$\sin 45^\circ = \frac{P}{H}$$

$$P = H \cdot \sin 45^\circ$$

$$P = \frac{a}{\sqrt{2}}$$

$$E = \frac{K q_3}{r^2}$$

$$= \frac{9 \times 10^9 \times 2 \times 1.6 \times 10^{-19}}{\left(\frac{a}{\sqrt{2}}\right)^2}$$

$$E = \frac{9 \times 10^9 \times 2 \times 1.6 \times 10^{-19}}{\frac{(6 \times 10^{-6})^2}{2}}$$

$$\Rightarrow E = 1.6 \times 10^2 \text{ N/C}$$

$$\boxed{E = 160 \text{ N/C}}$$

45° clockwise with +X-direction.

Question No #04

Given:

Radius $= R = 2.40\,cm$

$= 0.024\,m$

To Find:

Distance of the ring from centre $z = ?$

Solution:

$$\Rightarrow \frac{d}{dz}\left(\frac{qz}{4\pi\varepsilon_0(z^2+R^2)^{3/2}}\right)$$

$$\Rightarrow \frac{q}{4\pi\varepsilon_0}\cdot\frac{R^2-2z^2}{(z^2+R^2)^{5/2}} = 0$$

$$z = \frac{R}{\sqrt{2}} \quad \therefore R = 0.024\,m$$

$$z = \frac{0.024}{\sqrt{2}}$$

$$\boxed{z = 1.70\,cm}$$

Question No 5:

Given data:

Distance $r = 2.5\,cm \Rightarrow 0.025\,m$

Distance $(z) = 12\,cm \Rightarrow 0.012\,m$

Surface charge density $(\sigma) = 5.3\times10^{-6}\,C/m^2$

Permitivity of free space

$\varepsilon_0 = 8.85\times10^{-12}\,N^{-1}m^{-2}C^2$

Date:

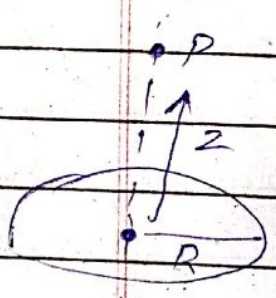
Solution:-

$$E = \frac{\sigma}{2\varepsilon_0}\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right)$$

$$E = \frac{5.3\times10^{-6}}{2\times8.85\times10^{-12}}\left[1 - \frac{0.012}{\sqrt{(0.012)^2+(0.025)^2}}\right]$$

$$\boxed{E = 6.3\times10^{3}\ N/C}$$

Question No #6



Given data:

Radius $= R = 0.600\ m$

$\varepsilon_0 = 8.85\times10^{-12}\ N^{-1}m^{-2}C^2$

To Find:

Field at center $E = ?$

Solution:

$$E = \frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right] \longrightarrow (1)$$

at center $(z = 0)$

$$\boxed{E_c = \frac{\sigma}{2\varepsilon_0}} \longrightarrow (2)$$

$$\therefore E = \frac{1}{2}E_c$$

$$\frac{\sigma}{2\varepsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right] = \frac{1}{2}\cdot\frac{\sigma}{2\varepsilon_0}$$

Date:

$$\frac{z}{\sqrt{R^2+z^2}} = \frac{1}{2}$$

$$2z = \sqrt{R^2+z^2}$$

Taking square both sides

$$4z^2 = R^2+z^2$$

$$3z^2 = R^2$$

$$z^2 = \frac{R^2}{3}$$

Taking under root both sides

$$z = \frac{R}{\sqrt{3}} \quad \text{with } R = 0.6 \text{ m}$$

$$z = \frac{0.6 \text{ m}}{\sqrt{3}}$$

$$z = 0.35 \text{m}$$