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21-Arid-557

ASSIGNMENT # 01

Question No 1:-

Given data:-

Coloumb constant (K) = $9\times10^9 Nm^2 kg^{-2}$

Electric field (E) = 1.00 N/C

Distance (r) = 1.00 m

To required:-

Magnitude of charge $|q| = ?$

Solution:-

Formula:-

$$\vec{E} = \frac{\vec{F}}{q_0} \qquad \because F = \frac{kqq_0}{r^2}$$

$$E = \frac{kqq_0}{r^2 q_0}$$

$$E = \frac{kq}{r^2} \Rightarrow |q| = \frac{Er^2}{K} \quad \text{—(A)}$$

Putting values in eq (A)

$$|q| = \frac{1\,N/C \times (1m)^2}{9\times10^9 Nm^2 kg^{-2}}$$

$$|q| = \frac{1}{9\times10^9}$$

$$\boxed{|q| = 1.11\times10^{-10} C}$$

$|q| = 1.11\times10^{-10}$ coulomb charge. ANS

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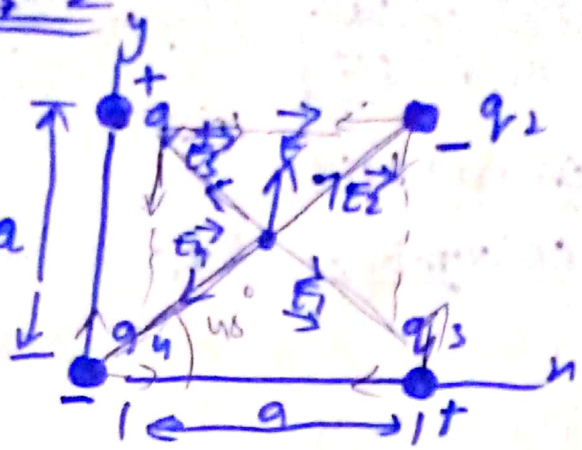
Questions-2

Given data:-

Length of square
of edge length $a = 5.00cm$
(r) distance $= \frac{5}{100} = 0.05m$



charge $(q_1) = 10.0nC$
$q_1 = 10\times10^{-9}C$
$q_2 = -20\times10^{-9}C$
$q_3 = 20\times10^{-9}C$
$q_4 = -10\times10^{-9}C$
$K = 9\times10^{9} Nm^2kg^{-2}$

To Required:-

The total electric field at centre $E = ?$

solution:-

The electric field at x component:

$$E_x = \frac{1}{4\pi\varepsilon_0}\left[+\frac{|q_1|}{(a/\sqrt{2})^2}\right]\cos45° + \frac{1}{4\pi\varepsilon_0}\frac{|q_2|}{(a/\sqrt{2})^2}\cos45° - \frac{1}{4\pi\varepsilon_0}\frac{|q_3|}{(a/\sqrt{2})^2} - \frac{|q_4|}{4\pi\varepsilon_0(a/\sqrt{2})^2}\cos45°$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\left[\frac{|q_1|}{a^2/2} + \frac{|q_2|}{a^2/2} - \frac{|q_3|}{a^2/2} - \frac{|q_4|}{a^2/2}\right]\cos45° \qquad \cos45° = \frac{1}{\sqrt{2}}$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\cdot\frac{1}{a^2/2}\left[|q_1| + |q_2| - |q_3| - |q_4|\right]\frac{1}{\sqrt{2}}$$

The field at y-component is:-

$$E_y = \frac{1}{4\pi\varepsilon_0}\left[-\frac{|q_1|}{a^2/2} + \frac{|q_2|}{a^2/2} + \frac{|q_3|}{a^2/2} - \frac{|q_4|}{a^2/2}\right]\cos45$$

$$E_y = \frac{1}{4\pi\varepsilon_0}\cdot\frac{1}{a^2/2}\left(-|q_1| + |q_2| + |q_3| - |q_4|\right)\frac{1}{\sqrt{2}}$$

The magnitude of the net electric field is

$$E = \sqrt{E_x^2 + E_y^2}$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{a^2}\left(|q_1| + |q_2| - |q_3| - |q_4|\right)$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{a^2}\left(10\times10^{-9} + 20\times10^{-9}C - 20\times10^{-9}C - 10\times10^{-9}C\right)$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{a^2}(0)$$

$$E_x = 0$$

and

$$E_y = \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{a^2}\left(-|q_1| + |q_2| + |q_3| - |q_4|\right)$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{a^2}\left(-10\times10^{-9} + 20\times10^{-9}C + 20\times10^{-9}C - 10\times10^{-9}C\right)$$

$\because a = 0.05\,m$

$$= \frac{1}{4\pi\varepsilon_0}\frac{\sqrt{2}}{(0.05)^2}(20\times10^{-9})$$

$$= \frac{8.99\times10^{+9}\times20\times10^{-9}\times\sqrt{2}}{(0.050)^2}$$

$$E_y = \frac{179.8\times\sqrt{2}}{0.0025}$$

$$E_y = \frac{254.27}{0.0025}$$

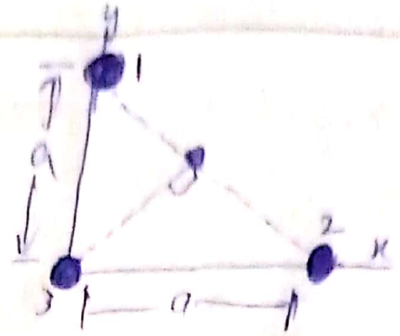
$$E_y = 1.017\times10^{5}\,N/C$$

The electric field of a square is

$$\vec{E} = E_y\hat{j}$$

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

Given data:- **Question: 3**



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

$q_1 = q_2 = +e$ cancel each other.
So will solve the magnitude $q_1 = +2e$.

Required:-
a): Magnitude of net electric fields ?
b): Field at 45°.

Solution:- charge of electron $e = 1.6 \times 10^{-19}$ C.

Formula:-

(a) $|\vec{E}_{net}| = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{r^2}$

$= \frac{1}{4\pi\varepsilon_0} \cdot \frac{2e}{(a/\sqrt{2})^2} \Rightarrow \frac{1}{4\pi\varepsilon_0} \cdot \frac{4e}{a^2}$

$= \frac{8.99 \times 10^9 \times 4 \times 1.6 \times 10^{-19}}{(6 \times 10^{-6})^2}$

$|\vec{E}_{net}| = 160$ N/C

(b): This net field points at 45°, counterclockwise from the x-axis.

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QNo4:-

Given data:-
Radius (R) = 2.40 cm ⇒ 0.0240 m

Required:-
Distance of the ring from center.

Solution:- The (E=0) for points infinitely far away can be reasoned directly. it goes $\frac{1}{z^2}$ as $z \to \infty$ or by recalling the starting part of its dilation. the field strength decreases $\frac{1}{r^2}$ at distant point

$\frac{d}{dz}\left(\frac{qz}{4\pi\varepsilon_0 (z^2+R^2)^{3/2}}\right) \Rightarrow \frac{q}{4\pi\varepsilon_0} \frac{R^2 - 2z^2}{(z^2+R^2)^{5/2}} = 0$

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$z = \frac{R}{\sqrt{2}} \Rightarrow R = 240cm$
$= 0.0240m$

$z = \frac{0.0240}{\sqrt{2}}$

$z = 1.70 cm$

$\boxed{z = 0.0170m}$

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QNO5:-

Given data:-

Radius$(r) = 2.5cm \Rightarrow \frac{2.5}{100} \Rightarrow 0.025m$

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

Permitivity of free space $(\epsilon_0) = 8.85 \times 10^{-12} N^{-1} m^{-2} C^2$

surface charge density $(\sigma) = 5.3 \times 10^{-6} C/m^2$

To Required:-

Electric field $(E) = ?$

solution:-

$$E = \frac{\sigma}{2\epsilon_0}\left(1 - \frac{z}{\sqrt{z^2+R^2}}\right)$$

$$= \frac{5.3 \times 10^{-6}}{2 \times 8.85 \times 10^{-12}}\left[1 - \frac{0.012}{\sqrt{(0.012)^2 + (0.025)^2}}\right]$$

$$\boxed{E = 6.3 \times 10^{5} N/C}$$

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Given data:- Q No 6:-

Radius (R) = 0.600m

$\varepsilon_0 = 8.85 \times 10^{-12} N^{-1} m^{-2} C^2$

To Required:-

Field at center E = ?

Solution:-

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

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

$z^2 = \frac{z^2}{4} + \frac{R^2}{4}$

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

$z = R/\sqrt{3}$ => $R = 0.600m$

we have

$z = \frac{0.600}{\sqrt{3}}$

$z = 0.346m$

The ration of Electric field is

$E = \frac{z}{R}$

$E = \frac{0.346}{0.600}$

$E = 0.577$

The ratio of field is indeed 1/2 half)

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