PHY112
Assignment-01

Submitted by :- Tasnim Rahman Moumita

ID :- 22301689

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Section :- 02

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Tasnim Rahman Moumita
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Signature

Answer to the Question NO - 01

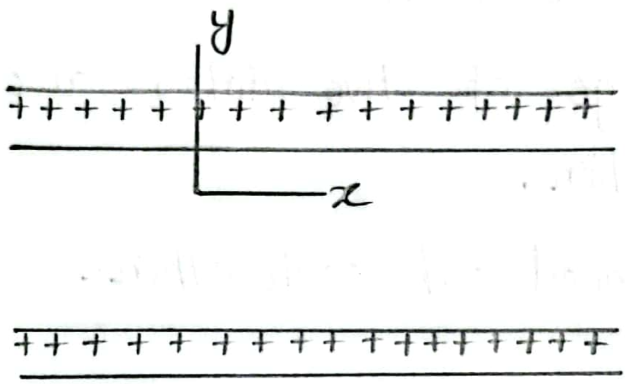


Fig. 1

Given,
surface charge density,
$\sigma = 1.77 \times 10^{-22}\ C/m^2$

We know,
The Electric field due to an infinite non conducting plate with surface charge density, σ is perpendicular to the plane of the plate and has magnitude,

$$E = \frac{\sigma}{2\varepsilon_0}$$

Now,

(a) for above the plates,

$$E = \frac{\sigma}{\varepsilon_0} \quad [\text{by using the superposition principle}]$$

$[\varphi = E.A]$

$$= \frac{1.77 \times 10^{-22}\ C/m^2}{8.85 \times 10^{-12}\ C^2/N.m^2}$$

$$= 2.00 \times 10^{-11}\ N/C$$

$\therefore$ above the plates, $\vec{E} = 2.00 \times 10^{-11}\ N/C$ (Ans:)

[P.T.O.]

02

(b) between the plates:

The electric field, $\vec{E}$ between the plates is 0 as the charge of two plates are equal but in opposite direction.

and they cancel out each other.

$\therefore \vec{E} = 0$

(Ans:)

(c) below the plates:

The electric field below the plates is similar to the electric field of above the sheets but in opposite direction.

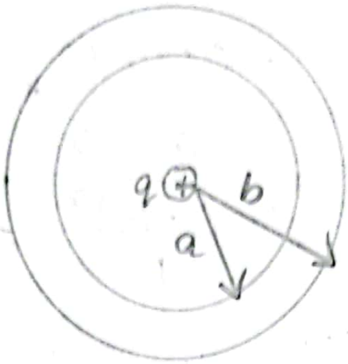
$$\therefore \vec{E} = -\frac{1.77 \times 10^{-22}\ C/m^2}{8.85 \times 10^{-12}\ C^2/N.m^2}$$

$$= -2.00 \times 10^{-11}\ N/C$$

$\therefore$ below the plates, $\vec{E} = -2.00 \times 10^{-11}\ N/C$

(Ans:)

Answer to the Question NO - 02



Given,

charge density, $\rho = 1.84 n\,Cm^{-3}$

inner radius $a = 10.0\ cm$

$= 0.1\ m$

outer radius, $b = 2.00\,a$

$= 2.00 \times 0.1$

$= 0.2 m$

$q = 45\ nC$

$= 45 \times 10^{-9}\ C$

(a) at $r = 0$:-

$$E = \frac{1}{4\pi\epsilon_0} \times 0 = 0\ N/C$$

(Ans:)

(b) at $= r = 0.5a = \frac{a}{2}$:-

$$E_0 \cdot E.\left\{4\pi\left(\frac{a}{2}\right)^2\right\} = q\left(\frac{\frac{4\pi}{3}\times\left(\frac{a}{2}\right)^3}{\frac{4}{3}\pi a^3}\right)$$

$$\Rightarrow E_{\frac{a}{2}} = \frac{1}{4\pi\epsilon_0} \times \frac{45 \times \cancel{4}^{1} \times 10^{-9}}{a^2 \times \cancel{8}_2}$$

$$= 20025\ N/C$$

(Ans:)

(c) at $r = a$:

$$E_a = \frac{q}{a^2} \times \frac{1}{4\pi\epsilon_0} = \frac{45\times10^{-9}}{(0.1)^2} \times 8.85 \times 10^{-12}$$

$$= 3.982 \times 10^{-17}\ N/C$$

(Ans:)

[P.T.O.]

(d) at $r = 1.50\,a$:

$a = 0.1$ (given)

$\therefore r = 1.5 \times 0.1 = 0.15\ m$

$$\therefore E_{1.5a} = \frac{1}{4\pi\epsilon_0} \times \frac{45\times10^{-9}}{(0.15)^2} = 17800\ N/C$$
$$= 1.77\times10^{-17}\ N/C$$

(Ans:)

(e) at $r = b$:-

$b = 2.00 \times a$ (given)

$= 2.00 \times 0.1 = 0.2\ m$

$$\therefore E_b = \frac{1}{4\pi\epsilon_0} \times \frac{45\times10^{-9}}{(0.2)^2} = 9.9562\times10^{-18}\ C$$

(Ans:)

(f) at $r = 3.00b$:-

$b = 2.00 \times a = 2.00 \times 0.1 = 0.2\ m$

$\therefore 3.00b = 3.00 \times 0.2 = 0.6\ m$

Now,

$\therefore E_0 = r = 3\times b = 0\ N/C$

$\therefore$ net charge $= 0\ N/C$

(Ans:)

Answer to the Question NO - 3

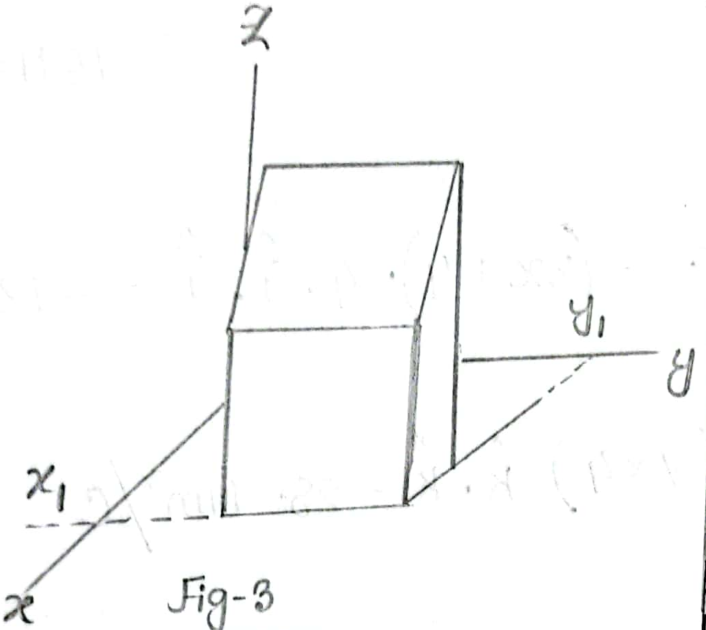


Fig-3

Given,

$\vec{E} = \{(3x+4)\hat{i} + 6y^2\hat{j} + 7\hat{k}\}$ N/C

$x_1 = 5.00$ m

$y_1 = 4.00$ m

length $= 2.00$ m

According to, net flux, $\varphi = \oint \vec{E}\cdot d\vec{A}$ — (i)

and, Gauss' law, $\varepsilon_0 \oint \vec{E}\cdot d\vec{A} = q_{enc}$ — (ii)

using (i) and (ii),

we only focus on x - dependent term because none of the constant terms will produce a nonzero contri-bution to the flux.

$dA = 4m^2$

Given, $\varphi_{right} = 4 \cdot 6y^2\, \hat{j}\cdot\hat{i} = 24y^2 = 24 \times 4^2$

$= 384\ Nm^2/C$

In fig.-3, the face of the cube is situated at with area, $A = 4\ m^2$.

$\therefore \varphi_{left} = -4\cdot 6y^2\ \hat{j}\cdot\hat{j} = -24y^2 = 24\times 2$ $\boxed{y=2m}$

$= 96\ Nm^2/C$

Again, the face of the cube located at the axis.

[P.T.O.]

Again,

$$\phi_{front} = (3x+4)\cdot 4\,\hat{i}\cdot\hat{i} = (19\times 4) \quad [y = 4\ m]$$
$$= 76\ Nm^2/C$$

$$\phi_{Back} = -(3x+4)\cdot 4\cdot\hat{i}\cdot\hat{i} = -13\times 4 = -52\ Nm^2/C$$
$$[x = 3\ m]$$

$$\phi_{Top} = (7\times 4)\ \hat{k}\cdot\hat{k} = 28\ Nm^2/C$$

$$\phi_{Bottom} = -(7\times 4)\ \hat{k}\cdot\hat{k} = -28\ Nm^2/C$$

∴ The net charge contained by the cube,

$$\phi_{net} = (384 + 76 - 96 - 52 + 28 - 28)\ Nm^2/C$$
$$= 312\ Nm^2/C$$

(Ans:)