24

Electric Flux

- Electric Flux
- ↓ Electric field lines
- ↓ Scalar quantity
- ↓ unit NM^2C^{-1}
- ↓ $\phi_E = EA\cos\theta$

$E \rightarrow$ Electric field

அகலம்
Length
breath

A -> Cross section area

θ -> Angle

$$\phi_E = EA\cos\theta$$

$$\phi_E = \vec{E}\cdot\vec{A}$$

$$\phi_E = EA\cos\theta = \vec{E}\cdot\vec{A}$$

$\theta = 0°$

$\cos\theta^{(0)} = 1$

$\cos(0°) = 1$

Electric flux +, -, 0

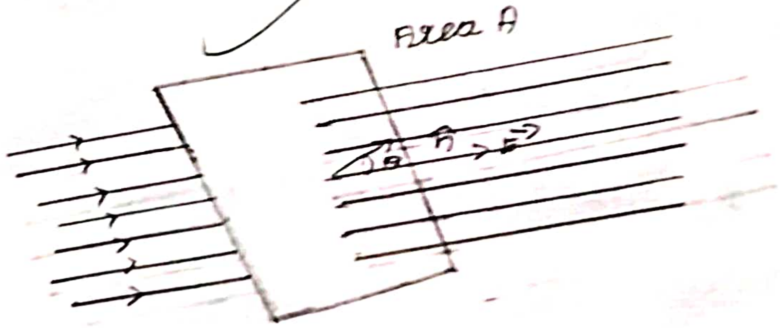
+	-	0
$\phi_E = EA\cos\theta$	$\phi_E = EA\cos\theta$	$\phi_E = EA\cos\theta$
$\theta = 0°$	$\theta = 180°$	$\theta = 90°$
$\phi_E = EA\cos(0)$	$\cos(180°) = -1$	$\phi_E = EA\cos(90°)$
$\cos(0°) = 1$	$\phi_E = EA\cos(180°)$	$\cos(90°) = 0$
$\phi_E = EA(1)$	$\phi_E = EA(-1)$	$\phi_E = EA(0)$
$\phi_E = EA$	$\phi_E = -EA$	$\phi_E = 0$

not only como public
pg: 38

Example 1.17

③ 3mark

calculate the electric flux through the rectangle of sides 5cm and 10 cm kept in region of uniform electric field 100NC-1, ang θ is 60°.



Electric flux

$\phi_E = EA\cos\theta$

Rectangle side

5cm and 10cm

uniform Electric field $E = 100NC^{-1}$

i) $\theta = 60^\circ$

ii) $\theta = 0^\circ$

$\phi_E = EA\cos\theta$

i) $\theta = 60^\circ$

$A = l \times b$

$= 5cm \times 10cm$

$= 5\times10^{-2}m \times 10\times10^{-2}m$

$= 5\times10\times10^{-2}\times10^{-2}$ (mm

$A = 5\times10\times10^{-4}m^2$

$\cos(60^\circ) = 1/2$

$E = 100NC^{-1}$

$\phi_E = 100\times5\times10\times10^{-4}$

$\cos(60^\circ)$

$\phi_E = 500\times10\times10^{-4}\times1/2$

$\phi_E = 500\times5\times10^{-4}$

$\phi_E = 2500\times10^{-4}$

$\phi_E = 0.25\ Nm^2C^{-1}$

ii) $\theta = 0^\circ$

$\phi_E = EA\cos\theta$

$\phi_E = 100\times5\times10\times10^{-4}\cos(0^\circ)$

$\cos(0^\circ) = 1$

$\phi_E = 500 \times 10 \times 10^{-4} (1)$

$\phi_E = 5000 \times 10^{-4}$

$\phi_E = 0.5 \, Nm^2C^{-1}$

Pg: 74

(3) marks LA

(16) Obtain Gauss law from coulomb's law

$\phi_E = \oint \vec{E} \cdot d\vec{A}$

$\phi = \oint E \, dA \cos\theta$ $\qquad$ $\oint$ closed integral

$\theta = 0°$

$\cos(0) = 1$

$\phi_E = \oint E \, dA (1)$

$\phi_E = \oint E \, dA$

$\phi_E = E \oint dA$

$E \rightarrow$ Electric field

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

$q = Q$

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

$\oint dA = 4\pi r^2$

$\phi_E = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2} = 4\pi r^2$

$\phi_E = \frac{1}{\varepsilon_0} (Q)$

$\phi_E = \frac{Q}{\varepsilon_0}$

Application of Gauss law

I) Electric field due to an infinitely long charged wire 11th LA Pg: 74

II) Electric field due to charged infinite plane sheet 12th LA Pg: 74

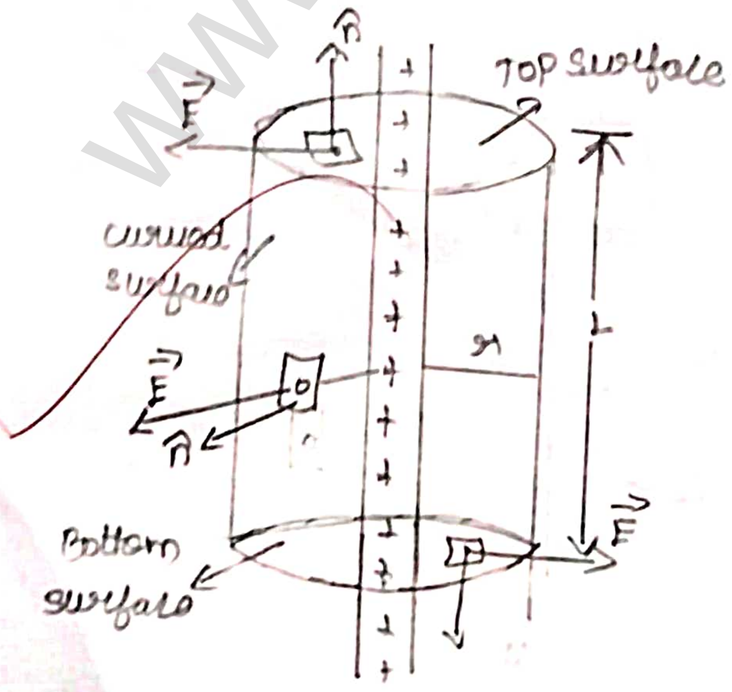
III) Electric field due to two parallel charged infinite sheets No book back
creative question, interior b/A

IV) Electric field due to a uniform charged spherical shell 13th LA Pg: 74

$\frac{Q}{\varepsilon_0}$

11th L/A

I) Electric field due to an infinitely long charged wire



$E \rightarrow$ Electric field

$\lambda \rightarrow$ Linear charge density
straight line

$r \rightarrow$ Distance

$L \rightarrow$ length

Infintely long charged wire

- curved surface ($0°$)
- Top surface ($90°$)
- Bottom surface ($90°$)

Electric Flux (Gauss law)

$\cos(0°) = 1$

$\cos(90°) = 0.$

$$\phi_E = \oint \vec{E}.d\vec{A}$$

$$\phi_E = \oint E\, dA \cos\theta$$

$$\phi_E = \oint_{\text{curved surface}} \vec{E}.d\vec{A} + \oint_{\text{Top surface}} \vec{E}.d\vec{A} + \oint_{\text{Bottom surface}} \vec{E}.d\vec{A}$$

$$\phi_E = \int_{\text{curved surface}} E\, dA \cos\theta + \int_{\text{Top surface}} E\, dA \cos\theta + \int_{\text{Bottom surface}} E\, dA \cos\theta$$

$$\phi_E = \int E\, dA \cos(0°) + \int E\, dA \cos(90°) + \int E\, dA \cos(90°)$$

$$\phi_E = \int_{\text{curved surface}} E\, dA\, (1)$$

$$\phi_E = \int_{\text{curved surface}} E\, dA$$

$$\phi_E = E \int_{\text{curved surface}} dA$$

$$\phi_E = E \int_{\text{curved surface}} dA$$

$\int dA$ = Total area of the curved surface
curved surface

$$\int dA = 2\pi r L$$

$$\phi_E = E \cdot 2\pi r L \rightarrow (1)$$

Gauss law

$$\phi_E = \frac{Q_{closed}}{\varepsilon_0}$$

$$Q_{closed} = \lambda L$$

$$\phi_E = \frac{\lambda L}{\varepsilon_0} \rightarrow (2)$$

From equation (1)

$$\phi_E = E \cdot 2\pi r L$$

$$E \cdot 2\pi r L = \frac{\lambda L}{\varepsilon_0}$$

$$E\, 2\pi r = \frac{\lambda}{\varepsilon_0}$$

Electric field

$$E = \frac{\lambda}{2\pi r \varepsilon_0}$$

$$\vec{E} = \frac{\lambda}{2\pi r \varepsilon_0} \hat{r}$$

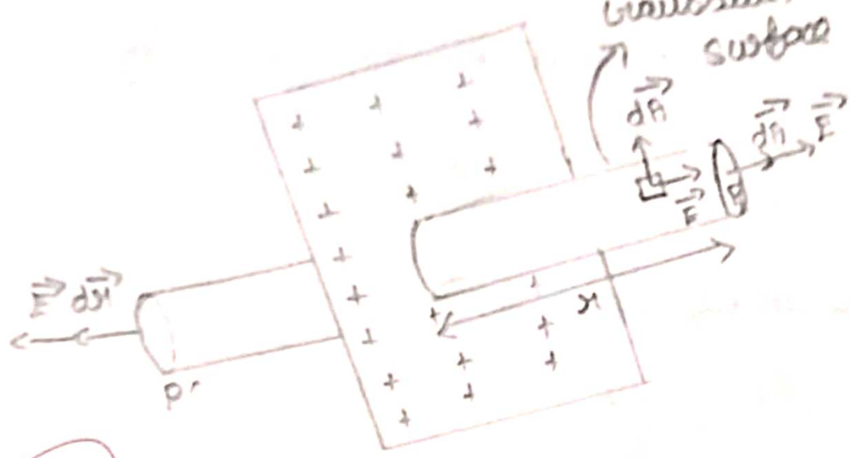
$\vec{E}$ => Electric field

r → Always perpendicular

$\lambda > 0$ ($\hat{r}$) outward

$\lambda < 0$ ($-\hat{r}$) inward

2) Electric field due to charged infinite plane sheet.



Electric field (Gauss law)

$$\phi_E = \oint \vec{E} \cdot \vec{dA}$$

$\int dA = x$

$\int dA = y$

$\int dA = z$

$\int dA = \gamma$

$\int dA = A$

$$\phi_E = \oint_{\text{curved surface}} \vec{E} \cdot \vec{dA} + \oint_{P} \vec{E} \cdot \vec{dA} + \oint_{P'} \vec{E} \cdot \vec{dA}$$

$$\phi_E = \int_{\text{curved surface}} E\,dA\cos\theta + \int_{P} E\,dA\cos\theta + \int_{P'} E\,dA\cos\theta$$

curved surface (90°) $\quad$ $P\ (0^\circ)$ $\quad$ $P'\ (0^\circ)$

$$\phi_E = \int_P E\,dA + \int_{P'} E\,dA$$

$$\phi_E = E\int_P dA + E\int_{P'} dA$$

$$\phi_E = 2E\int dA$$

$\int dA = A \Rightarrow$ Total surface of the area

$$\phi_E = 2EA \longrightarrow (1)$$

Gauss law

$$\phi_E = \frac{Q_{closed}}{\varepsilon_0}$$

$Q_{closed} = \sigma A$

↓

Stigma

$\sigma \rightarrow$ linear charge density

$\phi_E = \frac{\sigma A}{\varepsilon_0} \rightarrow$ (2)

From (1) equation

$\phi_E = 2EA$

From (2) equation

$\phi_E = \frac{\sigma A}{\varepsilon_0}$

$2EA = \frac{\sigma A}{\varepsilon_0}$

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

Electric field

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

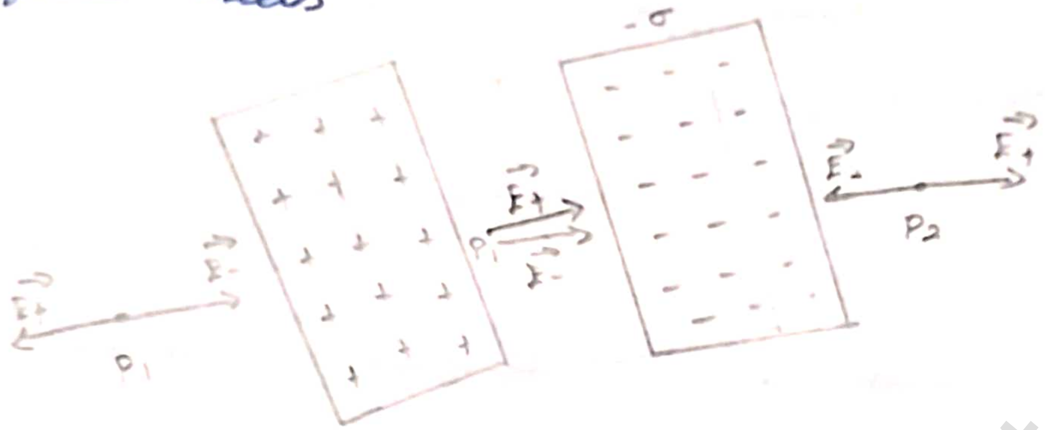
$E = \frac{\sigma}{2\varepsilon_0}$

$\vec{E} = \frac{\sigma}{2\varepsilon_0} \hat{n}$

i) $\sigma > 0$ Electric field Point (P) outward ($+\hat{n}$)

ii) $\sigma < 0$ Electric field Point (P') Inward ($-\hat{n}$)

3) Electric field due to two parallel charged infinite sheets



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

Parallel charged Infinite Sheet

Electric field inside

Electric field inside

$$E_{outside} = \frac{\sigma}{2\varepsilon_0} - \frac{\sigma}{2\varepsilon_0} = 0 \rightarrow (1)$$

$$E_{inside} = \frac{\sigma}{2\varepsilon_0} + \frac{\sigma}{2\varepsilon_0}$$

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

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

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

i) $\sigma > 0$ Electric field Point Perpendicular outward

ii) $\sigma < 0$ Electric field point perpendicular Inward

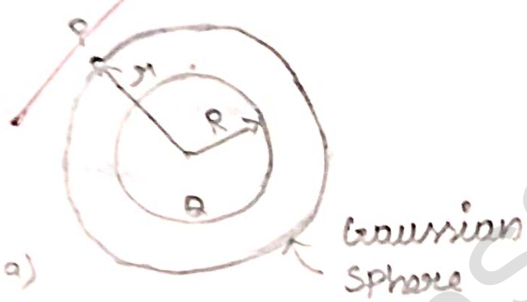
4) 18th LA

Electric field due to a uniform charged spherical shell

spherical shell

outside the shell ($r > R$) | surface ($r = R$) | Inside the shell ($r = R$)

1) outside the shell



Electric field (Gaussian law)

$\phi_E = \oint \vec{E} \cdot d\vec{A}$ Gaussian surface

$\phi_E = E \oint dA$ Gaussian surface

$\oint dA = 4\pi r^2$ Gaussian surface

$\oint dA \Rightarrow$ Total area of Gaussian surface

$\phi_E = E\, 4\pi r^2 \rightarrow (1)$

Gauss law

$$\phi_E = \frac{Q_{enclosed}}{\varepsilon_0} \rightarrow (6)$$

From equation (1)

$$\phi_E = E \cdot 4\pi r^2$$

$$E \cdot 4\pi r^2 = \frac{Q_{enclosed}}{\varepsilon_0}$$

$$E = \frac{Q_{enclosed}}{4\pi r^2 \varepsilon_0}$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{Q_{enclosed}}{r^2}$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q_{enclosed}}{r^2} \hat{r}$$

$Q > 0$ Electric field outward

$Q < 0$ Electric field inward

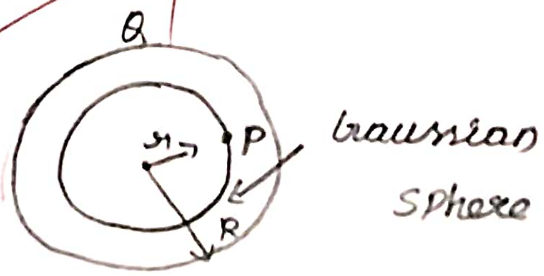
ii) surface.

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q_{enclosed}}{r^2}$$

$$r = R$$

$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q_{enclosed}}{R^2}$$

iv) Inside the shell



$$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{Q_{enclosed}}{r^2}$$

$Q = 0$

$E = 0$

Inside electricfield = 0