Class 12 chapter 1: Electric Charges & Fields
Lecture 15

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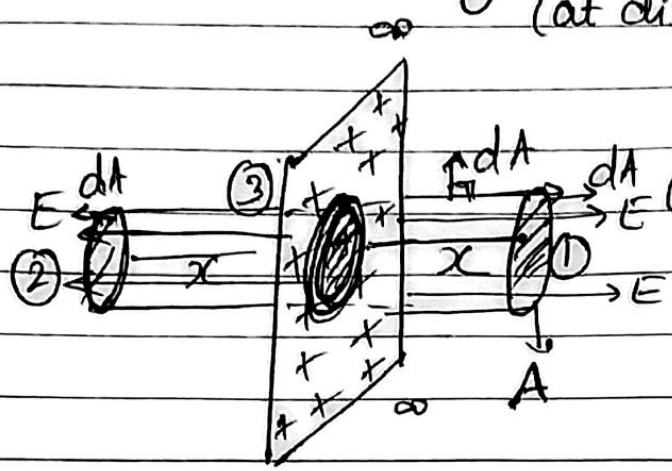
Electric Field due to a plane sheet of charge ($\sigma \rightarrow$ charge/Area) ↓ Charge on One Surface
(at dist x)



3 surfaces ①, ②, ③

$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$ (Curved)

$\int EdA\cos 0° + \int EdA\cos 0° + \int EdA\cos 90°$

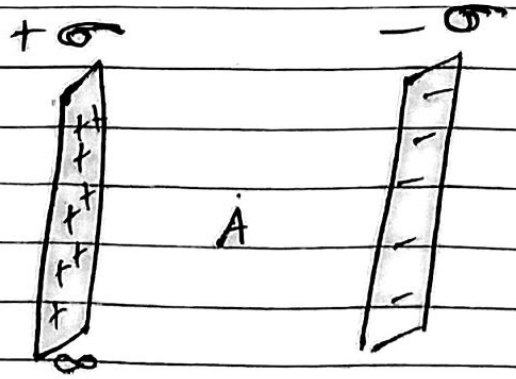
$$\frac{Q_{inside}}{\varepsilon_0} = EA + EA + 0$$

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

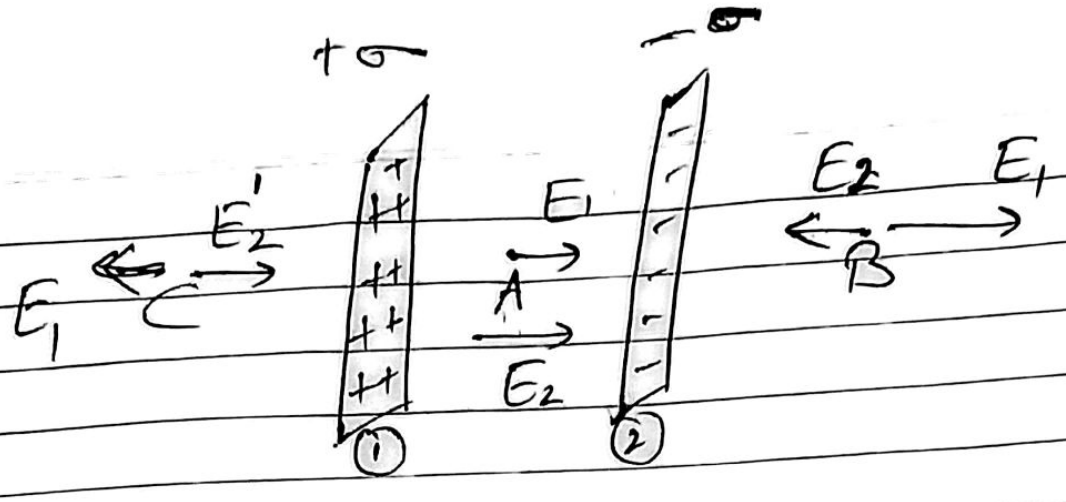
$$\boxed{E = \frac{\sigma}{2\varepsilon_0}}$$

Note: $\vec{E}$ is Independent of distance x (for small distances)

Q)



Find net $\vec{E}$ at A, B and C. and draw $\vec{E}$ field lines

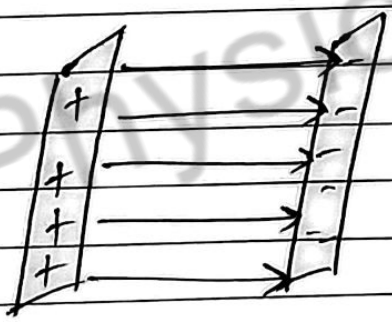


$$E_1 = E_2 = \frac{\sigma}{2\varepsilon_0}$$

A : $E_{net} = E_1 + E_2 = \frac{\sigma}{\varepsilon_0}$

B : $E_{net} = E_1 - E_2 = 0$

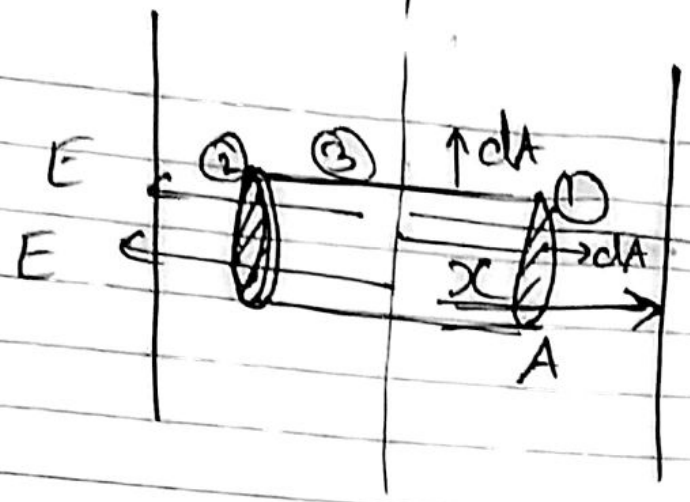
C : $E_{net} = E_2 - E_1 = 0$



Electric field is bounded here
⇓
(Used in Capacitor)

Q) A non conducting sheet of large surface Area and thickness d contains uniform charge distribution of density ρ. Find the Electric field at point P inside the plate, at a distance x from the central plane. Draw a graph for E v/s x.

$E_P = ?$



Q_{inside} = ρ × volume of gaussian cylinder

= ρ × A × 2x

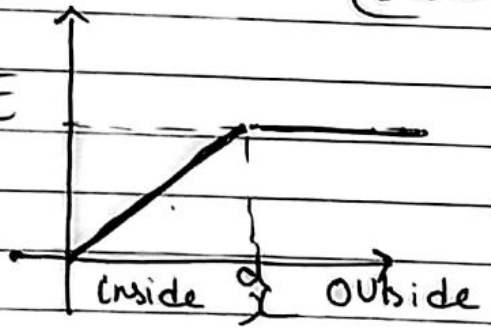
$\Phi_T = \Phi_1 + \Phi_2 + \Phi_3$

$= \int E dA\cos 0 + \int E dA\cos 0 + \int E dA\cos 90$ (curved)

$\frac{Q_{inside}}{\varepsilon_0} = EA + EA$

$\frac{\rho \times A \times 2x}{\varepsilon_0} = 2EA$

$\boxed{E = \frac{\rho x}{\varepsilon_0}}$ (inside) $\quad E \propto x$



for outside point (not asked)

$2EA = \frac{\rho \times A \times 2d}{\varepsilon_0}$

$\boxed{E = \frac{\rho d}{\varepsilon_0}}$ $\quad E$ = constant