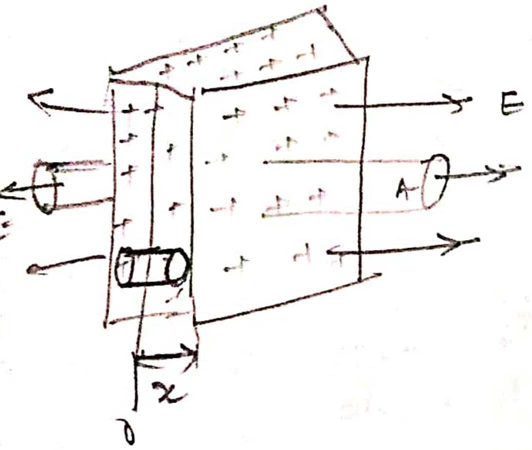
Eq. An infinite, insulating slab of thickness d has a uniform volume charge density ρ. Find the electric field inside and outside slab.

Solution:



Here ~~a~~ an infinite slab of thickness d with a uniform volume distribution of positive charge.

A small, imaginary Gaussian cylinder with end area A is used to find the field inside the slab, a distance x from the center.

A longer Gaussian cylinder with end area A is used to find the field outside slab.

When $|x| < d/2$ (this ~~s~~ implies ~~the~~ inside the slab)

To obtain E inside the slab, we use the smaller cylinder

$\therefore$ $Q_{inside} = \rho\, V_{inside}$

V_{inside} is volume of smaller cylinder $= 2xA$

Gauss Law

$$E \cdot 2A = \frac{\rho \times 2xA}{\epsilon_0}$$

$$E = \frac{\rho x}{\epsilon_0} \quad \text{when } (|x| \leq d/2)$$

Thus the electric field is zero at center as $x = 0$ and increases linearly with distance inside the slab.

Outside the slab, we use the larger Gaussian cylinder. The amount of volume inside it which contains charge is $V_{inside} = d \times A$

Here V_{inside} is volume of larger cylinder.

So Gauss Law

$$2EA = \frac{Q_{inside}}{\epsilon_0} = \frac{\rho d A}{\epsilon_0}$$

$$\Rightarrow E = \frac{\rho d}{2\epsilon_0} \quad (|x| \geq d/2)$$