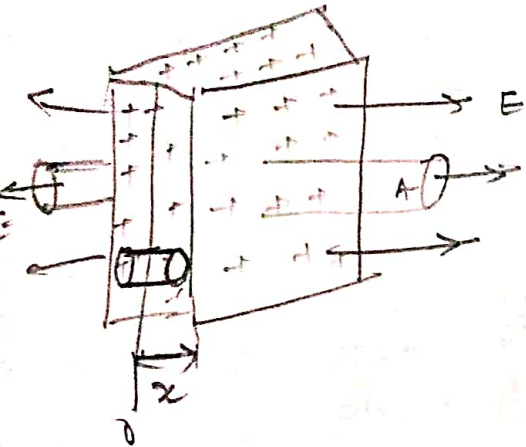


Ex. An infinite, insulating slab of thickness d has a uniform volume charge density ρ . Find the electric field inside and outside slab.

Solution:



Here is 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 implies ~~the~~ inside the slab)

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

$$Q_{\text{inside}} = \rho V_{\text{inside}}$$

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

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 $V_{inside} = \rho \times A$. Here V_{inside} is volume of larger cylinder.
So Gauss Law

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

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

Volume of the cylinder of radius R that is the electric field at the center of the slab is same to the electric field throughout. Hence in the absence of two slabs electric field is zero.

A rectangular lamina of

$$V = \frac{Q}{\rho} = \frac{\rho d A}{\rho} = d A$$

$$V = d A$$

with field is constant in the interior of the slabs
 $E = \frac{\rho d}{2\epsilon_0}$