8 Conductors, dielectrics, and polarization

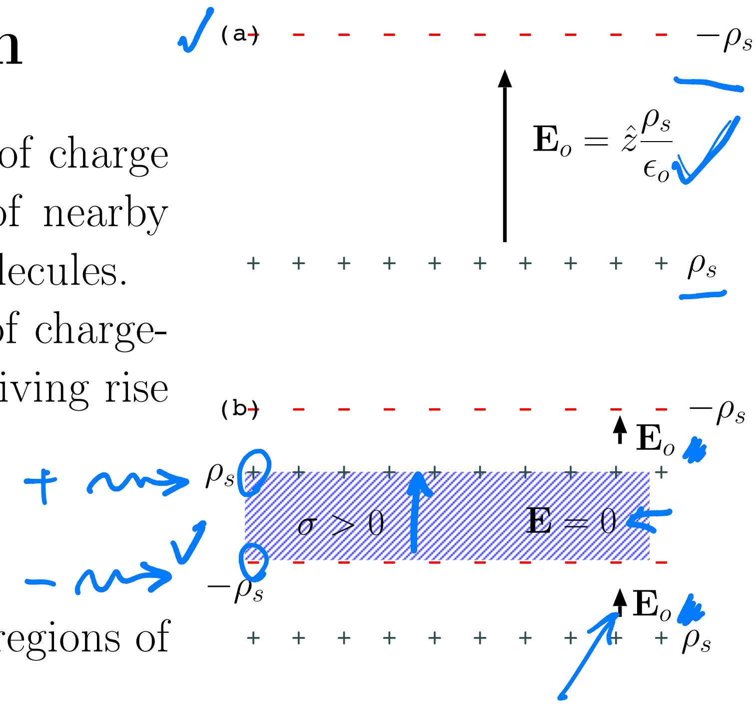
So far in this course we have examined static field configurations of charge distributions assumed to be fixed in free space in the *absence* of nearby materials (solid, liquid, or gas) composed of neutral atoms and molecules.

In the *presence* of material bodies composed of large number of charge-neutral atoms (in fluid or solid states) static charge distributions giving rise to electrostatic fields can be typically[1] found:

1. On exterior surfaces of *conductors* in "steady-state",

2. In crystal lattices occupied by *ionized* atoms, as in depletion regions of semiconductor junctions in diodes and transistors.

In this lecture we will examine these configurations and response of materials to applied electric fields.



A conducting slab inserted into a region with field E_o (as shown in b)develops surface charge which cancels out E_o within the slab.

E_o relates to surface charge as dictated by Gauss's law and superposition principle.

$\sim 10^{-18}$ s

DC: $\vec{E} = 0$. $\nabla \cdot \vec{E} = 0$. inside. ρ/ϵ_o.

$\rho = 0$.

Conductivity and static charges on conductor surfaces:

- **Conductivity** σ is an *emergent property* of materials bodies containing free charge carriers (e.g., unbound electrons, ionized atoms or molecules) which relates the applied *electric field* $\mathbf{E}$ (V/m) to the *electrical current density* $\mathbf{J}$ (A/m^2) conducted in the material via a linear

[1] More generally, materials containing charge carriers exhibiting divergence free flows will also exhibit static charge distributions.