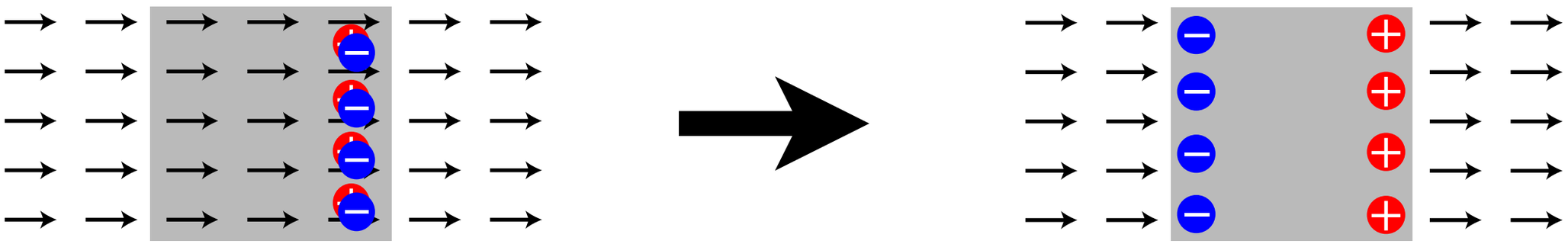
Conductors vs insulators

- Conductor (Insulator): Charge is free (not free) to move to establish electrostatic equilibrium

- Conductor have free charge: A sufficient and equal number of + and - charges can be “created” to cancel any E field in the conductor



All free charge is at the surface of conductors

- Use Gauss Law…

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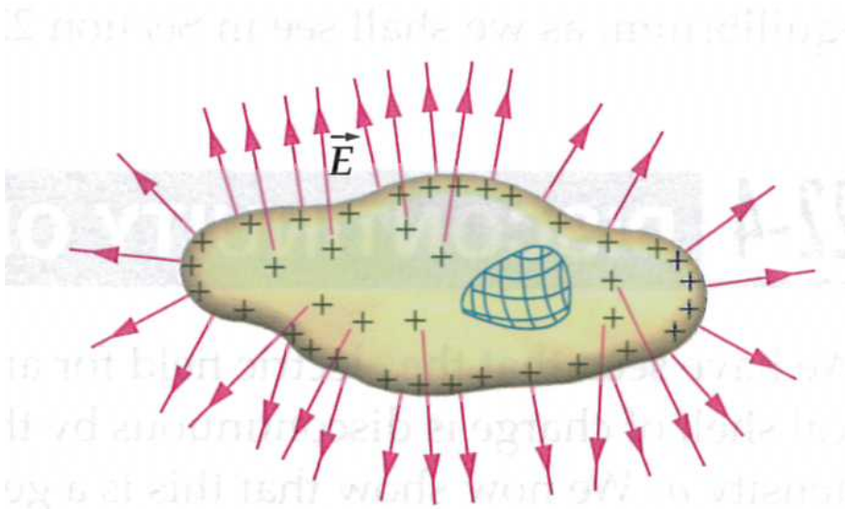


- Charge at the surface:

$$E_\perp = \frac{\sigma}{\epsilon_0}$$

$$\vec{E}_\parallel = 0 \quad \text{(Prove this soon!)}$$

Induced surface charge density is typically non-uniform in conductors.

Draw field lines…

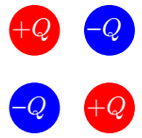
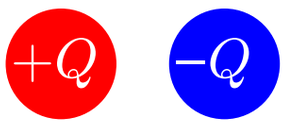
(2) Infinite line

1. Identify symmetry
2. Draw E field/field lines
3. Choose a gaussian surface
4. Compute E

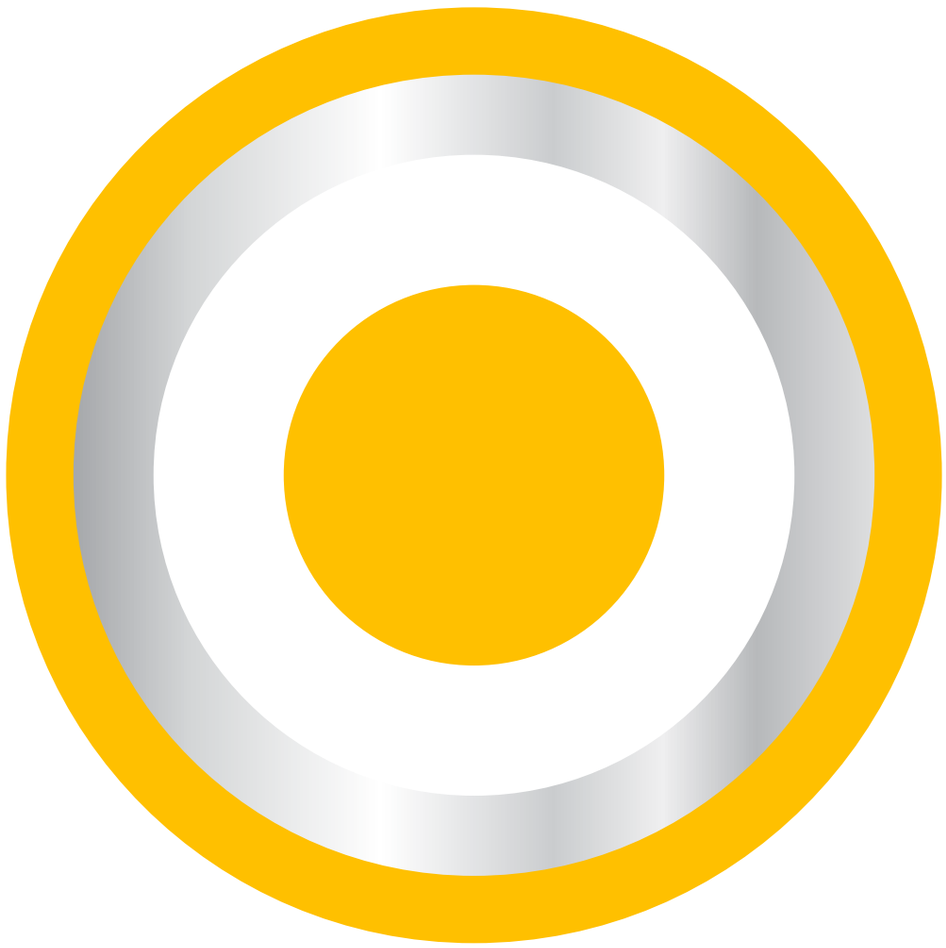
(3) Infinite plane/plate

1. Identify symmetry
2. Draw E field/field lines
3. Choose a gaussian surface
4. Compute E

Summary of field scaling

Charge configuration	**Symbol**	**Illustration**	**Asymptotic field**
quadrupole	Q_{ij}		$\propto r^{-4}$
dipole	p_i		$\propto r^{-3}$
point charge	q		$\propto r^{-2}$
line charge	λ		$\propto r^{-1}$
plane charge	σ		$\propto r^{0}$
…			

E field from a multi-layer Sphere/Coax cable



Co-axial cylinder, charged insulating center and metallic (neutral) metallic sheath