Electricity and Magnetism

- Physics 259 – L02
- Lecture 17

Chapter 23.3-4

Last time

- Chapter 23.2 

This time

- Chapter 23. and 23.4 

23-3: A Charges Isolated Conductor

Conductors

A conductor is a material in which the charges are free to move.

This means that two things are true:

1. There is zero net charge inside a conductor. ($Q_{net} = 0$)
2. There is zero electric field inside a conductor. ($E_{in} = 0$)

electrostatic equilibrium

Conductors -- Explanations

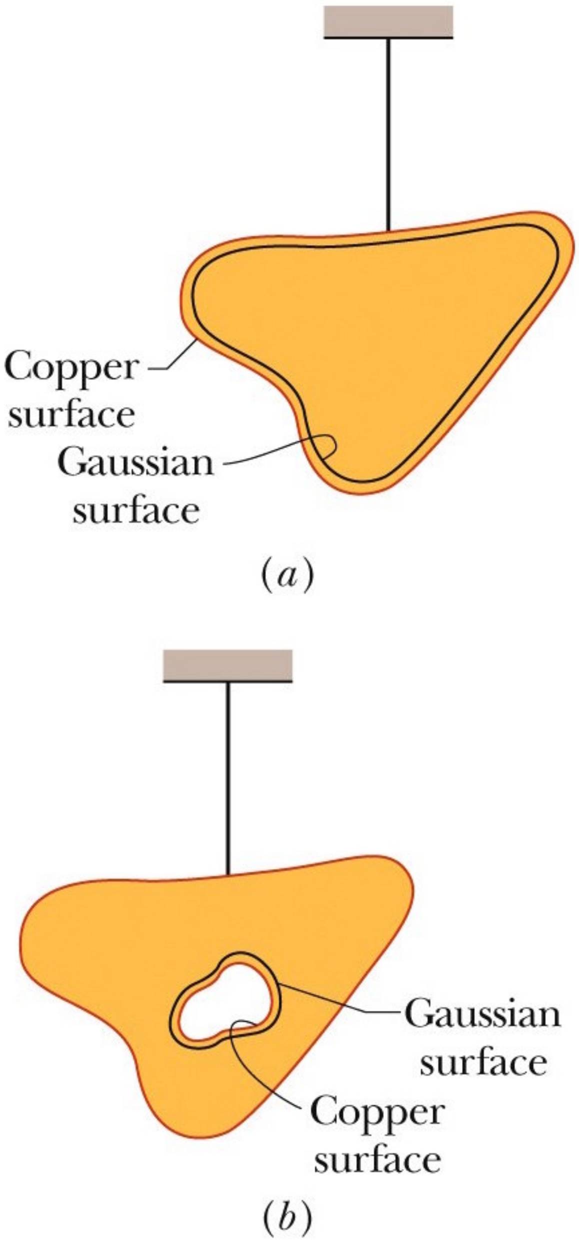
1. There is zero net charge inside a conductor. ($Q_{net} = 0$)

If there are 2 (or more) like charges inside a conductor then they will repel each other and push each other far away. (ie --to the surface)

2. There is zero electric field inside a conductor. ($E_{in} = 0$)

If there is a non-zero E field then $F = qE$ implies there is a net force which means charges would move until the force on them is zero – we have a STATIC situation. (Equilibrium)

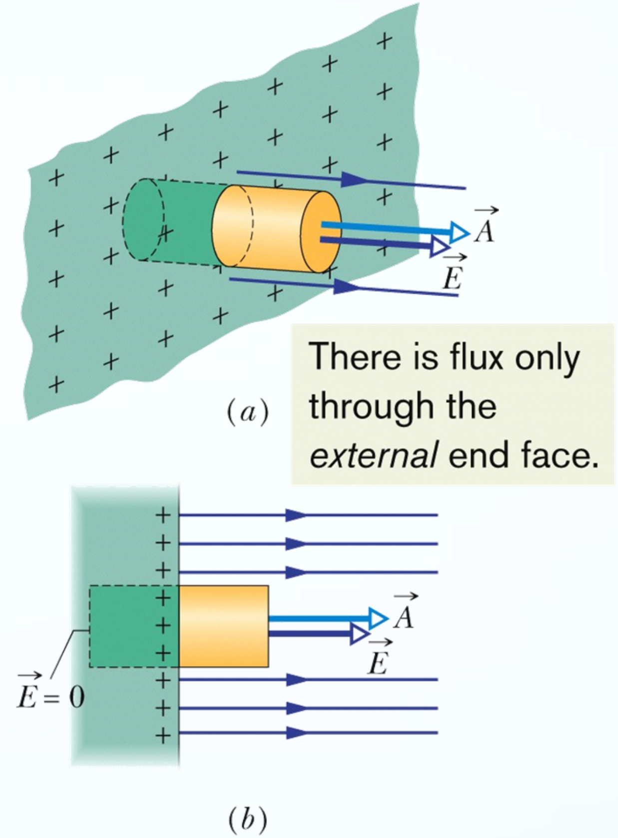
Hollow Conductors



The electric field inside a conductor is zero. This immediately implies that conductors are electrically neutral in their interiors.

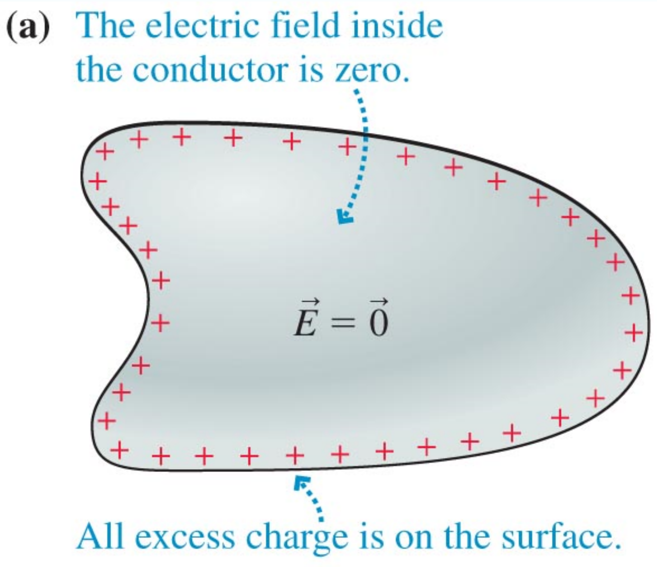
$$\oint \cancel{\vec{E}} \cdot d\vec{A} = 0 = \frac{q_{enc}}{\varepsilon_0}$$

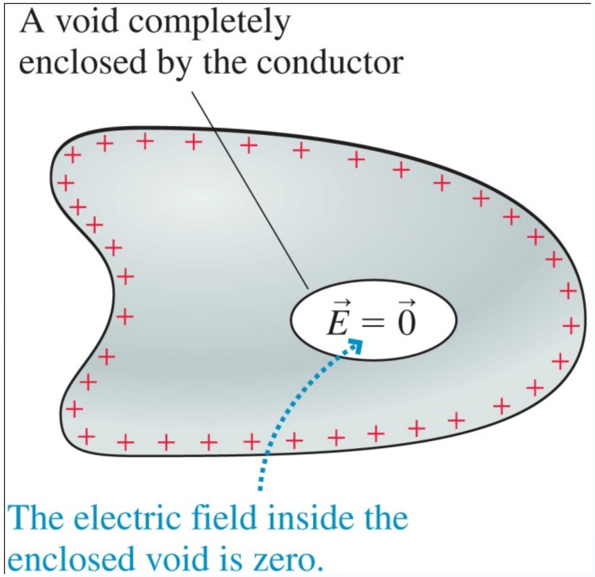
This also means that the surface of a hollow cavity inside a conductor cannot carry any excess charge. All excess charge must reside on the outside surface only.

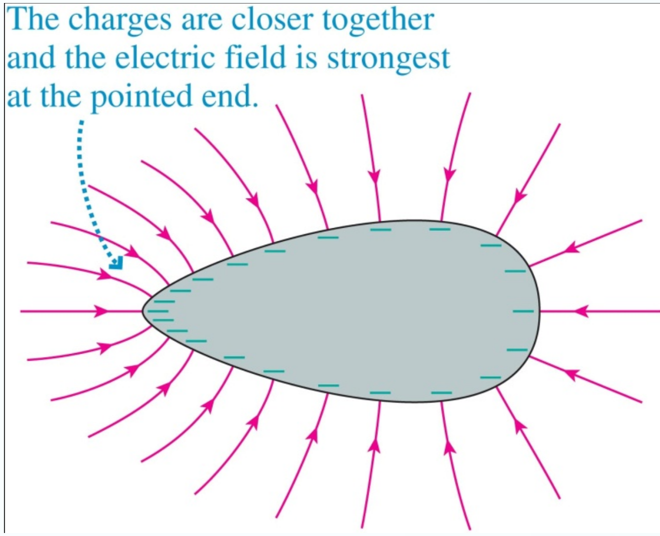


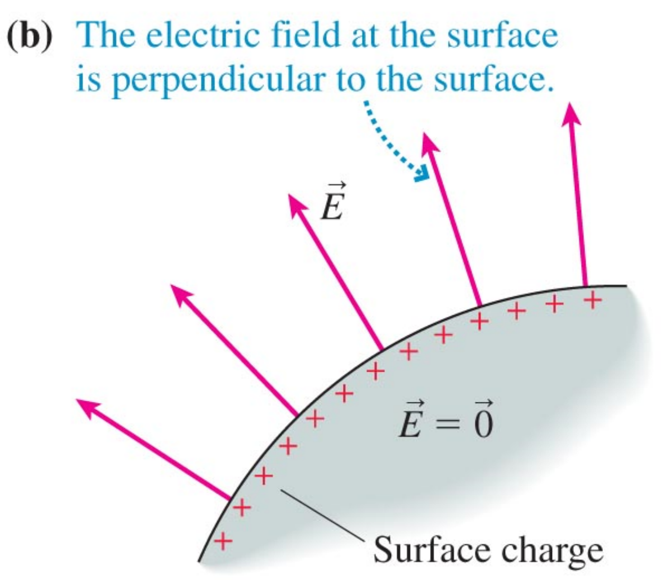
$$E = \frac{\sigma}{\varepsilon_0} \quad \text{(conducting surface).}$$

Summary of Conductors and Electric Fields









Properties of Conductors

Summary:

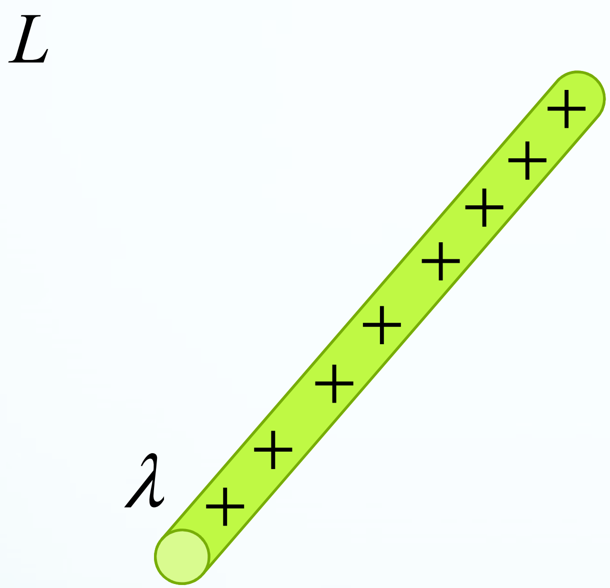
- 1. The electric field is zero inside a conductor. – Static Case
- 2. All excess charge is distributed over the outside surface.

    Inside, a conductor is neutral.
- 3. The electric field outside a conductor is parallel to the area vector (perpendicular to the surface) at each point and has a magnitude **E** = σ/ε_0
- 4. The charge density is greatest where the radius of curvature is smallest.

23-4 and 23-5

Electric field of a long, charged wire

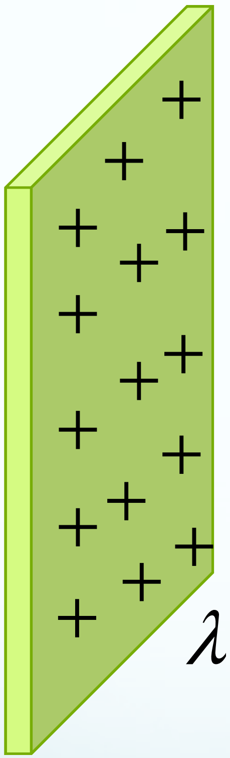
$$\Phi_e = \oint \vec{E}.d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$



$Q_{in} = ?$

$$E_{wire} = \frac{\lambda}{2\pi\varepsilon_0 r}$$

Electric field of a plane of charge



$$\Phi_e = \oint \vec{E}.d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$Q_{in} = ?$$

$$E_{plane} = \frac{\sigma}{2\varepsilon_0}$$

This section we talked about:

Chapter 23.3-4

See you on Wednesday