Announcements

2-hour tutorial this weekend

Where: ST141

When: 2:00-4:00 p.m. on Sunday Feb 12, 2017

Last time

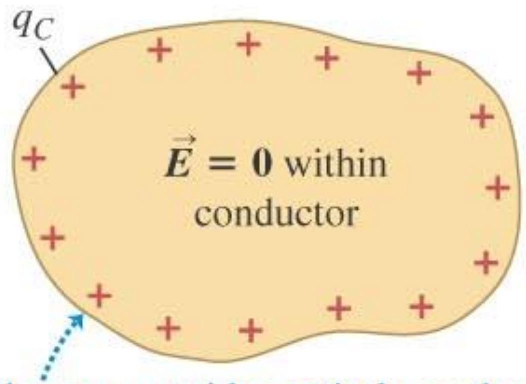
- Electric field for an infinite sheet of charge
- Electric properties of conductors and Gauss's law
- Electric field for a parallel plate capacitor
- Electrical shielding

This time

- Electrical shielding
- More on the electric properties of conductors and Gauss's law
- Activity #5

Electric field inside a solid (not a shell) irregular shaped conductor

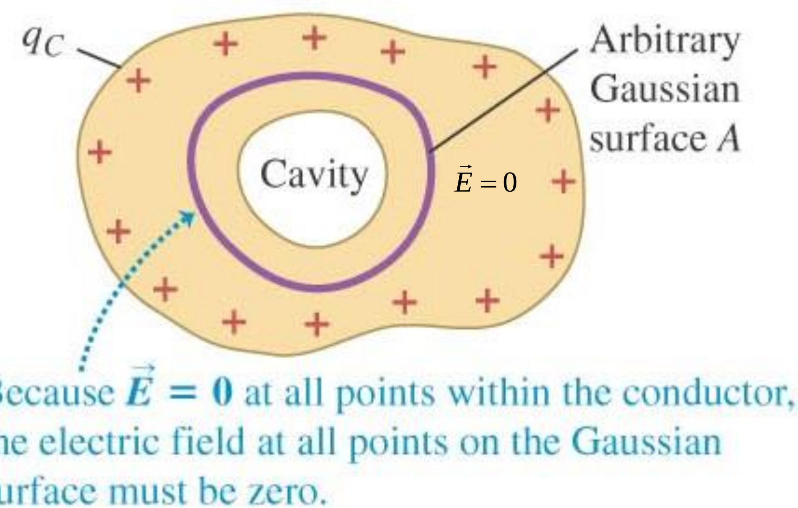
(a) Solid conductor with charge q_C



The charge q_C resides entirely on the surface of the conductor. The situation is electrostatic, so $\vec{E} = \mathbf{0}$ within the conductor.

Electric field inside a solid irregular shaped conductor with a cavity

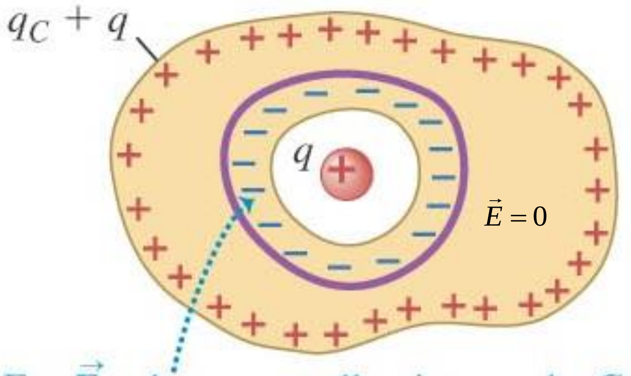
(b) The same conductor with an internal cavity



In the absence of any charge inside the cavity there will be no charge on the inner surface of the conductor. All of the charge will reside on the outer surface.

Electric field inside a solid irregular shaped conductor with a cavity and a point charge inside the cavity

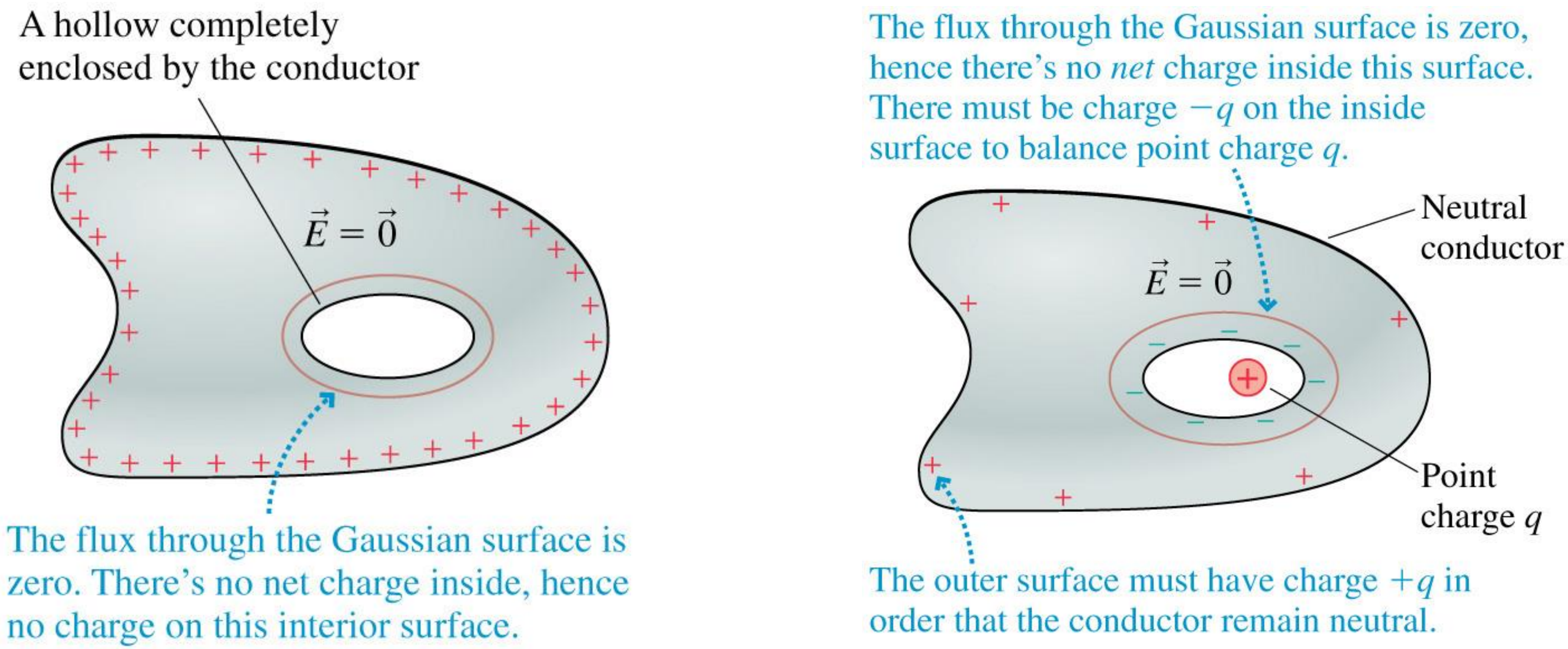
(c) An isolated charge q placed in the cavity



For $\vec{E}$ to be zero at all points on the Gaussian surface, the surface of the cavity must have a total charge $-q$.

The total charge on the inner surface must equal the charge present in the cavity but with the opposite sign for Gauss's law to hold. The total charge on the outer surface will increase by the amount of charge inside the cavity.

Practical application



Electrical shielding

Electrical shielding

That Fedora looks hawt!!!!!!!!

Electrical shielding

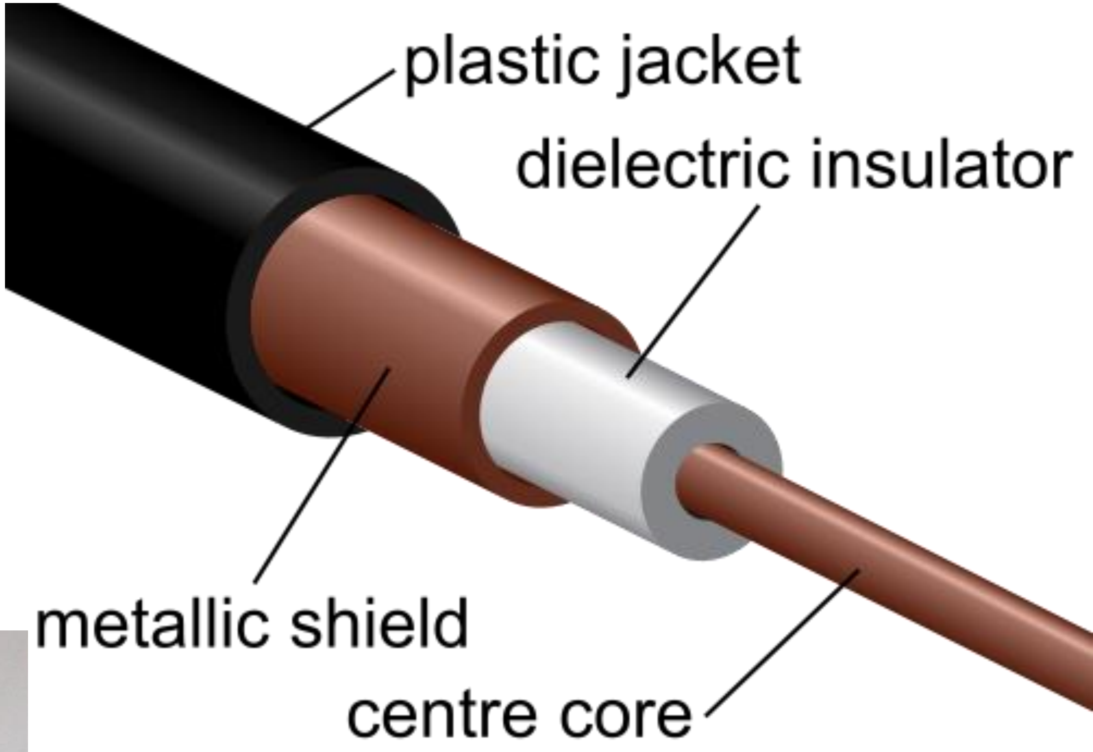
It works for American cars too!!!!!!!!!!!

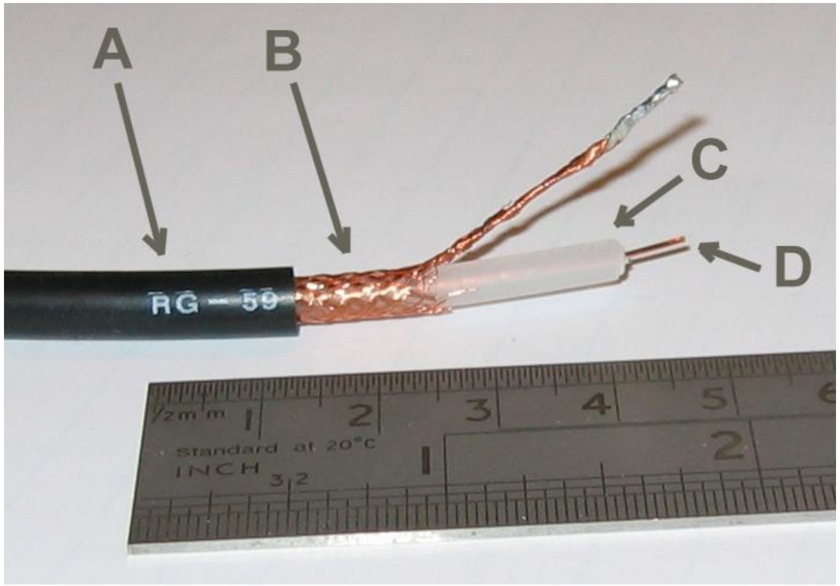
Application: Microwaves

The metal mesh is designed to prevent leakage of the powerful microwave radiation outside the microwave boundaries.

Electrical shielding

Co-axial cable





D carries the electric signal
C provides rigidity and prevents D from physical damage
B provides electrical shielding

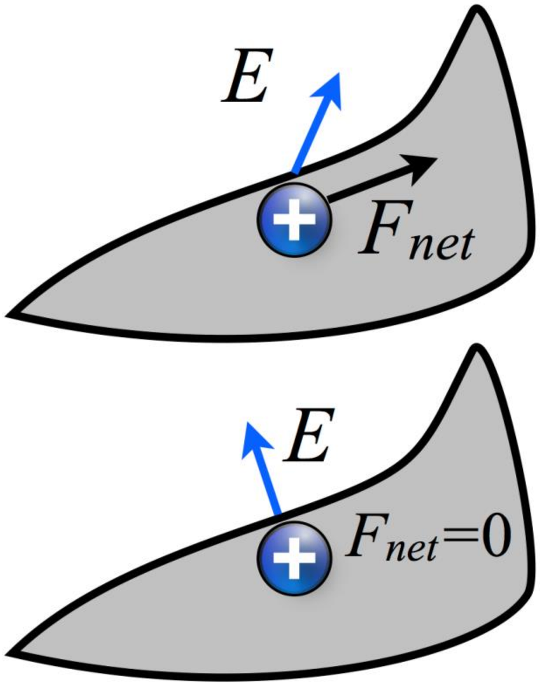
When a conductor is placed in an external electric field the charges inside will come to a static equilibrium after a short time.

While the electric field does not have to be zero outside the metal, the field lines do have to be perpendicular to the surface.

$$\vec{F} = q\vec{E}$$

The charges sitting on the surface of the metal are able to feel the external electric field, and so feel a force due to it.

The charge carriers are unable to leave the conductor, so the perpendicular component of the electric field will have no effect on them.



However, if the electric field has a component parallel to the surface, it will cause the charges to flow along the surface, which means the conductor is **not in electrostatic equilibrium**.

The electric field just outside the conductor is perpendicular to the conductor's surface and the magnitude of

$$E = \frac{\sigma}{\varepsilon_0}$$