1.3: Perfect Conductors and Perfect Insulators

Determining how electric charges in real materials respond to electric fields is incredibly important but also incredibly complicated. In light of this, we will initially restrict ourselves to two types of hypothetical materials.

In a *perfect conductor*, electric charges are free to move without any resistance to their motion. Metals provide a reasonable approximation to perfect conductors, although, of course, in a real metal a small amount of resistance to motion is present. When I refer to a material as a metal, we will approximate the metal as a perfect conductor.

In a *perfect insulator* electric charges cannot move, regardless of the amount of force applied to them. Many materials act as insulators, but all real materials experience electrical breakdown if the forces acting on charges become so great that the charges begin to move. When I refer to an insulating material, like plastic, for example, we will approximate the material as a perfect insulator.

Since electric fields create forces on electric charges, there cannot be static electric fields present inside perfect conductors. If a field was present inside a perfect conductor, the charges inside the conductor would feel an electric force and hence move in response to that force. They would continue to move until they redistributed themselves inside of the conductor in such a way as to cancel the electric field. The system could not reach equilibrium as long as an electric field was present. This re-arranging process would typically occur very quickly and we will always assume our analysis takes place after it is completed.