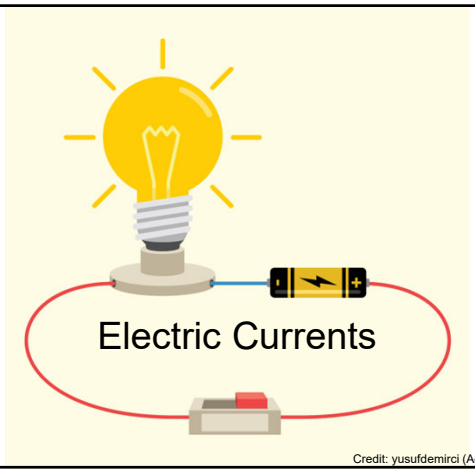


Credit: yusufdemirci (Adobe Stock)

Electric Current

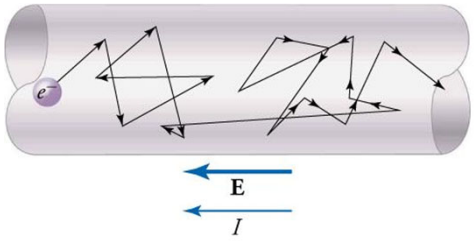
- Electric current is the rate at which electric charge moves.

$$I = \frac{q}{t}$$

Units: Ampere, Amp, A

- The direction of conventional current is the direction that positive charge would flow.
  - Although this is possible, it is usually the electrons that move.

- As electrons move through a metal wire, they encounter obstacles such as other electrons, atoms, impurities, etc.
- The electrons scatter from these obstacles and lose energy with each interaction.
- A force, supplied by an electric field, is required to keep the electrons moving.
- Electrons, carrying a negative charge, move on average (or *drift*) in the direction opposite the electric field.



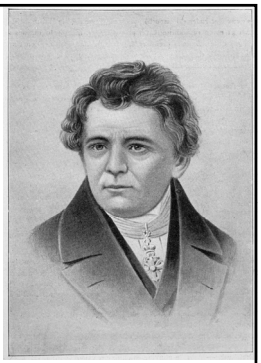
- For a typical wire with 1 A of current the drift velocity is 6×10^{-4} ms^{-1}.

Resistance

- Electrical current in a wire can be slowed down by many factors.
  - impurities in the wire, collisions between the charges in the material, etc.
- These factors create a resistance to the electrical current.
- Resistance is a description of how much a wire or other electrical component opposes the flow of charge through it.

- In the 19th century, Georg Ohm (German, 1787–1854) found experimentally that current through a conductor is proportional to the voltage drop across a current-carrying conductor.

$$I \propto V$$



Credit: Archivist (Adobe Stock)

- The constant of proportionality is the resistance R of the material, which leads to

$$V = IR$$

- This relationship is called **Ohm's law**.
  - The units of resistance are V/A called an ohm (Ω).

- Ohm's law holds for most materials at common temperatures.
  - At very low temperatures, resistance may drop to zero (superconductivity).
  - At very high temperatures, the thermal motion of atoms in the material inhibits the flow of electrons, increasing the resistance.
  - The many substances for which Ohm's law holds are called ohmic.

Resistivity

- The resistivity of a material is a measure of how strongly a material opposes the flow of electrical current.
  - The resistivity of some materials has a strong temperature dependence.
- The resistance of a material depends on resistivity, length and cross-sectional area.

$$R = \rho \frac{L}{A}$$