



Electrical Conduction

- Electrons move through metals, for example, because of the “sea” of electrons
- There is no NET movement of the electrons until connected to a source of potential difference (voltage)
- When a dry cell or battery is connected across the ends of a metal wire, an electric field is produced in the wire because of the potential difference

- The electrons in the battery “drift” towards the high positive potential end
- Electrons entering at one end of the metal push an equal number of electrons out the other end
- **Drift velocity:** approximately $10^{-4} \text{ m}\cdot\text{s}^{-1}$

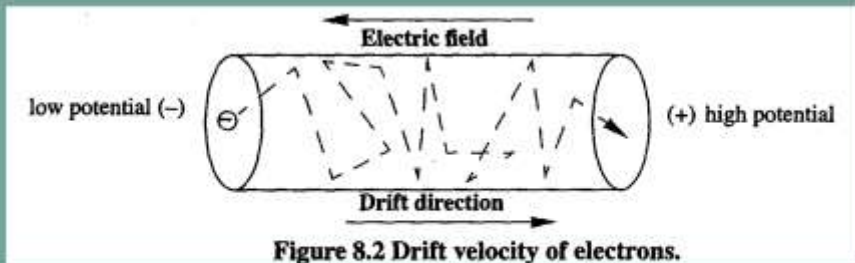


Figure 8.2 Drift velocity of electrons.

Electric Current



Fundamental Unit

- Ampere, or Amp (A)

- An electric current = movement of electric charge
 - Occurs in any state of matter
 - Steady current maintained when charge-carriers drift between points of different electric potential
- Charge-Carriers:
 - Solids = electrons in metals
 - Liquids = ions in molten and aqueous electrolytes
 - Gases = electrons and + ions stripped from gas molecules by large potential differences

Electric Current



- Electric current = **the rate at which charge flows**

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


- Therefore, 1 A = 1 C·s⁻¹
- A CIRCUIT is required for electric current to flow
 - Circuits consist of:
 - Source of voltage
 - Conducting path
 - Resistive electrical component



DC Current

- Circuit in which the current continuously flows in the same direction
 - Example: dry and wet cell batteries
- **Example problem:**
 - Calculate the current flowing through a hair drier if it takes 2.40×10^3 C of charge to dry a person's hair in 4.0 minutes:

$$I = \frac{q}{t} = \frac{2.40 \times 10^3 \text{ C}}{240 \text{ s}} = 10. \text{ A}$$

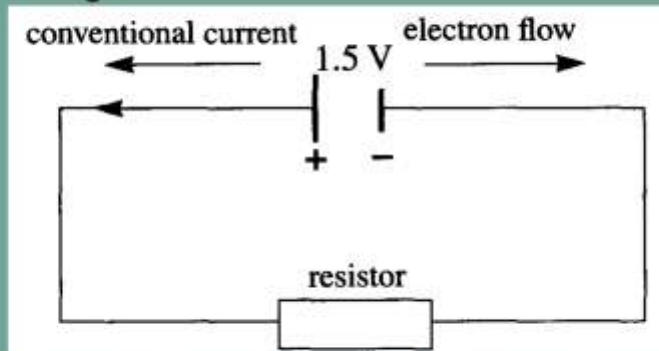


Conventional Current

- Historically, the direction of the flow of charge carriers was defined to be from **positive to negative**
- It is now known that current is a **flow of electrons** from negative to positive, however...
 - **CONVENTIONAL CURRENT STILL IS DRAWN AND INTERPRETED AS FLOWING FROM POSITIVE TO NEGATIVE!**



- **Electron Flow** = negative to positive
- **Conventional current** = positive to negative



- *Note: when drawing a voltage source into a circuit diagram, the positive end is always the larger of the two lines*

Resistance

- A measure of how easily charge flows through a material
- A **Resistor** is a material of significant resistance that has been placed in an electric circuit in order to control current or voltage
- **Electrical Resistance** = ratio of potential difference across the material to the current that flows through it.

$$R = \frac{V}{I}$$


- Units = $V \cdot A^{-1}$ = **Ohm (Ω)**



Resitivity

- Resistance of a conducting wire depends on:
 - **Length (l)** of the wire
 - **Cross-sectional Area (A)** of the wire
 - **Resistivity (ρ)** (a physical property of conductors) –units = $\Omega \cdot \text{m}$
 - **Temperature**
- When Temperature remains constant:

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



Material	Resistivity (Ωm)
Silver	1.6×10^{-8}
Copper	1.7×10^{-8}
Aluminium	2.8×10^{-8}
Tungsten	5.6×10^{-8}
Constantan (alloy of copper and nickel)	49×10^{-8}
Nichrome (alloy of nickel, iron and chromium)	100×10^{-8}
Graphite	$(3 - 60) \times 10^{-5}$
Silicon	$0.1 - 60$
Germanium	$(1 - 500) \times 10^{-3}$
Pyrex glass	10^{12}

Table 8.2 Resistivities for certain materials at 20°C.

Sample Problem:



○ What is the resistance of a piece of copper wire that is 10.0 m long and 1.2 mm in diameter?

- *Make sure the diameter is in m, then find radius in order to find area*
- *Resistivity of copper given in previous table: $= 1.7 \times 10^{-8} \Omega m$*

$$R = 0.150 \Omega$$



Temperature effect on R

- Temperature increases causes resistance to increase:

$$R_f = R_0(1 + \alpha t)$$

- R_0 = resistance at some reference temperature
- R_f = resistance at some temperature t (in °C) above the reference temperature
- α = temperature coefficient for material