# Current Electricity

## Problems Based on Drift Velocity

1. **Problem:**
   A copper wire has a cross-sectional area of $1 \times 10^{-6}\ \text{m}^2$ and carries a current of $3\ \text{A}$. If the number density of free electrons in copper is $8.5 \times 10^{28}\ \text{m}^{-3}$, calculate the drift velocity of the electrons in the wire.

2. **Problem:**
   An aluminum wire with a cross-sectional area of $2 \times 10^{-6}\ \text{m}^2$ carries a current of $5\ \text{A}$. Given that the number density of free electrons in aluminum is $6 \times 10^{28}\ \text{m}^{-3}$, find the drift velocity of the electrons.

3. **Problem:**
   A silver wire with a diameter of $0.5\ \text{mm}$ carries a current of $2\ \text{A}$. If the number density of free electrons in silver is $5.8 \times 10^{28}\ \text{m}^{-3}$, determine the drift velocity of the electrons.

4. **Problem:**
   Calculate the drift velocity of electrons in a gold wire of length $1\ \text{m}$ and cross-sectional area $1 \times 10^{-7}\ \text{m}^2$, when it carries a current of $1\ \text{A}$. The number density of free electrons in gold is $5.9 \times 10^{28}\ \text{m}^{-3}$.

5. **Problem:**
   A tungsten wire with a radius of $0.1\ \text{mm}$ carries a current of $0.5\ \text{A}$. Given that the number density of free electrons in tungsten is $6.3 \times 10^{28}\ \text{m}^{-3}$, find the drift velocity of the electrons.

6. **Problem:**
   An iron wire has a cross-sectional area of $3 \times 10^{-6}\ \text{m}^2$ and carries a current of $4\ \text{A}$. If the number density of free electrons in iron is $8.4 \times 10^{28}\ \text{m}^{-3}$, calculate the drift velocity of the electrons in the wire.

## Answer Key

1. **Solution:**
   Given:

   $$A = 1 \times 10^{-6}\ \text{m}^2,\ I = 3\ \text{A},\ n = 8.5 \times 10^{28}\ \text{m}^{-3}$$

   Drift velocity formula:

   $$v_d = \frac{I}{neA}$$

   Substituting the values:

$$v_d = \frac{3}{8.5 \times 10^{28} \times 1.6 \times 10^{-19} \times 1 \times 10^{-6}}$$

$$v_d = \frac{3}{1.36 \times 10^{-16}}$$

$$v_d \approx 2.21 \times 10^{-4}\ \text{m/s}$$

2. **Solution:**
   Given:

$$A = 2 \times 10^{-6}\ \text{m}^2,\ I = 5\ \text{A},\ n = 6 \times 10^{28}\ \text{m}^{-3}$$

   Drift velocity formula:

$$v_d = \frac{I}{neA}$$

   Substituting the values:

$$v_d = \frac{5}{6 \times 10^{28} \times 1.6 \times 10^{-19} \times 2 \times 10^{-6}}$$

$$v_d = \frac{5}{1.92 \times 10^{-16}}$$

$$v_d \approx 2.60 \times 10^{-4}\ \text{m/s}$$

3. **Solution:**
   Given:

$$d = 0.5\ \text{mm} = 0.5 \times 10^{-3}\ \text{m},\ I = 2\ \text{A},\ n = 5.8 \times 10^{28}\ \text{m}^{-3}$$

   Cross-sectional area:

$$A = \pi \left(\frac{d}{2}\right)^2 = \pi \left(\frac{0.5 \times 10^{-3}}{2}\right)^2 = \pi \times 6.25 \times 10^{-8}\ \text{m}^2$$

   Drift velocity formula:

$$v_d = \frac{I}{neA}$$

   Substituting the values:

$$v_d = \frac{2}{5.8 \times 10^{28} \times 1.6 \times 10^{-19} \times \pi \times 6.25 \times 10^{-8}}$$

$$v_d = \frac{2}{1.81 \times 10^{-15}}$$

$$v_d \approx 1.10 \times 10^{-4}\ \text{m/s}$$

4. **Solution:**
   Given:

$$l = 1\,\text{m},\ A = 1 \times 10^{-7}\,\text{m}^2,\ I = 1\,\text{A},\ n = 5.9 \times 10^{28}\,\text{m}^{-3}$$

   Drift velocity formula:

$$v_d = \frac{I}{neA}$$

   Substituting the values:

$$v_d = \frac{1}{5.9 \times 10^{28} \times 1.6 \times 10^{-19} \times 1 \times 10^{-7}}$$

$$v_d = \frac{1}{9.44 \times 10^{-16}}$$

$$v_d \approx 1.06 \times 10^{-4}\,\text{m/s}$$

5. **Solution:**
   Given:

$$r = 0.1\,\text{mm} = 0.1 \times 10^{-3}\,\text{m},\ I = 0.5\,\text{A},\ n = 6.3 \times 10^{28}\,\text{m}^{-3}$$

   Cross-sectional area:

$$A = \pi r^2 = \pi \times (0.1 \times 10^{-3})^2 = \pi \times 1 \times 10^{-8}\,\text{m}^2$$

   Drift velocity formula:

$$v_d = \frac{I}{neA}$$

   Substituting the values:

$$v_d = \frac{0.5}{6.3 \times 10^{28} \times 1.6 \times 10^{-19} \times \pi \times 1 \times 10^{-8}}$$

$$v_d = \frac{0.5}{3.17 \times 10^{-15}}$$

$$v_d \approx 1.58 \times 10^{-4}\,\text{m/s}$$

6. **Solution:**
   Given:

$$A = 3 \times 10^{-6}\,\text{m}^2,\ I = 4\,\text{A},\ n = 8.4 \times 10^{28}\,\text{m}^{-3}$$

   Drift velocity formula:

$$v_d = \frac{I}{neA}$$

Substituting the values:

$$v_d = \frac{4}{8.4 \times 10^{28} \times 1.6 \times 10^{-19} \times 3 \times 10^{-6}}$$

$$v_d = \frac{4}{4.03 \times 10^{-15}}$$

$$v_d \approx 9.93 \times 10^{-4}\ \text{m/s}$$