Ch—03 Current Electricity

Daily Practice Problem 02

Q1. A copper wire of cross-sectional area 3.00 x 10^{-6} m^2 carries a current 10.0 A.

(a) Find the drift speed of the electrons in the wire. Assume that each copper atom contributes one free electron to body of material.

(b) Find the average time between collisions for electrons in the copper at 20°C. The density of copper is 8.95 gcm^{-3}, molar mass of copper is 63.5 $gmol^{-1}$, Avogadro number is 6.02 x 10^{23} electrons per mol and resistivity of copper is 1.7 x 10^{-8} Ωm.

Q2. Consider a wire of length 0.1 m with an area of cross section 1 mm^2 connected to 5 V. Find the current flowing through the metallic wire where $\mu = 5 \times 10^{-6}\, m^2\, V^{-1} s^{-1}, e = 1.6 \times 10^{-19}\, C, and\ n = 8 \times 10^{28}\, m^{-3}$.

Q3. The free electrons of a copper wire of cross-sectional area 10^{-6} m^2 acquire a drift velocity of 10^{-4} m /s when a certain potential difference is applied across the wire. Find the current flowing in the wire if the density of free electrons in copper is 8.5 x 10^{28} electrons/m^3.

Q4. Estimate the average drift speed of conduction electrons in a copper wire of cross-sectional area 2.5 x 10^{-7} m^2 carrying a current of 2.7 A. Assume the density of conduction electrons to be 9 x10^{28} m^{-3}.

Q5. A current of 1.8 A flows through a wire of cross-sectional area 0.5 mm^2. Find the current density in the wire. If the number density of conduction electrons in the wire is 8.8 x 10^{28} m^{-3}, find the drift speed of electrons.

Q6. A current of 30 ampere is flowing through a wire of cross-sectional area 2 mm^2. Calculate the drift velocity of electrons. Assuming the temperature of the wire to be 27°C, also calculate the rms velocity at this temperature. Which velocity is larger? Given that Boltzmann's constant = 1.38 x 10^{-23} J K^{-1}, density of copper 8.9 g cm^{-3}, atomic mass of copper = 63.

Q7. What is the drift velocity of electrons in silver wire of length 1 m, having cross-sectional area 3.14 x 10^{-6} m^2 and carrying a current of 10 A? Given atomic mass of silver = 108, density of silver = 10.5 x 10^3 kg m^{-3}, charge on electron = 1.6 x 10^{-19} C and Avogadro's number = 6.023 x 10^{26} per kg-atom.

Q8. A potential difference of 4.5 V is applied across a conductor of length 0.1 m. If the drift velocity of electrons is 1.5 x 10^{-4} ms^{-1}, find the electron mobility.

Q9. The number density of electrons in copper is 8.5 x 10^{28} m^{-3}. A current of 1 A flows through a copper wire of length 0.24 m and area of cross-section 1.2 mm^2, when connected to a battery of 3 V. Find the electron mobility.

Q10. Drift speed of electrons, when 1.5 A of current flows in a copper wire of cross-section 5 mm^2 is v. If the electron density in copper is 9 x 10^{28} / m^3, the value of v in mm /s is close to (Take, charge of electron to be = 1.6 x 10^{-19} C)

(a) 0.02
(b) 0.2
(c) 2
(d) 3

Q11. A current of 5 A passes through a copper conductor (resistivity = 1.7 x 10^{-8} Ωm) of radius of cross-section 5 mm. Find the mobility of the charges, if their drift velocity is 1.1 x 10^{-3} m/s.

(a) 1.5 m^2 / V-s
(b) 1.3 m^2 / V-s
(c) 1.0 m^2 / V-s
(d) 1.8 m^2 / V-s

ANSWERS

1. (a) 2.46 x 10^{-4} ms^{-1} **(b)** 2.5 x 10^{-14} s

2. 3.2 A

3. 1.36 A

4. 0.75 $mrns^{-1}$

5. 3.6 x 10^{6} Am^{-2}, 2.56 x 10^{-4} ms^{-1}

6. 1.1 x 10^{-3} ms^{-1}, 1.17 x 10^{5} ms^{-1}

7. 3.399 x 10^{-4} ms^{-1}

8. 3.33 x 10^{-6} m^2 V^{-1} s^{-1}

9. 4.9 x 10^{-6} m^2 V^{-1} s^{-1}

10. a

11. c