Assignment 2

1. The current in a copper wire of cross-sectional area 0.500 mm² is 10.0 A. If the temperature of the wire is increased by 20.0 °C, what is the new current density in the wire? (Assume the resistivity of copper is 1.72 × 10⁻⁸ Ω·m.)

\[ \text{Current density} = \frac{\text{Current}}{\text{Cross-sectional area}} \]

\[ \text{Current density, initial} = \frac{10.0 \, \text{A}}{0.500 \times 10^{-6} \, \text{m}^2} = 2.00 \times 10^6 \, \text{A/m}^2 \]

\[ \text{Current density, final} = \frac{10.0 \, \text{A}}{0.500 \times 10^{-6} \, \text{m}^2} = 2.00 \times 10^6 \, \text{A/m}^2 \]

2. A resistor made of aluminum wire is 10.0 cm long and has a cross-sectional area of 0.500 mm². The resistivity of aluminum is 2.65 × 10⁻⁸ Ω·m. What is the resistance of the resistor? (Assume the temperature of the wire does not change.)

\[ \text{Resistance} = \rho \frac{L}{A} \]

\[ \text{Resistance} = (2.65 \times 10^{-8} \, \Omega \cdot \text{m}) \frac{0.100 \, \text{m}}{0.500 \times 10^{-6} \, \text{m}^2} = 5.30 \times 10^{-6} \, \Omega \]

3. A certain type of resistor has a resistance of 10.0 Ω at 0.0 °C. If the temperature coefficient of resistance is 0.00500 per degree Celsius, what is the resistance of the resistor at 100 °C? (Assume the resistivity of the material remains constant.)

\[ \text{Resistance at 100 °C} = \text{Resistance at 0 °C} \times (1 + \alpha \times \Delta T) \]

\[ \text{Resistance at 100 °C} = 10.0 \, \Omega \times (1 + 0.00500 \times 100) = 10.5 \, \Omega \]

4. A certain resistor has a resistance of 10.0 Ω at 0.0 °C. If a temperature of 100 °C is applied to the resistor, what is the new resistance of the resistor? (Assume the resistivity of the material remains constant.)

\[ \text{Resistance at 100 °C} = \text{Resistance at 0 °C} \times (1 + \alpha \times \Delta T) \]

\[ \text{Resistance at 100 °C} = 10.0 \, \Omega \times (1 + 0.00500 \times 100) = 10.5 \, \Omega \]

5. A resistor made of a material with a resistivity of 5.00 × 10⁻⁸ Ω·m has a cross-sectional area of 0.500 mm². The resistance of the resistor is 10.0 Ω. What is the length of the resistor? (Assume the temperature of the wire does not change.)

\[ \text{Resistance} = \rho \frac{L}{A} \]

\[ L = \frac{\text{Resistance} \times A}{\rho} \]

\[ L = \frac{10.0 \, \Omega \times 0.500 \times 10^{-6} \, \text{m}^2}{5.00 \times 10^{-8} \, \Omega \cdot \text{m}} = 1.00 \, \text{m} \]

6. A resistor made of a material with a resistivity of 5.00 × 10⁻⁸ Ω·m has a resistance of 10.0 Ω. What is the cross-sectional area of the resistor? (Assume the temperature of the wire does not change.)

\[ \text{Resistance} = \rho \frac{L}{A} \]

\[ A = \frac{\rho L}{\text{Resistance}} \]

\[ A = \frac{5.00 \times 10^{-8} \, \Omega \cdot \text{m} \times 1.00 \, \text{m}}{10.0 \, \Omega} = 5.00 \times 10^{-8} \, \text{m}^2 \]