Summary of chapter 26

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1. The electric current ***I*** is defined as:

$$I = \frac{dq}{dt}$$

The current is the rate of flow of electric charge. It has units of Coulomb/second or **Ampere** (A).

It is also given by:

$$I = n\, e\, v_d\, A$$

where ***n*** is number of charge carriers, *e* is the magnitude of the charge of the electron, $\boldsymbol{v_d}$ is drift speed, that is, the speed of the electrons in the conductor, and ***A*** is cross-sectional area of the conductor.

A uniform current density ***J*** is defined as:

$$J = \frac{I}{A} = n\, e\, v_d = \frac{1}{\rho} E = \sigma\, E$$

Where ρ is the resistivity and σ is conductivity and ***E*** is electric field. The current density has units of $\mathbf{A/m^2}$.

2. The resistance ***R*** of a conductor is defined as

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

where ***V*** is the potential difference across the conductor and ***I*** is the current through the condutor.

This relation is called ***Ohm's law***. The unit of the resistance $\boldsymbol{R}$ is volt per ampere or *Ohms* *(**Ω**)*.

The resistance depends on the geometry of the conductor, that is the length L and the cross section area A.

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

where ρ is resistivity and σ is conductivity.

3. The resistivity of a conductor varies with temperature as:

$$\rho = \rho_o[1+\alpha(T - T_o)]$$

where ρ is resistivity at temperature T, ρ_o is resistivity at temperature T_o and α is temperature coefficient of resistivity (constant).

We can see from the above equation that

$$\alpha = \frac{\rho - \rho_o}{\rho_o \Delta T}$$

It is easy to see that the unit of α is /^{o}C or /K.

Similarly, the resistance varies with temperature T as

$$R = R_o[1+\alpha(T - T_o)]$$

where R_o is the resistance of the conductor at T_o and R is the resistance at temperature T.

Note: We neglect the changes in the length and cross section area with temperature.

4. The dissipated power **P** in a resistor is given by;

$$P = VI = RI^2 = \frac{V^2}{R} \quad \text{(watt)}$$

This dissipated or lost power is transformed into heat.

Note: A light bulb with a power of 60 W has a resistance ***smaller*** than a light bulb with a power of 40 W!