Summary of Chapter 17 – Current and Resistance

Please read Chapter 17 carefully, and make sure that you understand the summary points below.

► The **electric current**, *I*, in a conductor is defined as

$$I = \frac{\Delta Q}{\Delta t}$$

where ΔQ is the charge that passes through a cross section of the conductor in time Δt. The SI unit of current is the **ampere (A)**; 1 A = 1 C/s. By convention, the direction of current is in the direction of flow of positive charge.

► The current *I* in a conductor is related to the motion of the charge carriers by

$$I = nqv_d A$$

where n is the number of mobile charge carriers per unit volume, q is the charge on each carrier, v_d is the drift speed of the charges, and A is the cross-sectional area of the conductor.

► The **resistance, R**, of a conductor is defined as the ratio of the potential difference across the conductor to the current

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

The SI unit of resistance is volt per ampere, or **ohm (Ω)**; 1 Ω = 1 V/A.

► **Ohm's law** describes many conductors, for which the applied voltage is directly proportional to the current it causes. The proportionality constant is the resistance:

$$\Delta V = IR$$

► If a conductor has length L and cross-sectional area A, its **resistance** is

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

where ρ is an intrinsic property of the conductor called the **electrical resistivity**. The SI unit of resistivity is the ohm-meter (Ω.m).

► The resistivity of a conductor varies with temperature over a limited temperature range, according to the expression

$$\rho = \rho_0 \left[1 + \alpha\left(T - T_0\right)\right]$$

where α is the **temperature coefficient of resistivity** and ρ_o is the resistivity at some reference temperature, T_o (usually taken to be 20 degrees C). The resistance of a conductor varies with temperature according to the expression

$$R = R_0 \left[1 + \alpha\left(T - T_0\right)\right]$$

► If a potential difference, ΔV, is maintained across a resistor, the **power,** or rate at which energy is supplied to the resistor, is

$$P = I\,\Delta V$$

Because the potential difference across a resistor is ΔV= IR, the power dissipated by a resistor can be expressed as

$$P = I^2 R = \frac{(\Delta V)^2}{R}$$

► A **kilowatt-hou**r is the amount of energy converted or consumed in 1 hour by a device supplied with power at the rate of 1 kW. This is equivalent to 3.6 x 10^6 joules.