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 $\Delta Q$ is the charge that passes through a cross section of the conductor in time $\Delta t$. 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

$$I = nq\nu_d A$$

where $n$ is the number of mobile charge carriers per unit volume, $q$ is the charge on each carrier, $\nu_d$ 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

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

where $\rho$ 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

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

where $\alpha$ is the temperature coefficient of resistivity and $\rho_0$ is the resistivity at some reference temperature, $T_0$ (usually taken to be 20 degrees C). The resistance of a conductor varies with temperature according to the expression

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

► If a potential difference, $\Delta V$, 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 $\Delta V = IR$, the power dissipated by a resistor can be expressed as

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

► A kilowatt-hour 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.