Chapter 26: Current and Resistance

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General

Quantities

$V =$ voltage
$i =$ current
$R =$ resistance
$q =$ charge
$t =$ time
$J =$ current density
$A =$ cross-sectional area
$L =$ length
$n =$ charge carriers per unit volume
$v_d =$ drift speed
$e =$ electron charge magnitude
$\rho =$ resistivity
$\sigma =$ conductivity
$E =$ electric field
$P =$ power

Constants

$$e = 1.60 \times 10^{-19}\,\mathrm{C} \tag{1}$$

1 Electric Current

$$i = \frac{dq}{dt} \tag{2}$$

Units

$$1\,\text{ampere} = 1\,\mathrm{A} = 1\,\text{coulomb per second} = 1\,\mathrm{C/s}$$

Junctions

$$i_{\text{in}} = i_{\text{out}} \tag{3}$$

2 Current Density

The current density tells how many charges are flowing within a given area of a conductor.

Units: $\mathrm{A/m^2}$

$$i = \int \vec{J} \cdot d\vec{A} \tag{4}$$

Uniform Current

$$J = \frac{i}{A} \tag{5}$$

Total Charge Within Length L

$$q = (nAL)\, e \tag{6}$$

Time For A Charge To Move Through The Conductor

$$t = \frac{L}{v_d} \tag{7}$$

Current Mnemonic: "nevada"

$$i = \frac{q}{t} = \frac{(nAL)\, e}{L/v_d} = nAev_d \tag{8}$$

Current Density

$$\vec{J} = (ne)\, \vec{v}_d \tag{9}$$

3 Resistance and Resistivity

Resistance Units: Ω

$$R = \frac{V}{i} \tag{10}$$

Resistivity Units: $\Omega\,\mathrm{m}$

$$\rho = \frac{E}{J} \tag{11}$$

$$\vec{E} = \rho \vec{J} \tag{12}$$

Conductivity

$$\sigma = \frac{1}{\rho} \tag{13}$$

Resistance and Resistivity Resistance is a property of an object. Resistivity is a property of a material.

$$R = \rho \frac{L}{A} \tag{14}$$

4 Ohm's Law

$$V = iR \tag{15}$$

5 Power

$$P = iV \tag{16}$$

$$P = i^2 R \tag{17}$$

$$P = \frac{V^2}{R} \tag{18}$$