Permeability constant: $\mu_0 = 1.26 \times 10^{-6}$
Permittivity of free space: $\epsilon_0 = 8.854 \times 10^{-12}$
Elementary charge: $e = 1.602 \cdot 10^{-19}$

$$\Delta V = -E_s \Delta s$$

$$W = Q \times V$$

$$C = \frac{Q}{\Delta V_C} = \text{ with units F or farad}$$

$$C = \frac{\epsilon_0 A}{d} \quad \text{(parallel-plate capacitor)}$$

$$Q = \frac{\epsilon_0 A}{d} \Delta V_C \quad \text{(parallel-plate capacitor)}$$

$$C_{\text{eq}} = C_1 + C_2 + C_3 + \cdots \quad \text{(parallel capacitors)}$$

$$\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots \quad \text{(sequential capacitors)}$$

$$C = \kappa C_0$$

Wires in series have the same current

$$i_e = n_e A v_d$$

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

where n is electron density and e is elementary charge

Metal	Electron density (m^{-3})
Aluminum	18×10^{28}
Iron	17×10^{28}
Copper	8.5×10^{28}
Gold	5.9×10^{28}
Silver	5.8×10^{28}

$$I = \frac{dQ}{dt} \text{ with units A or ampere or C/s}$$

$$\text{Current density: } J = \frac{I}{A} = n_e e v_d$$

$$I = JA = \sigma AE$$

Metal	Resistivity (Ωm)	Conductivity ($\Omega^{-1} m^{-1}$)
Aluminum	2.8×10^{-8}	3.5×10^{7}
Iron	9.7×10^{-8}	1.0×10^{7}
Copper	1.7×10^{-8}	6.0×10^{7}
Gold	2.4×10^{-8}	4.1×10^{7}
Silver	1.6×10^{-8}	6.2×10^{7}

Resistivity, $\rho = 1/\sigma$, is the inverse of the conductivity.

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

$$I = \frac{A}{\rho L} \Delta V$$

$$\Delta V = IR$$

$$R_{\text{eq}} = R_1 + R_2 + R_3 + \cdots \quad \text{(sequential resistors)}$$

$$\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots \quad \text{(parallel resistors)}$$

If one branch in a parallel circuit is opened, the current through the other stays the same

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

$$\tau = RC$$

$$Q = Q_0 e^{-t/\tau}$$

$$\Delta V_C = \Delta V_0 e^{-t/\tau}$$

Right-hand rule for magnetic field

1. Thumb is in direction of current
2. Fingers are curled around the wire
3. Fingers point in the direction of magnetic field

$$\oint B \cdot dl = Bl = \frac{mu_0 I}{2\pi r} \times 2\pi r = \mu_0 I_{\text{enc}}$$

$$\Phi_b = BA \cos\theta$$

$$F_B = qv \times B$$