Cheat Sheet

Constants:

$$\begin{aligned} k_e &= 8.98755 \times 10^9\,\mathrm{N \cdot m^2 \cdot C^{-2}} \\ \epsilon_0 &= 8.85 \times 10^{12}\,\mathrm{C^2/N \cdot m^2} \\ e &= 1.60218 \times 10^{-19}\,\mathrm{C} \\ c &= 2.99792 \times 10^8\,\mathrm{m/s} \\ m_{e^-} &= 9.10938 \times 10^{-31}\,\mathrm{kg} \\ m_{p^+} &= 1.67262 \times 10^{-27}\,\mathrm{kg} \\ m_{n^0} &= 1.67493 \times 10^{-27}\,\mathrm{kg} \\ g &\approx 9.81\,\mathrm{m/s^2} \end{aligned}$$

Current:

$$\begin{aligned} I &= \frac{\Delta Q}{\Delta t} = nqAv_d \\ J &= \frac{I}{A} = nqv_d \\ v_d &= \frac{-e\tau}{m}E \quad \tau = \text{scattering time} \\ \varrho &= \frac{m}{ne^2\tau} \\ \Delta V &= \frac{\varrho l}{A}I = RI \\ R &= \frac{\Delta V}{I} = \frac{\varrho l}{A} \\ \mathscr{P} &= E \cdot \Delta t = I\Delta V = I^2R = \frac{[\Delta V]^2}{R} \text{ power} \end{aligned}$$

Electric Force & Field

$$\begin{aligned} \vec{\mathbf{F}}_e &= q\vec{\mathbf{E}} \\ \vec{\mathbf{E}} &= k_e\frac{|q|}{r^2} \\ \Phi_E &= |\vec{\mathbf{E}}|A\cos\theta_{EA} = \frac{Q_{\text{inside}}}{\epsilon_0} \\ \Delta PE &= -W = -q|\vec{\mathbf{E}}||\Delta\vec{\mathbf{x}}|\cos\theta = -qE_x\Delta x \\ &\quad \uparrow \text{ constant E field} \end{aligned}$$

Capacitors:

$$\begin{aligned} Q_{\text{capacitor}} &= C\Delta V \\ C_{\text{parallel plate}} &= \frac{\epsilon_0 A}{d} \\ E_{\text{capacitor}} &= \frac{1}{2}Q\Delta V = \frac{Q^2}{2C} \\ C_{\text{eq, par}} &= C_1 + C_2 \\ C_{\text{eq, series}} &= \frac{C_1C_2}{C_1 + C_2} \\ C_{\text{with dielectric}} &= \kappa C_{\text{without}} \end{aligned}$$

Quadratic formula:

$$0 = ax^2 + bx^2 + c \Longrightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Basic Equations:

$$\begin{aligned} \vec{\mathbf{F}}_{\text{net}} &= m\vec{\mathbf{a}} \text{ Newton's Second Law} \\ \vec{\mathbf{F}}_{\text{centr}} &= -\frac{mv^2}{r}\hat{\mathbf{r}} \text{ Centripetal} \\ \text{KE} &= \frac{1}{2}mv^2 \\ \text{KE}_{\text{initial}} + \text{PE}_{\text{initial}} &= \text{KE}_{\text{final}} + \text{PE}_{\text{final}} \end{aligned}$$

Electric Potential:

$$\begin{aligned} \Delta V &= V_B - V_A = \frac{\Delta\text{PE}}{q} \\ \Delta PE &= q\Delta V = -q|\vec{\mathbf{E}}||\Delta\vec{\mathbf{x}}|\cos\theta = -qE_x\Delta x \\ &\quad \uparrow \text{ constant E field} \\ V_{\text{point charge}} &= k_e\frac{q}{r} \\ PE_{\text{pair of point charges}} &= k_e\frac{q_1q_2}{r_{12}} \\ PE_{\text{system}} &= \text{sum over unique pairs of charges} \\ -W &= \Delta\text{PE} = q(V_B - V_A) \end{aligned}$$

Resistors:

$$\begin{aligned} R_{\text{eq, series}} &= R_1 + R_2 \\ \frac{1}{R_{\text{eq, par}}} &= \frac{1}{R_1} + \frac{1}{R_2} \\ R_{\text{eq, par}} &= \frac{R_1R_2}{R_1 + R_2} \end{aligned}$$

Units

$$\begin{aligned} 1\,\text{eV} &= 1.6 \times 10^{-19}\,\text{J} \\ 1\,\text{J} &= 1\,\text{N} \cdot \text{m} = 1\,\text{kg} \cdot \text{m}^2/\text{s}^2 \\ 1\,\text{N} &= 1\,\text{kg} \cdot \text{m/s}^2 \\ 1\,\text{W} &= 1\,\text{J/s} = 1\,\text{kg} \cdot \text{m}^2/\text{s}^3 \\ 1\,\text{F} &= 1\,\text{C/V} \\ 1\,\text{C} &= 1\,\text{A/s} \\ 1\,\text{N/C} &= 1\,\text{V/m} \end{aligned}$$