$$g = 9.81 \text{ m/s}^2 \qquad\qquad e = 1.60 \times 10^{-19} \text{ C}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg} \qquad\qquad m_p = 1.67 \times 10^{-27} \text{ kg}$$

$$k_e = \frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^9 \text{ N m}^2/\text{C}^2 \qquad \varepsilon_0 = 8.85 \times 10^{-12} \ \frac{\text{s}^4\text{A}^2}{\text{kg m}^3}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$v = v_0 + a_c \Delta t \qquad\qquad \Delta x = v_0 \Delta t + \frac{1}{2} a_c \left(\Delta t\right)^2$$

$$v^2 = v_0^2 + 2a_c \Delta x \qquad\qquad \vec{F} = m\vec{a}$$

$$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{\ell}}$$

$$\vec{F}_{12} = \frac{k_e q_1 q_2}{r^2}\hat{r}_{12} \qquad\qquad \vec{F}_e = q\vec{E}$$

$$\vec{E}_q = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}\hat{r} \qquad\qquad E_{\text{line}} = \frac{|\lambda|}{2\pi\varepsilon_0 r}$$

$$E_{\text{plane}} = \frac{|\sigma|}{2\varepsilon_0} \qquad\qquad \vec{E}_{\text{ring}} = \frac{k_e Q z}{\left(r^2 + z^2\right)^{3/2}}\hat{k}$$

$$\Phi_e = \int_{\text{surface}} \vec{E} \cdot d\vec{A} \qquad\qquad \oint \vec{E} \cdot d\vec{A} = \frac{q_{\text{encl}}}{\varepsilon_0}$$

$$U_{\text{elec}} = \frac{k_e q_1 q_2}{r} \qquad\qquad V = \frac{U}{q}$$

$$\Delta V = -\int_{P_1}^{P_2} \vec{E} \cdot d\vec{\ell} \qquad\qquad V_q = \frac{k_e q}{r}$$

$$F_s = -\frac{dU}{ds} \qquad\qquad E_s = -\frac{dV}{ds}$$

$$C = \frac{Q}{V_C} \qquad\qquad C = \varepsilon_0 \frac{A}{d}$$

$$C_{\text{eq}} = \sum_i C_i \quad \text{(parallel)} \qquad\qquad \frac{1}{C_{\text{eq}}} = \sum_i \frac{1}{C_i} \quad \text{(series)}$$

$$U_C = \frac{1}{2}QV_C = \frac{1}{2}CV_C^2 = \frac{Q^2}{2C}$$

$$u_E = \frac{1}{2}\varepsilon_0 E^2$$

$$I_{\text{avg}} = \frac{\Delta Q}{\Delta t}$$

$$I = \frac{dQ}{dt}$$

$$I = qnv_d A$$

$$J = \frac{I}{A} = \sigma E$$

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

$$V_R = IR$$

$$P = \frac{dE}{dt}$$

$$P_R = IV_R = \frac{V_R^2}{R} = I^2 R$$

$$\sum I_{\text{in}} = \sum I_{\text{out}}$$

$$\Delta V_{\text{loop}} = \sum_i \Delta V_i = 0$$

$$R_{\text{eq}} = \sum_i R_i \quad \text{(series)}$$

$$\frac{1}{R_{\text{eq}}} = \sum_i \frac{1}{R_i} \quad \text{(parallel)}$$