Constants:

$$N_A = 6.022 \times 10^{23} \text{ things/mol}$$
$$k_e \equiv 1/4\pi\epsilon_o = 8.98755 \times 10^9 \text{ N} \cdot \text{m}^2 \cdot \text{C}^{-2}$$
$$\epsilon_o = 8.85 \times 10^{-12} \text{ C}^2/\text{N} \cdot \text{m}^2$$
$$\mu_o \equiv 4\pi \times 10^{-7} \text{ T} \cdot \text{m/A}$$
$$e = 1.60218 \times 10^{-19} \text{ C}$$
$$h = 6.6261 \times 10^{-34} \text{ J} \cdot \text{s} = 4.1357 \times 10^{-15} \text{ eV} \cdot \text{s}$$
$$\hbar = \frac{h}{2\pi}$$
$$k_B = 1.38065 \times 10^{-23} \text{ J} \cdot \text{K}^{-1} = 8.6173 \times 10^{-5} \text{ eV} \cdot \text{K}^{-1}$$
$$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = 2.99792 \times 10^8 \text{ m/s}$$
$$m_e = 9.10938 \times 10^{-31} \text{ kg} \qquad m_e c^2 = 510.998 \text{ keV}$$
$$m_p = 1.67262 \times 10^{-27} \text{ kg} \qquad m_p c^2 = 938.272 \text{ MeV}$$

Quadratic formula:

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

Basic Equations:

$$\vec{F}_{net} = m\vec{a} \quad \text{Newton's Second Law}$$
$$\vec{F}_{centr} = -\frac{mv^2}{r}\,\hat{r} \quad \text{Centripetal}$$

E & M

$$\vec{F}_{12} = k_e \frac{q_1 q_2}{r_{12}^2}\,\hat{r}_{12} = q_2 \vec{E}_1 \qquad \vec{r}_{12} = \vec{r}_1 - \vec{r}_2$$
$$\vec{E}_1 = \vec{F}_{12}/q_2 = k_e \frac{q_1}{r_{12}^2}\,\hat{r}_{12}$$
$$\vec{F}_B = q\vec{v} \times \vec{B}$$

EM Waves:

$$c = \lambda f = \frac{|\vec{E}|}{|\vec{B}|}$$
$$I = \left[\frac{\text{photons}}{\text{time}}\right]\left[\frac{\text{energy}}{\text{photon}}\right]\left[\frac{1}{\text{Area}}\right]$$
$$I = \frac{\text{energy}}{\text{time} \cdot \text{area}} = \frac{E_{max} B_{max}}{2\mu_0} = \frac{\text{power } (\mathscr{P})}{\text{area}} = \frac{E_{max}^2}{2\mu_0 c}$$

Blackbody

$$E_{tot} = \sigma T^4 \qquad \sigma = 5.672 \times 10^{-8} \text{ W} \cdot \text{m}^{-2} \cdot \text{K}^{-4}$$
$$T\lambda_{max} = 0.29 \times 10^{-2} \text{ m} \cdot \text{K} \qquad \text{Wien}$$
$$E_{quantum} = hf$$
$$E_{oscillator} = hf/\left(e^{hf/k_B T} - 1\right)$$
$$I(\lambda, T) = \frac{8\pi hc^2}{\lambda^5}\left[e^{\frac{hc}{\lambda k_b T}} - 1\right]^{-1}$$
$$I(f, t) = \frac{8\pi hf^3}{c^2}\left[e^{\frac{hf}{k_b T}} - 1\right]^{-1}$$

Relativity

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$
$$\Delta t'_{moving} = \gamma \Delta t_{stationary} = \gamma \Delta t_p$$
$$L'_{moving} = \frac{L_{stationary}}{\gamma} = \frac{L_p}{\gamma}$$
$$x' = \gamma(x - vt)$$
$$\Delta t' = t'_1 - t'_2 = \gamma\left(\Delta t - \frac{v\Delta x}{c^2}\right)$$
$$p = \gamma m v$$
$$v_{obj} = \frac{v + v'_{obj}}{1 + \frac{v v'_{obj}}{c^2}} \qquad v'_{obj} = \frac{v_{obj} - v}{1 - \frac{v v_{obj}}{c^2}}$$
$$KE = (\gamma - 1)mc^2 = \sqrt{m^2c^4 + c^2p^2} - mc^2$$
$$E_{rest} = mc^2$$
$$p = \gamma m v$$
$$E^2 = p^2c^2 + m^2c^4 = \left(\gamma mc^2\right)^2$$

Quantum

$$E = hf \qquad p = h/\lambda = E/c \qquad \lambda f = c \qquad \text{photons}$$
$$\lambda_f - \lambda_i = \frac{h}{m_e c}(1 - \cos\theta)$$
$$\lambda = \frac{h}{|\vec{p}|} = \frac{h}{\gamma m v} \approx \frac{h}{mv}$$
$$\Delta x \Delta p \geqslant \frac{h}{4\pi}$$
$$\Delta E \Delta t \geqslant \frac{h}{4\pi}$$
$$eV_{stopping} = KE_{electron} = hf - \varphi = hf - W$$

Calculus of possible utility:

$$\int \frac{1}{x}\,dx = \ln x + c$$
$$\int u\,dv = uv - \int v\,du$$
$$\int \sin ax\,dx = -\frac{1}{a}\cos ax + C$$
$$\int \cos ax\,dx = \frac{1}{a}\sin ax + C$$
$$\frac{d}{dx}\tan x = \sec^2 x = \frac{1}{\cos^2 x}$$

Vectors:

$$|\vec{F}| = \sqrt{F_x^2 + F_y^2} \quad \text{magnitude} \qquad \theta = \tan^{-1}\left[\frac{F_y}{F_x}\right] \quad \text{direction}$$
$$\hat{r} = \vec{r}/|\vec{r}| \quad \text{construct any unit vector}$$
$$\text{let} \quad \vec{a} = a_x\,\hat{x} + a_y\,\hat{y} + a_z\,\hat{z} \quad \text{and} \quad \vec{b} = b_x\,\hat{x} + b_y\,\hat{y} + b_z\,\hat{z}$$
$$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z = \sum_{i=1}^{n} a_i b_i = |\vec{a}||\vec{b}|\cos\theta$$
$$|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}|\sin\theta$$
$$\vec{a} \times \vec{b} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix} = (a_y b_z - a_z b_y)\,\hat{x} + (a_z b_x - a_x b_z)\,\hat{y} + (a_x b_y - a_y b_x)\,\hat{z}$$