Formula Sheet

$$\vec{r} = \vec{r_0} + \vec{v_0}t + \frac{1}{2}\vec{a}t^2$$

$$\vec{v_f} = \vec{v_0} + \vec{a}t$$

$$v_f^2 = v_0^2 + 2\vec{a} \cdot \Delta\vec{r}$$

$$x = \frac{v_0^2}{g} \sin 2\theta_0$$

$$y = \frac{v_0^2}{2g} \sin^2 \theta_0$$

$$y = x \tan \theta_0 - \frac{g}{2v_0^2 \cos^2 \theta_0} x^2$$

$$\vec{F} = m\vec{a}$$

$$F = \frac{mv^2}{r}$$

$$f_k = \mu_k N$$

$$f_s \leq \mu_s N$$

$$\vec{W} = m\vec{g}$$

$$\vec{F} = -k\vec{x}$$

$$K = \frac{1}{2}mv^2$$

$$W = \vec{F} \cdot \Delta\vec{r}$$

$$\Delta K = W$$

$$W = \int \vec{F} \cdot \Delta\vec{r}$$

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

$$\vec{F} = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$$

$$U = \frac{1}{2}kx^2$$

$$U = mgh$$

$$\vec{p} = m\vec{v}$$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{r}_{cm} = \frac{\sum_i m_i \vec{r}_i}{\sum_i m_i}$$

$$v_f - v_i = v_{er} \ln \frac{M_i}{M_f}$$

$$\theta(t) = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega(t) = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$W = \tau\Delta\theta$$

$$W = \int \tau \, d\theta$$

$$I = \sum_i m_i r_i^2$$

$$I = \int r^2 \, dm$$

$$\vec{L} = \vec{r} \times \vec{p} = I\vec{\omega}$$

$$\vec{\tau} = \frac{d\vec{L}}{dt}$$

$$\vec{\tau} = I\vec{\alpha}$$

$$I_{solid-sphere} = \frac{2}{5}MR^2$$
$$I_{hollow-sphere} = \frac{2}{3}MR^2$$
$$K = \frac{1}{2}I\omega^2$$
$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$
$$mv\hat{i} - Mu\hat{i} = -mv'\hat{i} + Mu'\hat{i}$$
$$u' = \frac{2mv + (m-M)u}{M+m}$$
$$v' = \frac{2Mu + (M-m)v}{M+m}$$
$$\vec{F} = -\frac{GmM}{r^2}\hat{r}$$
$$U = -\frac{GmM}{r}$$
$$T^2 = \frac{4\pi^2}{G(M_1+M_2)}a^3$$
$$v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$$
$$m\frac{d^2x}{dt^2} + kx = 0$$
$$x(t) = A\cos(\omega t + \phi)$$
$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = 0$$
$$x(t) = Ae^{-bt/2m}\cos(\omega_D t + \phi)$$
$$m\frac{d^2x}{dt^2} + b\frac{dx}{dt} + kx = F_0\cos(\omega_{drive}t)$$
$$x(t) = A_{drive}\cos(\omega_{drive}t + \phi_{drive})$$
$$A_{drive} = \frac{F_0}{\sqrt{m^2(\omega_{drive}^2 - \omega_0^2)^2 + b^2\omega_{drive}^2}}$$
$$\phi_{drive} = \tan^{-1}\left(\frac{b\,\omega_{drive}}{m(\omega_{drive}^2 - \omega_0^2)}\right)$$
$$\omega_D = \sqrt{\frac{k}{m} - \left(\frac{b}{2m}\right)^2}$$
$$D(x,t) = A\sin(kx - \omega t + \phi)$$
$$D(x,t) = A\sin(\frac{2\pi}{\lambda}x - 2\pi ft + \phi)$$
$$v = f\lambda$$
$$f_r = \frac{v \pm v_r}{v \mp v_s}f_s$$
$$\vec{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}\hat{r}$$
$$\vec{F} = q\vec{E}$$
$$\vec{p} = q\vec{d}$$
$$U = \frac{Qq}{4\pi\epsilon_0 r}$$
$$U = qV$$
$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$
$$V_b - V_a = -\int_a^b \vec{E}\cdot d\vec{r}$$
$$\oint \vec{E}\cdot d\vec{A} = \frac{1}{\epsilon_0}\sum q_{enc}$$
$$Q = CV$$
$$C = \frac{\epsilon A}{d}$$

$$U = \frac{1}{2}CV^2 \qquad u_E = \frac{1}{2}\epsilon_0 E^2$$

$$C_{parallel} = \sum_{i=1}^{N} C_i \qquad \frac{1}{C_{series}} = \sum_{i=1}^{N} \frac{1}{C_i}$$

$$R_{series} = \sum_{i=1}^{N} R_i \qquad \frac{1}{R_{parallel}} = \sum_{i=1}^{N} \frac{1}{R_i}$$

$$I = \frac{V}{R} \qquad R = \rho\frac{l}{A}$$

$$P = I^2 R \qquad \vec{F} = q\vec{v} \times \vec{B}$$

$$\vec{F} = -I \int \vec{B} \times d\vec{l} \qquad \omega = \frac{qB}{m}$$

$$\vec{\mu} = I\vec{A} \qquad \vec{\tau} = \vec{\mu} \times \vec{B}$$

$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l} \times \hat{r}}{r^2} \qquad \oint \vec{B} \cdot d\vec{l} = \mu_0 \sum I_{enc}$$

$$\frac{F_{12}}{l} = \frac{\mu_0 I_1 I_2}{2\pi R} \qquad \mu_n = \frac{e}{2m}\hbar n$$

Fundamental Constants

$$G = 6.673 \times 10^{-11}\,\mathrm{m^3\,kg^{-1}\,s^{-2}} \qquad c = 2.997 \times 10^{8}\mathrm{m\,s^{-1}}$$

$$N_A = 6.022 \times 10^{23}\,\mathrm{particles\,mol^{-1}} \qquad e = 1.602 \times 10^{-19}\,\mathrm{C}$$

$$\epsilon_0 = 8.854 \times 10^{-12}\,\mathrm{C^2\,N^{-1}\,m^{-2}} \qquad \mu_0 = 4\pi \times 10^{-7}\,\mathrm{N\,A^{-2}}$$

$$\hbar = 1.055 \times 10^{-34}\,\mathrm{J \cdot s}$$