Math / Constants

$$\begin{Bmatrix} x = r\cos\theta \\ y = r\sin\theta \end{Bmatrix}; \quad \begin{Bmatrix} r = \sqrt{x^2+y^2} \\ \theta = \tan^{-1}\left(\frac{y}{x}\right) \end{Bmatrix}; \quad x = \frac{-B \pm \sqrt{B^2-4AC}}{2A}; \quad \begin{Bmatrix} g = 9.80 \text{ m/s}^2 \\ G = 6.67\times10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2 \\ M_{Earth} = 5.98\times10^{24}\text{kg} \\ R_{Earth} = 6.27\times10^{6}\text{m} \end{Bmatrix};$$

Kinematics

$$\begin{Bmatrix} v_x = v_{0x} + a_x t \\ \Delta x = \frac{1}{2}(v_{0x}+v_x)t \\ \Delta x = v_{0x}t + \frac{1}{2}a_x t^2 \\ v_x^2 = v_{0x}^2 + 2a_x\Delta x \end{Bmatrix}; \quad \begin{Bmatrix} v_y = v_{0y} + a_y t \\ \Delta y = \frac{1}{2}(v_{0y}+v_y)t \\ \Delta y = v_{0y}t + \frac{1}{2}a_y t^2 \\ v_y^2 = v_{0y}^2 + 2a_y\Delta y \end{Bmatrix}; \quad \begin{Bmatrix} \Delta x = x_f - x_i \\ speed_{ave} = \frac{d}{\Delta t} \\ v_{ave} = \frac{\Delta x}{\Delta t} \\ a_{ave} = \frac{\Delta v}{\Delta t} \\ v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t} \\ a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t} \end{Bmatrix};$$

Forces

$$\begin{Bmatrix} \sum\vec{F} = 0 \to \vec{a} = 0 \\ \sum\vec{F} = m\vec{a} \\ \vec{F}_{2on1} = -\vec{F}_{1on2} \end{Bmatrix}; \quad \begin{Bmatrix} \sum F_x = ma_x \\ \sum F_y = ma_y \end{Bmatrix}; \quad \begin{Bmatrix} 0 \le f_s \le \mu_s F_N \\ f_k = \mu_k F_N \end{Bmatrix}; \quad \begin{Bmatrix} F_g = mg \\ F_g = G\frac{Mm}{r^2} \\ \vec{F}_d = -b\vec{v} \\ \vec{F}_s = -k\Delta\vec{x} \end{Bmatrix};$$

Work/Energy

$$\begin{Bmatrix} KE = \frac{1}{2}mv^2 \\ PE_g = mgh \\ PE_s = \frac{1}{2}k(\Delta x)^2 \\ P = \frac{\Delta E}{\Delta t} \end{Bmatrix}; \quad \begin{Bmatrix} W = \vec{F}\cdot\Delta\vec{x} \\ W = |F|\cdot|\Delta x|\cos\theta \\ W = \int\vec{F}(x)\cdot d\vec{x} \end{Bmatrix}; \quad \begin{Bmatrix} W_c + W_{nc} = \Delta KE \\ W_c = -\Delta PE \\ E_{tot} = KE + PE_s + PE_g \\ \Delta E_{tot} = \Delta KE + \Delta PE_s + \Delta PE_g \\ \Delta E_{tot} = W_{nc} \end{Bmatrix};$$

Momentum

$$\begin{Bmatrix} \vec{p} = m\vec{v} \\ \vec{I} = \Delta\vec{p} = \vec{F}\Delta t \\ F_{ext} = 0 \to \Delta p = 0 \\ \Delta\vec{p} = m\cdot\Delta\vec{v} + \Delta m\cdot\vec{v} \\ v_{1f} = \left(\frac{m_1-m_2}{m_1+m_2}\right)v_{1i} + \left(\frac{2m_2}{m_1+m_2}\right)v_{2i} \\ v_{2f} = \left(\frac{2m_1}{m_1+m_2}\right)v_{1i} + \left(\frac{m_2-m_1}{m_1+m_2}\right)v_{2i} \end{Bmatrix};$$

Rotational motion

$$\left\{\begin{matrix} x_{CM} = \frac{Mx+m(L-x)}{M+m} \\ s = R\theta \\ \omega = \frac{\Delta\theta}{\Delta t} \\ \alpha = \frac{\Delta\theta}{\Delta t} \end{matrix}\right\}; \quad \left\{\begin{matrix} v_T = R\omega \\ a_T = R\alpha \\ a_c = \frac{v^2}{r} \\ T = \frac{2\pi}{\omega} = \frac{2\pi r}{v} \end{matrix}\right\}; \quad \left\{\begin{matrix} \omega_f = \omega_i + \alpha t \\ \Delta\theta = \frac{1}{2}(\omega_i + \omega_f)t \\ \Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2 \\ \omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \end{matrix}\right\};$$

$$\left\{\begin{matrix} I = \sum m_i r_i^2 \\ I_{\text{hoop/hollow cylinder}} = MR^2 \\ I_{\text{solid cylinder}} = \frac{1}{2}MR^2 \\ I_{\text{rod, axis through center}} = \frac{1}{12}MR^2 \\ I_{\text{rod, axis through end}} = \frac{1}{3}MR^2 \\ I_{\text{solid sphere}} = \frac{2}{5}MR^2 \\ I_{\text{hollow sphere}} = \frac{2}{3}MR^2 \end{matrix}\right\}; \quad \left\{\begin{matrix} KE_{rot} = \frac{1}{2}I\omega^2 \\ \vec{\tau} = \vec{r} \times \vec{F} \\ \sum \tau = I\alpha \\ \sum \tau = 0 \to \alpha = 0 \\ W_{rot} = \tau\Delta\theta \\ \Delta L = \tau\Delta t \\ L = I\omega \\ \tau_{ext} = 0 \to \Delta L = 0 \end{matrix}\right\};$$

Fluids

$$\left\{\begin{matrix} P = \frac{F}{A} \\ P = \rho g h \\ F_B = \rho_f g V_{displaced} \end{matrix}\right\}$$