*Equations and Constants*

$$\begin{Bmatrix} x = r\cos\theta \\ y = r\sin\theta \end{Bmatrix}; \qquad \begin{Bmatrix} r = \sqrt{x^2+y^2} \\ \theta = \tan^{-1}\left(\frac{y}{x}\right) \end{Bmatrix};$$

$$\begin{Bmatrix} v_x = v_{0x} + a_x t \\ \Delta x = \frac{1}{2}(v_{0x}+v_x)t \\ \Delta x = v_{0x}t + \frac{1}{2}a_x t^2 \\ v_x^2 = v_{0x}^2 + 2a_x\Delta x \end{Bmatrix}; \qquad \begin{Bmatrix} v_y = v_{0y} + a_y t \\ \Delta y = \frac{1}{2}(v_{0y}+v_y)t \\ \Delta y = v_{0y}t + \frac{1}{2}a_y t^2 \\ v_y^2 = v_{0y}^2 + 2a_y\Delta y \end{Bmatrix};$$

$$\begin{Bmatrix} \Delta x = x_f - x_i \\ speed_{ave} = \frac{d}{\Delta t} \end{Bmatrix}; \qquad \begin{Bmatrix} v_{ave} = \frac{\Delta x}{\Delta t} \\ a_{ave} = \frac{\Delta v}{\Delta t} \end{Bmatrix}; \qquad \begin{Bmatrix} v = \lim_{\Delta t\to 0}\frac{\Delta x}{\Delta t} \\ a = \lim_{\Delta t\to 0}\frac{\Delta v}{\Delta t} \end{Bmatrix};$$

$$\begin{Bmatrix} a_c = \frac{v^2}{r} \\ T = \frac{2\pi r}{v} \end{Bmatrix}; \qquad x = \frac{-B \pm \sqrt{B^2-4AC}}{2A};$$

$$\begin{Bmatrix} \sum \vec{F} = 0 \to \vec{a} = 0 \\ \sum \vec{F} = m\vec{a} \\ \vec{F}_{2on1} = -\vec{F}_{1on2} \end{Bmatrix}; \qquad \begin{Bmatrix} \sum F_x = ma_x \\ \sum F_y = ma_y \end{Bmatrix}; \qquad \begin{Bmatrix} 0 \le f_s \le \mu_s F_N \\ f_k = \mu_k F_N \\ F_g = mg \\ \vec{F}_d = -b\vec{v} \end{Bmatrix};$$

$$\begin{Bmatrix} F_g = G\frac{Mm}{r^2} \\ G = 6.67\times 10^{-11}\ \mathrm{N\cdot m^2/kg^2} \\ g = 9.80\ \mathrm{m/s^2} \\ M_{Earth} = 5.98\times 10^{24}\mathrm{kg} \\ R_{Earth} = 6.27\times 10^{6}\mathrm{m} \end{Bmatrix};$$

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