Geometry/Trigonometry:

$$\cos(30°) = \frac{1}{2}\sqrt{3} \quad \sin(30°) = \frac{1}{2} \quad \tan(30°) = \frac{1}{3}\sqrt{3}$$

$$\cos(45°) = \frac{1}{2}\sqrt{2} \quad \sin(45°) = \frac{1}{2}\sqrt{2} \quad \tan(45°) = 1$$

$$\cos(60°) = \frac{1}{2} \quad \sin(60°) = \frac{1}{2}\sqrt{3} \quad \tan(60°) = \sqrt{3}$$

$$\cos\left(\frac{1}{2}\pi - \theta\right) = \sin(\theta) \qquad \sin\left(\frac{1}{2}\pi - \theta\right) = \cos(\theta)$$

$$\cos(2\theta) = 1 - 2\sin^2(\theta) \qquad \sin(2\theta) = 2\sin(\theta)\cos(\theta)$$

	circle	sphere
circumference	$2\pi r$	
(surface) area	πr^2	$4\pi r^2$
volume		$\frac{4}{3}\pi r^3$

Integrating and Differentiating:

$$\frac{d(x^n)}{dx} = nx^{n-1}$$

$$\int x^n dx = \frac{x^{n+1}}{n+1}$$

Linear Motion in One Dimension (general):

$$v = \frac{dx}{dt}$$

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

Linear Motion in One Dimension (special case):

$$a(t) = a = \text{ constant}$$

$$v(t) = v_0 + at$$

$$x(t) = x_0 + v_0 t + \frac{1}{2}at^2$$

Linear Motion in Two/Three Dimensions:

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt} = \frac{d^2\vec{r}}{dt^2}$$

Circular Motion:

$$a_R = \frac{v^2}{r}$$

$$a_{\tan} = \frac{dv}{dt}$$

Force Laws:

$\sum_i \vec{F}_i = m\vec{a}$ Newton's Second Law of Motion

$\vec{F}_{12} = -\vec{F}_{21}$ Newton's Third Law of Motion

Friction:

$F_s \leq \mu_s N$ Static Friction

$F_k = \mu_k N$ Kinetic Friction

$F_D = -bv$ Dragg Force

Newton's Gravitational Law:

$$\vec{F}_{12} = -G\frac{m_1 m_2}{r^2{}_{21}}\hat{r}_{21}$$

Kepler's Third Law (Law of Periods):

$$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3$$

Work Done by a Force:

$W = \vec{F} \bullet \vec{d}$ Constant Force

$W = \int_a^b \vec{F} \bullet d\vec{l}$ Variable Force

Translation Kinetic Energy:

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

Work-Energy Theorem:

$$W = \Delta K$$

Potential Energy:

$\Delta U = U_2 - U_1 = -\int_1^2 \vec{F} \bullet d\vec{l} = -W$ General Definition of Potential Energy

$$\vec{F} = -\frac{dU}{dx}\hat{x} - \frac{dU}{dy}\hat{y} - \frac{dU}{dz}\hat{z}$$

$U(h) = mgh$ Gravitational Potential Energy (Close to the Surface)

$U(r) = -G\frac{mM_E}{r}$ Gravitational Potential Energy ($r>r_E$)

$U(x) = \frac{1}{2}kx^2$ Spring with Spring Constant k

Conservation of Energy:

$\Delta U + \Delta K = 0$ Conservation of Mechanical Energy

$\Delta U + \Delta K = W_{NC}$ Conservation of Energy

Power:

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

Linear Momentum and Newton's Second Law:

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

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

Collision Impulse:

$$\vec{J} = \int_{t_1}^{t_2} \vec{F} dt = \vec{p}_f - \vec{p}_i = \Delta\vec{p}$$

Elastic Collisions in One Dimension:

$$v_1' = v_1\left(\frac{m_1 - m_2}{m_1 + m_2}\right) + v_2\left(\frac{2m_2}{m_1 + m_2}\right)$$

$$v_2' = v_1\left(\frac{2m_1}{m_1 + m_2}\right) + v_2\left(\frac{m_1 - m_2}{m_1 + m_2}\right)$$

Center of Mass:

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

$$\vec{r}_{cm} = \frac{1}{M}\int \vec{r} dm$$

Motion of the Center of Mass:

$$M\vec{a}_{cm} = \sum \vec{F}_i$$

Rocket Equations:

$$M\frac{d\vec{v}}{dt} = \sum \vec{F}_{ext} + \vec{v}_{rel}\frac{dM}{dt}$$

$Ma_{rocket} = RU_0$ First Rocket Equation

$v_f = v_i + u\ln\left(\frac{M_i}{M_f}\right)$ Second Rocket Equation