Kinematics *One Dimension*

$v_{avg} = d/\Delta t$

$v_{x\,avg} = \Delta x/\Delta t = (x_f - x_i)/\Delta t$

$v_x = dx/dt$

$a_{x\,avg} = \Delta v_x/\Delta t = (v_{xf} - v_{xi})/\Delta t$

$v_{avg} = \frac{1}{2}(v_i + v_f)$

$v_{xf} = v_{xi} + a_x t$

$x_f = x_i + v_i t + \frac{1}{2} a_x t^2$

$v_{xf}^2 = v_{xi}^2 + 2 a_x (x_f - x_i)$

$x_f = x_i + \frac{1}{2}(v_f + v_i) t$

Projectile Motion

$v_{xi} = v_{xf}$

$x_f = x_i + v_{xi} t$

$v_{yf} = v_{yi} + a_y t$

$y_f = y_i + v_{yi} t + \frac{1}{2} a_y t^2$

$v_{yf}^2 = v_{yi}^2 + 2a_y (y_f - y_i)$

$y_f = y_i + \frac{1}{2}(v_{yf} + v_{yi}) t$

Vectors

*If θ is the angle the vector, **V**, makes with the x axis then the components of **V** are*:

$V_x = V\cos(\theta)$

$V_y = V\sin(\theta)$

$V = (V_x^2 + V_y^2)^{1/2}$

$\tan(\theta) = V_y/V_x$

Quadratic Formula

$$at^2 + bt + c = 0$$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Newton's Laws and Forces

(Note Bold Symbols Represent Vector Quantities)

$\sum \mathbf{F} = m\,\mathbf{a}$

$\mathbf{F}_{AB} = -\mathbf{F}_{BA}$

$F_g = m\,g$

$$F_g = G\frac{m_1 m_2}{r^2}$$

$F_f \leq \mu_s F_N$

$F_f = \mu_k F_N$

Uniform Circular Motion

$v = 2\pi r / T$

$a_c = v^2 / r$

$T = 1/f$

$a_t = d|\mathbf{v}|/dt$

Circular Motion and Gravitation

$$F_c = m\frac{v^2}{r}$$

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

$$g = G\frac{M}{r^2}$$

$$r^3 = \frac{GM}{4\pi^2}T^2$$

Work and Energy

$$W = \int F dr \cos\theta = \int \vec{F} \bullet d\vec{r} = F\Delta r\cos\theta = \vec{F} \bullet \Delta\vec{r}$$

$$\vec{A} \bullet \vec{B} = A_x B_x + A_y B_y + A_z B_z = AB\cos\theta$$

KE = ½mv^2

$W_{net} = \Delta K = K_f - K_i$

$U_g = mgy$ (gravitational potential energy)

$U_s = 1/2kx^2$

$E = K + U_s + U_g$ (total mechanical energy)

$W_{other} = K_f + U_{gf} + U_{sf} - K_i - U_{gi} - U_{si} = E_f - E_i$

$K_f + U_{gf} + U_{sf} = K_i + U_{gi} + U_{si}$

Momentum

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

$$\Delta\vec{p} = \int \vec{F}_{\substack{net \\ external}} dt = \vec{F}_{average}\Delta t$$

$$\vec{p}_{initial} = \vec{p}_{final}$$

$$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$$

Two body collision in one dimension (could be generalized for multi body)

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$\frac{1}{2}m_1 v_{1i}^2 + \frac{1}{2}m_2 v_{2i}^2 = \frac{1}{2}m_1 v_{1f}^2 + \frac{1}{2}m_2 v_{1f}^2$$

$$v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$$

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

Angular Motion

$$\omega = \frac{d\theta}{dt}$$

$$\alpha = \frac{d\omega}{dt}$$

$$\omega_f = \omega_i + \alpha t$$

$$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$$

$$\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$$

$$\theta_f = \theta_i + \frac{1}{2}(\omega_f + \omega_i)t$$

$$s = r\theta$$

$$v_t = r\omega$$

$$a_t = r\alpha$$

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

$$K_R = \frac{1}{2}I\omega^2$$

$$|\vec{\tau}| = |\vec{r} \times \vec{F}| = rF\sin\theta$$

$$\sum \tau = I\alpha$$

$$|\vec{L}| = |\vec{r} \times \vec{p}| = mvr\sin\theta$$

$$\sum \vec{\tau}_{ext} = \frac{d\vec{L}_{total}}{dt}$$

$$\vec{L}_{totali} = \vec{L}_{totalf}$$