Constant $a = a_c$

$$\begin{aligned} v &= v_0 + a_c t \\ s &= s_0 + v_0 t + \frac{1}{2} a_c t^2 \\ v^2 &= v_0^2 + 2a_c(s - s_0) \end{aligned}$$

General Expressions (variable α)

$$\begin{aligned} \alpha &= \frac{d\omega}{dt} \\ \omega &= \frac{d\theta}{dt} \\ \omega d\omega &= \alpha d\theta \end{aligned}$$

Constant $\alpha = \alpha_c$

$$\begin{aligned} \omega &= \omega_0 + \alpha_c t \\ \theta &= \theta_0 + \omega_0 t + \frac{1}{2} \alpha_c t^2 \\ \omega^2 &= \omega_0^2 + 2\alpha_c(\theta - \theta_0) \end{aligned}$$

Relative Motion

$$\begin{aligned} \vec{v}_A &= \vec{v}_B + \vec{v}_{A/B} \\ \vec{a}_A &= \vec{a}_B + \vec{a}_{A/B} \end{aligned}$$

General Plane Motion

$$\begin{aligned} \vec{v}_B &= \vec{v}_A + \vec{\omega} \times \vec{r}_{B/A} \\ \vec{a}_B &= \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A} + \vec{\omega} \times (\vec{\omega} \times \vec{r}_{B/A}) \\ \vec{a}_B &= \vec{a}_A + \vec{\alpha} \times \vec{r}_{B/A} - \omega^2 \vec{r}_{B/A} \end{aligned}$$

Equations of Motion

$$\begin{aligned} \sum \vec{F} &= m\vec{a}_G \\ \sum \vec{M}_G &= I_G \vec{\alpha} \\ \sum \vec{M}_p &= \sum (\vec{\mathcal{M}}_k)_p \end{aligned}$$

Mass Moments of Inertia

$$\begin{aligned} I_G &= \frac{1}{12} m l^2 \text{ (slender rod)} \\ I_z &= \frac{1}{2} m r^2 \text{ (uniform disk)} \\ I_z &= m r^2 \text{ (thin ring)} \\ I_o &= I_G + m d^2 \\ k_G &= \sqrt{\frac{I_G}{m}} \end{aligned}$$

Principle of Work and Energy

$$\begin{aligned} U_{1\to 2} &= T_2 - T_1 \\ T &= \frac{1}{2} m v_G^2 + \frac{1}{2} I_G \omega^2 \\ T_1 + V_1 + (U_{1\to 2})_{noncons.} &= T_2 + V_2 \end{aligned}$$

Principle of Impulse and Momentum

$$\begin{aligned} \sum \int_{t_1}^{t_2} \vec{F} dt &= \vec{p_2} - \vec{p_1} \\ \vec{p} &= m\vec{v} \\ \sum \int_{t_1}^{t_2} \vec{M}_G dt &= \vec{H}_{G_2} - \vec{H}_{G_1} \\ \vec{H}_G &= I_G \vec{\omega} \end{aligned}$$

Rotation About Fixed Axis o

$$\begin{aligned} \sum \int_{t_1}^{t_2} \vec{M}_o dt &= \vec{H}_{o_2} - \vec{H}_{o_1} \\ \vec{H}_o &= I_o \vec{\omega} \end{aligned}$$