Equations

Kinematics – Uniform Acceleration

$$\Delta x = v_0 t + \frac{1}{2}at^2 \qquad \Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$v = v_0 + at \qquad \omega = \omega_0 + \alpha t$$

$$v^2 = v_0^2 + 2a\Delta x \qquad \omega^2 = \omega^2 + 2\alpha\Delta\theta$$

Newton's 2nd Law

$$\sum \vec{F} = m\vec{a} \qquad \sum \vec{\tau} = I\vec{\alpha}$$

Friction

$$f_s \leq \mu_s n \qquad f_k = \mu_k n$$

Torque

$$\tau = rF\sin\theta$$

Static Equilibrium

$$\sum \vec{F} = 0 \qquad \sum \vec{\tau} = 0$$

Work and Energy

$$W = F\Delta s\cos\theta$$

$$KE_{trans} = \frac{1}{2}mv^2 \quad KE_{rot} = \frac{1}{2}I\omega^2$$

$$PE_{grav} = mgy \quad PE_{elas} = \frac{1}{2}kx^2$$

$$E = PE + KE$$

$$W_{nc} = \Delta E$$

Power

$$\bar{P} = \frac{\Delta E}{\Delta t} = \frac{\Delta W}{\Delta t} = F\bar{v}$$

Universal Gravitation

$$F = G\frac{m_1 m_2}{r^2} \qquad PE_{grav} = -G\frac{m_1 m_2}{r}$$

Circular Motion

$$\omega \equiv \frac{\Delta\theta}{\Delta t} \qquad \alpha \equiv \frac{\Delta\omega}{\Delta t}$$

$$s = r\theta \qquad v_t = r\omega \qquad a_t = r\alpha$$

$$a_r = \frac{v^2}{r} = r\omega^2$$

Impulse and Momentum

$$\text{Impulse} \equiv \vec{F}\Delta t$$

$$\vec{p} = m\vec{v} \qquad \vec{L} = I\vec{\omega}$$

$$\vec{F}\Delta t = \Delta\vec{p} \qquad \vec{\tau}\Delta t = \Delta\vec{L}$$

Conservation of Momentum

$$\sum \vec{p}_i = \sum \vec{p}_f \qquad \sum \vec{L}_i = \sum \vec{L}_f$$

Collisions

$$\sum \vec{p}_i = \sum \vec{p}_f \qquad \sum \vec{L}_i = \sum \vec{L}_f$$

$$\underbrace{KE_i = KE_f}_{\text{elastic}} \qquad \underbrace{KE_i \neq KE_f}_{\text{inelastic}}$$

Moment of Inertia

$$\text{Discrete Masses: } I = \sum mr^2$$

$$\text{Solid Sphere through CM: } I_{CM} = \frac{2}{5}MR^2$$

$$\text{Solid Cylinder through CM: } I_{CM} = \frac{1}{2}MR^2$$

$$\text{Hollow Cylinder through CM: } I_{CM} = MR^2$$

$$\text{Thin Rod through CM: } I_{CM} = \frac{1}{12}MR^2$$

$$\text{Thin Rod through end: } I = \frac{1}{3}MR^2$$

Constants

$$g = G\frac{M_E}{R_E^2} = 9.8\ \text{m/s}^2$$

$$M_E = 5.98 \times 10^{24}\ \text{kg}$$

$$R_E = 6.38 \times 10^{6}\ \text{m}$$

$$G = 6.67 \times 10^{-11}\ \text{N}\cdot\text{m}^2/\text{kg}^2$$