FORMULA SHEET

- Constants:

$$g = 9.8\text{m/s}^2$$

- Vectors:

$$\begin{aligned}\vec{A}\cdot\vec{B} &= AB\cos\theta \\ &= A_xB_x + A_yB_y + A_zB_z\end{aligned}$$

$$\left|\vec{A}\times\vec{B}\right| = AB\sin\theta$$

- Kinematics:

$$\Delta x = v_0t + \frac{1}{2}at^2$$

$$v = v_0 + at$$

$$v^2 = v_0^2 + 2a\Delta x$$

- Forces:

$$\sum \vec{F} = m\vec{a}$$

$$W = mg$$

$$f_{s,max} = \mu_s N$$

$$f_k = \mu_k N$$

- Work & Energy:

$$W = \vec{F}\cdot\Delta\vec{x} \quad \text{or} \quad W = \int \vec{F}\cdot d\vec{x}$$

$$W_{tot} = \Delta K$$

$$W_{cons} = -\Delta U$$

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

$$U_g = mgy$$

$$K_i + U_i + W_{nc} = K_f + U_f$$

$$\vec{F} = -\vec{\nabla}U$$

$$\vec{\nabla}f = \frac{\partial f}{\partial x}\hat{i} + \frac{\partial f}{\partial y}\hat{j} + \frac{\partial f}{\partial z}\hat{k}$$

- Momentum & Collisions:

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

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

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$\vec{v}_{1i} - \vec{v}_{2i} = \vec{v}_{2f} - \vec{v}_{1f}$$

- Rotational Mechanics

$$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

$$s = r\theta$$

$$v = r\omega$$

$$a = r\alpha$$

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

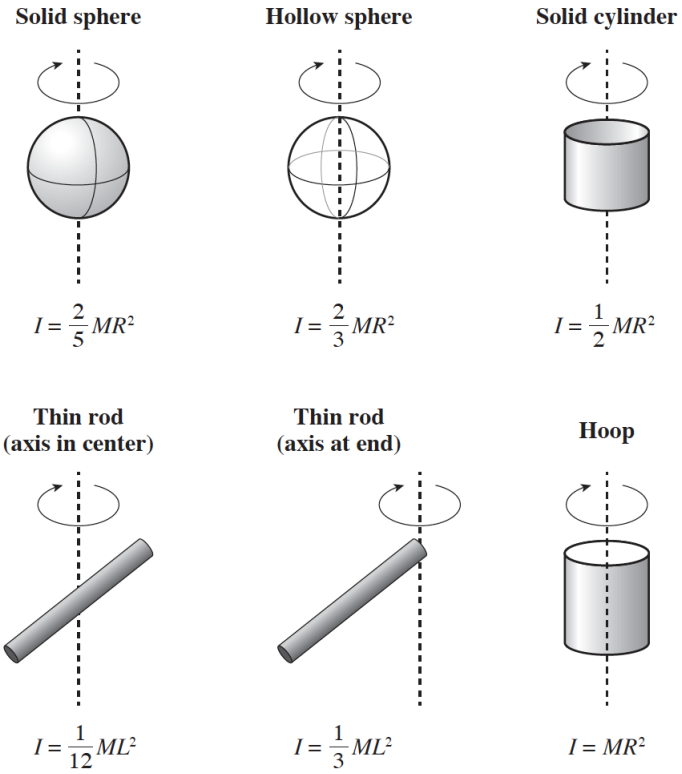
$$\sum \tau = I\alpha \quad \text{or} \quad \sum \tau = \frac{dL}{dt}$$

$$K_{rot} = \frac{1}{2}I\omega^2$$

$$L = I\omega \quad \text{or} \quad L = rp$$

$$I = \int r^2 dm$$

$$I_{new} = I_{cm} + md^2$$



- Gravity:

$$G = 6.67 \times 10^{-11} \ \frac{\mathrm{N}m^2}{\mathrm{kg}^2}$$

$$F_G = G\frac{mM}{r^2}$$

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

$$v_{esc} = \sqrt{\frac{2GM}{R}}$$

$$v_{orb} = r\omega_{orb} = \frac{2\pi r}{T_{orb}}$$

- Oscillations:

$$F_{sp} = kx$$

$$U_{sp} = \frac{1}{2}kx^2$$

$$\omega_{sp} = \sqrt{\frac{k}{m}}$$

$$\omega_{pend} = \sqrt{\frac{g}{l}}$$

$$f = 1/T$$

$$\omega = 2\pi f$$

- Waves:

$$v = \lambda f$$

$$f_{beat} = |f_1 - f_2|$$

- Heat, Ideal Gases, and Thermodynamics:

$$PV = Nk_BT$$

$$k_B = 1.38 \times 10^{-23} \text{ J/K}$$

$$Q = mc\Delta T$$

$$c_{vapor} = 1996 \text{ J/kg K}$$

$$c_{water} = 4186 \text{ J/kg K}$$

$$c_{ice} = 2108 \text{ J/kg K}$$

$$C = mc = \frac{\partial U}{\partial T}$$

$$U = \frac{f}{2}Nk_BT$$

$$W = -P\Delta V \quad \text{or} \quad W = -\int PdV$$

$$\Delta U = W + Q$$