

Physics 7A Midterm 2 Equation Sheet

$$\Delta x = x_2 - x_1$$
$$v_x = \lim_{\Delta t \rightarrow 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

$$a_x = \lim_{\Delta t \rightarrow 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt}$$

$$v_{fx} = v_{ix} + a_x \Delta t$$

$$\Delta x = \frac{1}{2}(v_{ix} + v_{fx})\Delta t$$

$$\Delta x = v_{ix}\Delta t + \frac{1}{2}a_x\Delta t^2$$

$$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x$$

Projectile Motion Equations

$$v_{ix} = v_i \cos \theta_i$$

$$v_{iy} = v_i \sin \theta_i$$

$$\frac{v_y}{v_x} = \tan \theta$$

$$\Delta x = v_{ix}\Delta t$$

$$v_{fy} = v_{iy} - g\Delta t$$

$$\Delta y = \frac{1}{2}(v_{iy} + v_{fy})\Delta t$$

$$\Delta y = v_{iy}\Delta t - \frac{1}{2}g\Delta t^2$$

$$v_{fy}^2 = v_{iy}^2 - 2g\Delta y$$

Range formula:

$$\Delta x = \frac{v_i^2 \sin 2\theta}{g}$$

Newton's 1st Law

$$\vec{v} = \text{constant} \Rightarrow \sum \vec{F} = \vec{0}$$

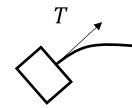
Newton's 2nd Law

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

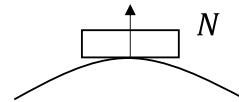
Newton's 3rd Law

$$\vec{F}_{A \text{ on } B} = -\vec{F}_{B \text{ on } A}$$

Tension:



Normal Force



Gravity

$$\vec{F}_g = m\vec{g}$$

Static Friction

$$f_s \leq \mu_s N$$

Kinetic Friction

$$f_k = \mu_k N$$

Spring Force

$$F_{spx} = -kx \text{ (x measured from relaxed position)}$$

Uniform Circular Motion

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

$$v = \frac{2\pi r}{T}$$

Work and Energy

$$W = \int_A^B \vec{F} \cdot d\vec{r}$$

$$W = Fd \cos\theta \text{ (constant angle and magnitude)}$$

$$W_g = -mg\Delta y \text{ (height axis pointing upward)}$$

$$W_{sp} = -\frac{k}{2}(x_f^2 - x_i^2) \text{ (x measured from relaxed position)}$$

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

$$W_{net} = \sum W_i = \Delta K$$

$$U + K = E_{mech}$$

$$\Delta E_{mech} = W_{NC}$$

$$U_g = mgy \text{ (height axis pointing upward)}$$

$$U_{sp} = \frac{1}{2}kx^2 \text{ (x measured from relaxed position)}$$

Universal Gravitation

$$F_g = \frac{GMm}{r^2}$$

$$U_G = -\frac{GMm}{r}$$

$$v_{orb} = \sqrt{\frac{GM}{r}}; v_{esc} = \sqrt{\frac{2GM}{r}}$$

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

Linear Momentum

$$\vec{p} = m\vec{v}; \vec{P} = \sum_i \vec{p}_i$$

$$\sum \vec{F}_{ext} = \frac{d\vec{P}}{dt}$$

$$\sum \vec{F}_{ext} = 0 \Rightarrow \Delta \vec{P} = 0$$

Reversal of relative velocity (elastic collisions)

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

$$\text{Center of mass: } \vec{r}_{cm} = \frac{1}{M} \sum_i m_i \vec{r}_i$$

Rotational Kinematics

$$\theta(t) = \text{angular position}$$

$$\Delta\theta = \theta_2 - \theta_1$$

$$\omega = \lim_{\Delta t \rightarrow 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$$

$$\alpha = \lim_{\Delta t \rightarrow 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$$

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

$$\Delta\theta = \frac{1}{2}(\omega_i + \omega_f)\Delta t$$

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

$$\omega_f^2 = \omega_i^2 + 2\alpha \Delta\theta$$

$$s = r\theta \text{ (arc length)}$$

$$v = r\omega$$

$$a_{tan} = r\alpha$$

$$a_{rad} = \frac{v^2}{r} = r\omega^2$$

Rotational Dynamics

$$I_{\square} = \sum_{i=1}^n m_i r_i^2 \text{ (point masses)}$$

$$I = I_{CM} + MD^2 \text{ (parallel axis theorem)}$$

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

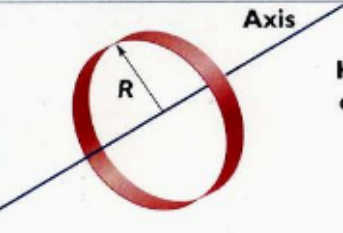
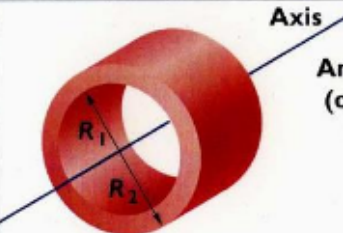
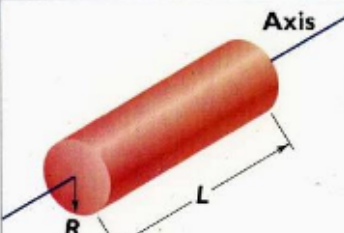
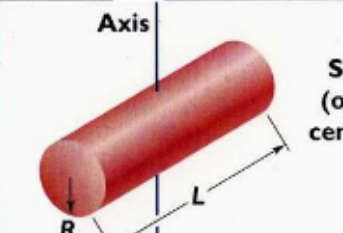
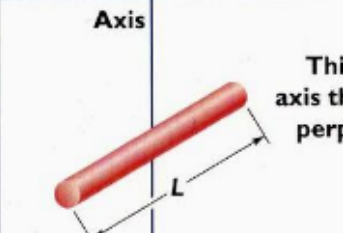
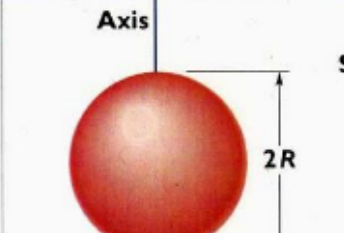
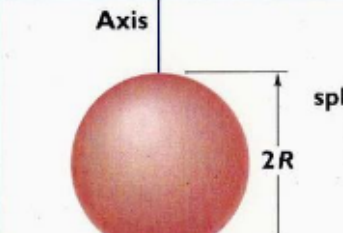
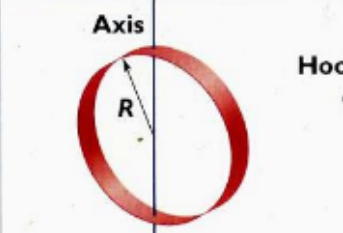
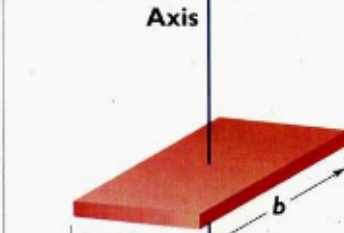
$$\sum \tau_{ext} = I\alpha$$

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

Rolling without slipping: $v = R\omega$

$$K = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

Table of rotational inertias

 <p>Hoop about central axis</p> <p>$I = MR^2$</p> <p>(a)</p>	 <p>Annular cylinder (or ring) about central axis</p> <p>$I = \frac{1}{2}M(R_1^2 + R_2^2)$</p> <p>(b)</p>	 <p>Solid cylinder (or disk) about central axis</p> <p>$I = \frac{1}{2}MR^2$</p> <p>(c)</p>
 <p>Solid cylinder (or disk) about central diameter</p> <p>$I = \frac{1}{4}MR^2 + \frac{1}{12}ML^2$</p> <p>(d)</p>	 <p>Thin rod about axis through center perpendicular to length</p> <p>$I = \frac{1}{12}ML^2$</p> <p>(e)</p>	 <p>Solid sphere about any diameter</p> <p>$I = \frac{2}{5}MR^2$</p> <p>(f)</p>
 <p>Thin spherical shell about any diameter</p> <p>$I = \frac{2}{3}MR^2$</p> <p>(g)</p>	 <p>Hoop about any diameter</p> <p>$I = \frac{1}{2}MR^2$</p> <p>(h)</p>	 <p>Slab about perpendicular axis through center</p> <p>$I = \frac{1}{12}M(a^2 + b^2)$</p> <p>(i)</p>