Physics 7A Midterm 2 Equation Sheet

$$\Delta x = x_2 - x_1$$

$$v_x = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$$

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

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

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

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

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

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

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

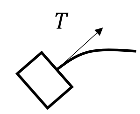
Newton's 2nd Law

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

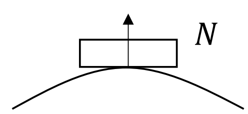
Newton's 3rd Law

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

Tension:



Normal Force



Gravity

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

Static Friction

$$f_S \le \mu_S N$$

Kinetic Friction

$$f_K = \mu_K N$$

Spring Force

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

Uniform Circular Motion

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

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

Work and Energy

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

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

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

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

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

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

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

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

$U_g = mgy$ (height axis pointing upward)

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

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

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

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

Reversal of relative velocity (elastic collisions)

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

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

Rotational Kinematics

$\theta(t) = angular\ position$

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

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

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

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

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

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

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

$s = r\theta$ *(arc length)*

$$v = r\omega$$

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

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

Rotational Dynamics

$I = \sum_{i=1}^{n} m_i r_i^2$ *(point masses)*

$I = I_{CM} + MD^2$ *(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