PHYS-101 Formula Sheet for the Second Major Exam

$r = r_0 + v_o t + \frac{1}{2} a t^2$

$v = v_o + at$

$v^2 = v_0^2 + 2a(x - x_0)$

$x - x_o = \frac{(v_o + v)t}{2}$

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

$f_k = \mu_k N$

$f_s \le \mu_s N$

$W = \int \vec{F} . d\vec{s}$

$W = \vec{F} . \vec{s}$ if $\vec{F} = \text{Constant}$

$\vec{A} . \vec{B} = A\,B \cos\theta$

$|\vec{A} \times \vec{B}| = A\,B \sin\theta$

$W_{net} = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$P = \frac{dW}{dt} = \vec{F} . \vec{v}$

$U_s = \frac{1}{2} kx^2$, $F_s = -kx$

$U_g = mgy$

$E_{mech} = K + U$

$\Delta U = -W$ for a conservative force

$\Delta K + \Delta U + \Delta E_{th} = W_{ext}$

where $\Delta E_{th} = f_k d$

$\left\{ \vec{J} = \int \vec{F}\, dt = \vec{F}_{avg} \Delta t \right\} = \Delta \vec{p}$

$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$

$\sum \vec{F}_{ext} = M \vec{a}_{cm}$

$\vec{r}_{com} = \frac{1}{M} \sum_{i=1}^{n} m_i \vec{r}_i = \frac{1}{M} \int \vec{r}\, dm$

$v_{com} = \frac{1}{M} \sum_{i=1}^{n} m_i \vec{v}_i = \frac{1}{M} \sum_{i=1}^{n} \vec{p}_i = \frac{\vec{P}}{M}$

$\omega = \frac{d\theta}{dt}; \quad \alpha = \frac{d\omega}{dt}$

$s = r\,\theta$, $v = r\,\omega$

$a_t = r\alpha; \quad a_r = \frac{v^2}{r} = r\omega^2$

$\vec{a} = \vec{a}_t + \vec{a}_r$

If α = constant,

$\omega = \omega_o + \alpha t$

$\theta = \theta_o + \omega_o t + \frac{1}{2} \alpha t^2$

$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

$I = \sum_i m_i r_i^2 = \int r^2\, dm$

$I_p = I_{com} + Mh^2$

$\vec{\tau} = \vec{r} \times \vec{F}$

$\tau = rF \sin\theta = r_\perp F = rF_t$

$W = \int \tau\, d\theta$

$= \tau \Delta\theta$ if τ is constant

$\vec{l} = \vec{r} \times \vec{p} = m\vec{r} \times \vec{v}$

$l = m r_\perp v = m r v_\perp$

For a solid rotating about a fixed axis,

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

$\Delta K = \frac{1}{2} I(\omega_f^2 - \omega_i^2) = W$

$P = \frac{dW}{dt} = \tau\,\omega$

$\vec{\tau} = \frac{d\vec{l}}{dt}$

$\sum \vec{\tau}_{ext} = \frac{d\vec{L}}{dt} = I\vec{\alpha}$

$g = 9.80\ m/s^2$

I_{com}(cylinder) = $(1/2)MR^2$

I_{com}(solid sphere) = $(2/5)MR^2$

I_{com}(thin rod) = $(1/12)ML^2$

I_{com}(hoop) = MR^2