PHYS-101 Formula Sheet for the Final Exam

$v = \frac{dx}{dt}$ $\quad a = \frac{dv}{dt}$

$v_{avg} = \frac{\Delta x}{\Delta t}$ $\quad a_{avg} = \frac{\Delta v}{\Delta t}$

For constant acceleration a:

$v = v_0 + at$

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

$x - x_0 = v_0 t + \frac{1}{2}at^2$

$x - x_0 = \frac{1}{2}(v + v_0)t$

$x - x_0 = vt - \frac{1}{2}at^2$

$\vec{r} = x\hat{\imath} + y\hat{\jmath}$ $\quad \vec{v} = \vec{v}_0 + \vec{a}t$

$\vec{r} - \vec{r}_0 = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$

$a_r = \frac{v^2}{r}$ $\quad a_t = \frac{d|\vec{v}|}{dt}$

$\vec{a} = \vec{a}_t + \vec{a}_r$ $\quad \vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}$

$H = \frac{v_0^2 \sin^2\theta}{2g}$ $\quad R = \frac{v_0^2 \sin 2\theta_0}{g}$

$y = (\tan\theta_0)x - \frac{gx^2}{2(v_0\cos\theta_0)^2}$

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

$f_k = \mu_k N$ $\quad f_s \le \mu_s N$

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

if $\vec{F}$ *is a constant* $W = \vec{F}.\vec{s}$

$P = \vec{F}.\vec{v}$ $\quad P_{avg} = \frac{W}{\Delta t}$

$W_{net} = \Delta K = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$

$W_c = -\Delta U$

$\Delta U_s = \frac{1}{2}kx_f^2 - \frac{1}{2}kx_i^2$

$F_s = -kx$

$\Delta U_g = mg(y_f - y_i)$

$W = \Delta K + \Delta U + \Delta E_{th}$

$\Delta E_{th} = f_k d$

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

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

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

$\vec{R}_{com} = \frac{\sum m_i \vec{r}_i}{m_i} = \frac{1}{M}\int \vec{r}\, dn$

$\vec{v}_{com} = \frac{\sum m_i \vec{v}_i}{\sum m_i}$

$\vec{P}_{com} = \sum m_i \vec{v}_i$

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

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

$a_t = r\alpha$ $\quad a_r = r\omega^2$

If $\alpha = constant$:

$\omega = \omega_0 + \alpha t$

$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$

$\theta - \theta_0 = \frac{\omega + \omega_0}{2}t$

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

$I = \sum m_i {r_i}^2 = \int r^2\, dm$

$I = I_{com} + Md^2$

For cylinder $I_{com} = \frac{1}{2}MR^2$

For disk $I_{com} = \frac{1}{2}MR^2$

For thin rod $I_{com} = \frac{1}{12}ML^2$

For sphere $I_{com} = \frac{2}{5}MR^2$

For thin loop $I_{com} = MR^2$

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

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

$\vec{A}\cdot\vec{B} = A_x B_x + A_y B_y + A_z B_z$

$\vec{A}\cdot\vec{B} = AB\cos\theta$

$W = \int \tau d\theta$

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

For a solid rotating about a fixed axis:

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

$\vec{L} = \vec{r} \times \vec{p} = m(\vec{r} \times \vec{v})$

$L_z = I_\omega$

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

$a_{com,x} = -\frac{g\sin\theta}{1 + I_{com}/MR^2}$

$\sum \tau_{ext} = \frac{dL}{dt} = I\alpha$

For static equilibrium:

$\sum \vec{F} = 0$ *and* $\sum \vec{\tau} = 0$

$E = \frac{F/A}{\Delta L/L_0}$ $\quad G = \frac{F/A}{\Delta x/L}$

$B = \frac{p}{|\Delta V|/V}$

$F = \frac{Gm_1m_2}{r^2}$ $\quad U = -\frac{Gm_1m_2}{r}$

Energy in Planetary Motion:

$E = -\frac{GMm}{2r}$

$v_{esc} = \sqrt{\frac{2GM}{R}}$ $\quad T^2 = \frac{4\pi^2}{GM}r^3$

$\rho = \frac{m}{V}$ $\quad p = \frac{F}{A}$

$p = p_0 + \rho g h$

$F_b = m_f g = \rho_f V_f\, g$

$A_1 v_1 = A_2 v_2 = constant$

$p + \frac{1}{2}\rho v^2 + \rho g y = constant$

$x = x_m\cos(\omega t + \phi)$

$k = m\omega^2$

$T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$

$E = K + U = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kx_m^2$

$T = 2\pi\sqrt{\frac{L}{g}}$ $\quad T = 2\pi\sqrt{\frac{I}{mgh}}$

$G = 6.67 \times 10^{-11}\, Nm^2/kg^2$

$1\, Pa = 1N/m^2$

$p_{atm} = 1.01 \times 10^5 Pa = 1\, atm$

$\rho_{water} = 1000\frac{kg}{m^3}$

$g = 9.80\, m/s^2$

For Earth:

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

$R_E = 6.37 \times 10^6 m$