# 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:*

$$v = v_0 + \mathrm{at}$$
$$v^2 = {v_0}^2 + 2a(x - x_0)$$
$$\mathrm{x} - \mathrm{x}_0 = v_0\mathrm{t} + \frac{1}{2}at^2$$
$$\mathrm{x} - \mathrm{x}_0 = \frac{1}{2}(v + v_0)\mathrm{t}$$
$$\mathrm{x} - \mathrm{x}_0 = v\mathrm{t} - \frac{1}{2}at^2$$

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

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

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

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

$H = \frac{v_0^2 sin^2\theta}{2g}$ $\quad R = \frac{v_0^2 sin2\theta_0}{g}$

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

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

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

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

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

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

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

$$W_c = -\Delta U$$
$$\Delta U_s = \frac{1}{2}kx_f^2 - \frac{1}{2}kx_i^2$$
$$F_s = -kx$$
$$\Delta U_g = mg(y_f - y_i)$$
$$W = \Delta K + \Delta U + \Delta E_{th}$$
$$\Delta E_{th} = f_k d$$

$$\vec{p} = m\vec{v}$$
$$\vec{J} = \Delta\vec{p} = \int \vec{F}\ dt = \vec{F}_{avg}\ \Delta t$$
$$\vec{p}_{1i} + \vec{p}_{2i} = \vec{p}_{1f} + \vec{p}_{2f}$$
$$\vec{R}_{com} = \frac{\sum m_i\vec{r}_i}{m_i} = \frac{1}{M}\int \vec{r}\,dn$$
$$\vec{v}_{com} = \frac{\sum m_i\,\vec{v}_i}{\sum m_i}$$
$$\vec{P}_{com} = \sum m_i\,\vec{v}_i$$

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

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

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

$If\ \alpha = constant:$

$$\omega = \omega_0 + \alpha t$$
$$\theta - \theta_0 = \omega_0 t + \tfrac{1}{2}\alpha t^2$$
$$\theta - \theta_0 = \frac{\omega + \omega_0}{2}\,t$$
$$\omega^2 = {\omega_0}^2 + 2\alpha(\theta - \theta_0)$$

$$I = \sum m_i {r_i}^2 = \int r^2\,dm$$
$$I = I_{com} + Md^2$$

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

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

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

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

$For\ hoop\ I_{com} = \ MR^2$

$$\vec{\tau} = \vec{r} \times \vec{F}$$
$$|\vec{A} \times \vec{B}| = ABsin\theta$$
$$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$$
$$\vec{A}\cdot\vec{B} = ABcos\theta$$
$$W = \int \tau d\theta$$
$$P = \frac{dW}{dt} = \tau\omega$$

*For a solid rotating about a fixed axis:*

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

$$\vec{L} = \vec{r} \times \vec{p} = m(\vec{r} \times \vec{v})$$
$$L_z = I_\omega$$
$$\vec{\tau} = \frac{d\vec{L}}{dt}$$
$$a_{com,x} = -\frac{gsin\theta}{1 + I_{com}/MR^2}$$
$$\sum \tau_{ext} = \frac{dL}{dt} = I\alpha$$

*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:

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

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

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

$$p = p_0 + \rho gh$$
$$F_b = m_f g = \rho_f V_f\,g$$
$$A_1v_1 = A_2v_2 = constant$$
$$p + \frac{1}{2}\rho v^2 + \rho gy = constant$$

$$x = x_m cos(\omega t + \phi)$$
$$k = m\omega^2$$
$$T = \frac{1}{f} = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{m}{k}}$$
$$E = K + U = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kx_m^2$$

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

$$G = 6.67 \times 10^{-11}\ Nm^2/kg^2$$
$$1\ Pa = 1N/m^2$$
$$p_{atm} = 1.01 \times 10^5 Pa = 1\ atm$$
$$\rho_{water} = 1000\frac{kg}{m^3}$$
$$g = 9.80\ m/s^2$$

$For\ Earth:$

$$M_E = 5.98 \times 10^{24}\ kg$$
$$R_E = 6.37 \times 10^6 m$$