# Physics 101 Unified Formula Sheet

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

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

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

$$\vec{A}\cdot\vec{B} = ABcos\theta$$

$$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$$

$$\left|\vec{A}\times\vec{B}\right| = ABsin\theta$$

$$\vec{r} = x\hat{\imath} + y\hat{\jmath} + z\,\hat{k} \qquad \vec{v} = \vec{v}_0 + \vec{a}t$$

$$\vec{r} - \vec{r}_0 = \vec{v}_0t + \frac{1}{2}\vec{a}t^2$$

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

$$y = x\,tan\theta_0 - \frac{gx^2}{2(v_0cos\theta_0)^2}$$

$$a_r = \frac{v^2}{r} \qquad \mathrm{T} = \frac{2\pi r}{v}$$

$$\vec{v}_{PA} = \vec{v}_{PB} + \vec{v}_{BA}$$

$$\vec{\mathrm{F}}_{\mathrm{net}} = m\vec{a}$$

$$f_k = \mu_k F_N \qquad f_s \le \mu_s F_N$$

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

$$If\ \vec{F}\ is\ constant: W = \vec{F}.\vec{s}$$

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

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

$$F_s = -kx$$

$$W = -\Delta U$$

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

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

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

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

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

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

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

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

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

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2}v_{1i} + \frac{2m_2}{m_1 + m_2}v_{2i}$$

$$v_{2f} = \frac{2m_1}{m_1 + m_2}v_{1i} + \frac{m_2 - m_1}{m_1 + m_2}v_{2i}$$

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

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

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

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

$$a = \sqrt{{a_r}^2 + {a_t}^2}$$

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

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

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

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

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

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

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

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

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

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

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

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

$$a_{com,x} = -\frac{gsin\theta}{1 + (I_{com}/MR^2)}$$

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

$$L_z = I\omega$$

$$\vec{L}_i = \vec{L}_f$$

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

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

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

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

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

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

$$E = K + U = -\frac{GMm}{2r}$$

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

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

$$p = p_0 + \rho gh$$

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

$$A_1v_1 = A_2v_2 = constant$$

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

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

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

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

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

## Constants

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

$$G = 6.67\times10^{-11}\ Nm^2/kg^2$$

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

$$p_{atm} = 1.01\times10^5 Pa = 1\ atm$$

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

$For\ Earth$:

$$M_E = 5.98\times10^{24}\ kg$$
$$R_E = 6.37\times10^6 m$$