10^9 *giga* – G 10^6 *mega* – M 10^3 *kilo* – k 10^2 *hecto* – h 10^1 *deka* – da	10^{-2} *centi* – c 10^{-3} *milli* – m 10^{-6} *micro* – μ 10^{-9} *nano* – n 10^{-12} *pico* – p	$1\,N = 1\,kg \cdot m/s^2$ $1\,J = 1\,kg \cdot \frac{m}{s^2} m = 1\,N \cdot m$ $1\,watt = 1\,W = 1\,J/s$ $1\,g = 9.8\frac{m}{s^2}$ (*g unit*)	A=cB → ΔA=|c|ΔB, A=B^n→ ΔA=A|n| ΔB/B, C=A+-B→ ΔC=√(ΔA^2+ΔB^2), C=A*/B→ ΔC=|C|√((ΔA/A)^2+(ΔB/B)^2)

$\Delta\vec{x} = \vec{x_2} - \vec{x_1}$

$\vec{v}_{avg} = \frac{\Delta\vec{x}}{\Delta t} = \frac{\vec{x_2} - \vec{x_1}}{t_2 - t_1}$

$\vec{v}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$

$\vec{a}_{avg} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v_2} - \vec{v_1}}{t_2 - t_1}$

$\vec{a}_{ins} = \frac{dv}{dt} = \frac{d}{dt}\left(\frac{dx}{dt}\right) = \frac{d^2x}{dt^2}$

$ax^2 + bx + c = 0$

$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$v = v_0 + at$

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

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

$v_0 = v_{0x} i + v_{0y} j$

$v_{0x} = v_0 \cos\theta_0$

$v_{0y} = v_0 \sin\theta_0$

$x - x_0 = v_{0x} t$

$x - x_0 = \frac{v_0^2}{g} \sin 2\theta_0$

$y - y_0 = v_{0y} t - \frac{1}{2} g t^2$

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

$v_y^2 = (v_0 \sin\theta_0)^2 - 2g(y - y_0)$

$v_y = v_0 \sin\theta_0 - gt$

$\Delta\vec{r} = \vec{r_2} - \vec{r_1},$

$\vec{v}_{avg} = \frac{\Delta\vec{r}}{\Delta t} = \frac{\vec{r_2} - \vec{r_1}}{t_2 - t_1}$

$\vec{v}_{ins} = \lim_{\Delta t \to 0} \frac{\Delta r}{\Delta t} = \frac{dr}{dt}$

$\vec{a}_{ins} = \frac{dv}{dt} = \frac{d}{dt}\left(\frac{dr}{dt}\right) = \frac{d^2r}{dt^2}$

$\vec{s} = \vec{a} + \vec{b}$

(*commutative law*)

$\vec{a} + \vec{b} = \vec{b} + \vec{a}$

(*associative law*)

$(\vec{a} + \vec{b}) + \vec{c} = \vec{a} + (\vec{b} + \vec{c})$

vector substraction

$\vec{d} = \vec{a} - \vec{b} = \vec{a} + (-\vec{b})$

$\vec{a} = a_x i + a_y j$

$\vec{b} = a_x i + a_y j$

$a_x = a\cos\theta$

$a_y = a\sin\theta$

$a = \sqrt{a_x^2 + a_y^2}$

$\tan\theta = \frac{a_y}{a_x}$

$\vec{a} \cdot \vec{b} = ab\,\cos\phi$

$\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$

$\vec{a} \times \vec{b} = ab\,\sin\phi$

$\vec{a} \times \vec{b} = (a_y b_z - b_y a_z)i + (a_z b_x - b_z a_x)j + (a_x b_y - b_x a_y)k$

$F_{net,x} = ma_x,\ F_{net,y} = ma_y, F_{net,z} = ma_z$

$W = F_g = mg,\quad f_{s,max} = \mu_s F_N,\quad f_k = \mu_k F_N,$

weight W, normal force F_N*, frictional force f*

~~$D = \frac{1}{2} C\rho A v^2,\quad v_t = \sqrt{\frac{2F_g}{C\rho A}}$~~

$\vec{F}_s = -k\vec{d}, F_x = -kx$

$W = \vec{f}\vec{d}$

$W = \sum \Delta w_j = \sum F_{j,avg}\Delta x$

$W = \int_{xi}^{xf} F(x)dx$

$W = \Delta K = K_f - K_i$

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

$W_g = mgd\,\cos\phi$

$W_s = -\frac{1}{2}k\,x^2$

$\Delta U = -W_s = \frac{1}{2}k\,x^2$

$P_{avg} = \frac{W}{\Delta t}, P = \frac{dW}{dt}$

$P_{avg} = \frac{\Delta E}{\Delta t}, P = \frac{dE}{dt}$

$P = \vec{F} \cdot \vec{v}$

$F(x) = -\frac{dU(x)}{dx}$

$\Delta U = -\int_{xi}^{xf} F(x)dx$

$\Delta U = \frac{1}{2}kx_f^2 - \frac{1}{2}k\,x_i^2$

$\Delta U = -W$

$W_{ab,2} = -W_{ba,2}$

$U(y) = -mgy$

$E_{mec} = K + U$

$\Delta E_{mec} = \Delta K + \Delta U = 0$

$K_2 + U_2 = K_1 + U_1$

$W = \Delta E = \Delta E_{mec} + \Delta E_{th}\ (= 0)$

$W = \Delta E = \Delta E_{mec} + \Delta E_{th} + \Delta E_{int}\ (= 0)$

$\Delta E_{th} = f_k d$

$F = m\frac{v^2}{R}$

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

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

$x_{com} = \frac{1}{M}\sum_{l=1}^{n} m_l x_l$, $x_{com} = \frac{1}{M}\int_i^f x\,dm$

$\rho = \frac{dm}{dV} = \frac{M}{V}$, $\sigma = \frac{dm}{dA} = \frac{M}{A}$, $\lambda = \frac{dm}{dx} = \frac{M}{L}$

$x_{com} = \frac{1}{V}\int x\,dV$, $\vec{r}_{com} = \frac{1}{M}\sum_{l=1}^{n} m_l \vec{r}_l$

$M = \int_i^f \lambda dx$, $M = \int_i^f \sigma dA$, $M = \int_i^f \rho dV$

$\vec{F}_{net} = M\vec{a}_{com}$, $\vec{P} = M\vec{v}_{com}$

$\vec{p} = m\vec{v}$, $\vec{F}_{net} = \frac{dP}{dt}$

$\vec{J} = \int_{ti}^{tf} \vec{F}(t)dt$

$\vec{F}_{avg} = \frac{\vec{J}}{\Delta t}$

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

$\vec{p}_f - \vec{p}_i = \Delta\vec{p} = \vec{J}$

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

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

$K_{1i} + K_{2i} = K_{1f} + K_{2f}$

$V = \frac{m_1}{m_1 + m_2} v_{1i}$

$\vec{v}_{com} = \frac{\vec{P}}{m_1 + m_2} = \frac{\vec{p}_{1i} + \vec{p}_{2i}}{m_1 + m_2}$

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

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

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

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

$\omega_{avg} = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$

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

$\alpha_{avg} = \frac{\omega_2 - \omega_1}{t_2 - t_1} = \frac{\Delta\omega}{\Delta t}$

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

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

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

$\theta = \frac{s}{r}$ $\Delta\theta = \theta_2 - \theta_1$

$1\,rev = 360 = \frac{2\pi r}{r} = 2\pi\,rad$

$v = v_0 + at$

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

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

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

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

$\omega = \omega_0 + \alpha t$

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

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

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

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

$I = \sum m_l r_l^2$, $I = \int r^2 dm$, $I = I_{com} + Mh^2$

$K = \frac{1}{2}I\omega^2$, $K = \frac{1}{2}I_{com}\omega^2 + \frac{1}{2}Mv_{com}^2$

$\Delta K = K_f - K_i = \frac{1}{2}I\omega_f^2 - \frac{1}{2}Iw_i^2 = W$

$\tau_{net} = I\alpha$, $\tau = (r)(F\sin\phi)$.

$v_{com} = \omega R$, $a_{com} = \alpha R$

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

$L = I\omega$, $\vec{L}_i = \vec{L}_f$, $l = rp_\perp = r_\perp mv$

x	θ
$v = dx/dt$	$\omega = d\theta/dt$
$a = dv/dt$	$\alpha = d\omega/dt$
m	I
$F_{net} = ma$	$\tau_{net} = I\alpha$
$W = \int F\,dx$	$W = \int \tau\,d\theta$
$K = 1/2\ mv^2$	$K = 1/2\ I\omega^2$
$P = Fv$	$P = \tau\omega$
$W = \Delta K$	$W = \Delta K$

$W = \int_{\theta i}^{\theta f} \tau\,d\theta$,

$W = \tau(\theta_f - \theta_i)$,

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

$\tau = rF\ \sin\phi = rF_\perp = r_\perp F$,

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

$f_s = -I_{com}\frac{a_{com,x}}{R^2}$

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

$\vec{F}$	$\vec{\tau}(= \vec{r} \times \vec{F})$
$\vec{P}$	$\vec{l}(= \vec{r} \times \vec{p})$
$\vec{P}(= \sum \vec{p}_i)$	$\vec{L}(= \sum \vec{l}_i)$
$\vec{P} = M\vec{v}_{com}$	$\vec{L} = I\omega$
$\vec{P} = a\ cons$	$\vec{L} = a\ cons$
$\vec{F}_{net} = \frac{d\vec{P}}{dt}$	$\vec{\tau}_{net} = \frac{d\vec{L}}{dt}$
	$\frac{dL}{dt} = \sum_{i=1}^{n} \vec{\tau}_{net,l}$

~~$x(t) = x_m \cos(wt + \phi)$~~

~~$v(t) = -\omega x_m \sin(wt + \phi)$~~

~~$a(t) = -\omega^2 x_m \cos(wt + \phi)$~~

~~$F = ma = -(m\omega^2)x$~~

~~$y(x,t) = y_m \sin(kx - \omega t)$~~

~~$T = 2\pi\sqrt{\frac{m}{k}}$ $T = 2\pi\sqrt{\frac{I}{\kappa}}$~~

~~$T = 2\pi\sqrt{\frac{l}{g}}$ $T = 2\pi\sqrt{\frac{I}{mgh}}$~~

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

~~$K(t) = \frac{1}{2}mv^2 = \frac{1}{2}kx_m^2 \sin^2(wt + \phi)$~~

~~$U(t) = \frac{1}{2}kx^2$~~

~~$U(t) = \frac{1}{2}kx_m^2 \cos^2(wt + \phi)$~~

~~$v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda f$, $k = \frac{2\pi}{\lambda}$~~

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