

$$F_g = Gm_1m_2/r^2, \quad G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$$

$$U = -Gm_1m_2/r, \quad g = Gm_E/R_E^2$$

$$T = 2\pi a^{3/2}/\sqrt{Gm}$$

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

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

$$A = \sqrt{x_0^2 + v_0^2/\omega^2}, \quad \phi = \arctan(-v_0/(x_0\omega))$$

$$\omega = \sqrt{g/L} = \sqrt{mgd/I}$$

$$x = Ae^{-(b/2m)t} \cos \omega' t, \quad \omega' = \sqrt{k/m - b^2/4m^2}$$

$$A = F_{max}/\sqrt{(k - m\omega_d^2)^2 + b^2\omega_d^2}$$

$$y(x, t) = A \cos[\omega(x/v - t)] = A \cos(kx - \omega t)$$

$$\lambda = 2\pi/k, \quad v = \omega/k = \lambda f = \sqrt{F/\mu}$$

$$P_{av} = (1/2)\sqrt{\mu F \omega^2} A^2, \quad I_1/I_2 = r_2^2/r_1^2$$

$$y(x, t) = A_{SW} \sin kx \sin \omega t$$

$$f_n = nv/(2L)$$

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

$$\vec{J} = \int \vec{F} dt = \Delta \vec{p}$$

$$\vec{F} = d\vec{p}/dt$$

$$\sum \vec{F}_{ext} = d\vec{P}/dt = M\vec{a}_{CM}$$

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

$$\vec{r}_{CM} = (\sum m_i \vec{r}_i)/(\sum m_i)$$

$$\omega = d\theta/dt, \quad \alpha = d\omega/dt = d^2\theta/dt^2$$

$$\ell = r\theta, \quad v = r\omega, \quad a_{tan} = r\alpha, \quad a_{rad} = \omega^2 r$$

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

$$\omega = \omega_0 + \alpha t$$

$$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$$

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

$$I = \sum m_i r_i^2$$

$$I_P = I_{cm} + Md^2$$

$$K = \frac{1}{2}I\omega^2$$

Moments of inertia:

Slender rod, about center	$\frac{1}{12}ML^2$
Slender rod, about end	$\frac{1}{3}ML^2$
Rectangular plate, about center	$\frac{1}{12}M(a^2 + b^2)$
Rectangular plate, about edge	$\frac{1}{3}Ma^2$
Hollow cylinder	$\frac{1}{2}M(R_1^2 + R_2^2)$
Solid cylinder	$\frac{1}{2}MR^2$
Thin-walled hollow cylinder	MR^2
Solid sphere	$\frac{2}{5}MR^2$
Thin-walled hollow sphere	$\frac{2}{3}MR^2$

$$\tau = F\ell, \quad \vec{\tau} = \vec{r} \times \vec{F}$$

$$\tau = I\alpha$$

$$K = \frac{1}{2}Mv_{cm}^2 + \frac{1}{2}I_{cm}\omega^2$$

$$W = \int \tau d\theta, \quad P = \tau\omega$$

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

$$\vec{L} = I\vec{\omega}$$

$$\sum \vec{\tau} = d\vec{L}/dt$$

$$\sum F_x = 0, \quad \sum F_y = 0, \quad \sum \vec{\tau} = 0$$

$$|\vec{A} \times \vec{B}| = AB \sin \phi = AB_{\perp} = A_{\perp}B$$

$$\vec{\mathbf{A}} \times \vec{\mathbf{B}} = (A_y B_z - A_z B_y)\hat{\mathbf{i}} + (A_z B_x - A_x B_z)\hat{\mathbf{j}} + (A_x B_y - A_y B_x)\hat{\mathbf{k}}$$

$$\vec{\mathbf{F}} = m\vec{\mathbf{a}}$$

$$\vec{\mathbf{F}}_{B \text{ on } A} = -\vec{\mathbf{F}}_{A \text{ on } B}$$

$$w = mg$$

$$f_s \leq \mu_s n, f_k = \mu_k n$$

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

$$W = \vec{\mathbf{F}} \cdot \vec{\mathbf{s}} = Fs \cos \phi$$

$$W = \int_{x_1}^{x_2} F_x dx = \int_{P_1}^{P_2} \vec{\mathbf{F}} \cdot d\vec{\ell}$$

$$W_{tot} = K_2 - K_1 = \Delta K$$

$$P = dW/dt$$

$$W = -\Delta U$$

$$U = mgh, U = \frac{1}{2}kx^2$$

$$K_2 + U_2 = K_1 + U_1 + W_{other}$$

$$F_x(x) = -dU(x)/dx$$

$$\vec{\mathbf{F}} = -\left[\frac{\partial U}{\partial x}\hat{\mathbf{i}} + \frac{\partial U}{\partial y}\hat{\mathbf{j}} + \frac{\partial U}{\partial z}\hat{\mathbf{k}}\right]$$

$$v_x = dx/dt, v_{av-x} = (x_2 - x_1)/(t_2 - t_1)$$

$$a_x = dv_x/dt, a_{av-x} = (v_{2x} - v_{1x})/(t_2 - t_1)$$

$$x(t) = x_0 + \int_0^t v_x(t) dt$$

$$v_x(t) = v_{0x} + \int_0^t a_x(t) dt$$

$$\vec{\mathbf{v}} = d\vec{\mathbf{r}}/dt$$

$$\vec{\mathbf{a}} = d\vec{\mathbf{v}}/dt$$

$$x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2$$

$$v_x(t) = v_{0x} + a_x t$$

$$v_x(t)^2 = v_{0x}^2 + 2a_x \Delta x$$

$$\Delta x = \frac{v_{0x} + v_x(t)}{2}t$$

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

$$\vec{\mathbf{v}} = \vec{\mathbf{v}}_0 + \vec{\mathbf{a}}t$$

$$\vec{\mathbf{A}} = A_x\hat{\mathbf{i}} + A_y\hat{\mathbf{j}} + A_z\hat{\mathbf{k}}$$

$$A_x = A \cos \theta, A_y = A \sin \theta$$

$$A = \sqrt{A_x^2 + A_y^2}, \tan \theta = A_y/A_x$$

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

$$a_{rad} = v^2/R = 4\pi^2 R/T^2$$

$$\vec{\mathbf{v}}_{P/A} = \vec{\mathbf{v}}_{P/B} + \vec{\mathbf{v}}_{B/A}$$

$$g = 9.80 \text{ m/s}^2, 1 \text{ hr} = 3600 \text{ s}, 1 \text{ km/hr} = 0.278 \text{ m/s}$$

$$\text{If } at^2 + bt + c = 0, \text{ then } t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

$$\text{If } x = at^n, \text{ then } dx/dt = nat^{n-1}.$$

$$\text{If } x = at^n, \text{ then } \int_{t_1}^{t_2} x(t) dt = \frac{a}{n+1} (t_2^{n+1} - t_1^{n+1}).$$