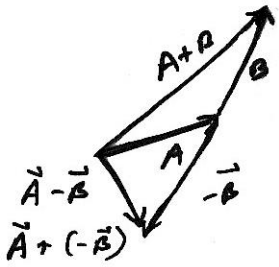
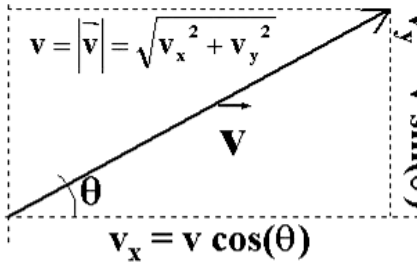
$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$





$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) \qquad \theta = \cos^{-1}\left(\frac{v_x}{v}\right) \qquad \theta = \sin^{-1}\left(\frac{v_y}{v}\right)$$

1D

$$\Delta x = x_f - x_i$$
$$\Delta v = v_f - v_i$$
$$a = \Delta v/\Delta t$$
$$\Delta x = \bar{v}\,\Delta t$$

a = constant

$$\bar{v} = (v_f + v_i)/2$$
$$v = v_o + at$$
$$x = x_o + v_o t + \frac{1}{2}at^2$$
$$v^2 - v_o^{\,2} = 2a(x - x_o)$$

2D

$x \rightarrow x, y \qquad x_o \rightarrow x_o, y_o$

$v \rightarrow v_x, v_y \qquad v_o \rightarrow v_{ox}, v_{oy}$

$a \rightarrow a_x, a_y$

$$\omega = \frac{\Delta\theta}{\Delta t} \qquad \alpha = \frac{\Delta\omega}{\Delta t}$$
$$\omega = 2\pi f \qquad f = \frac{1}{T}$$

Rotation

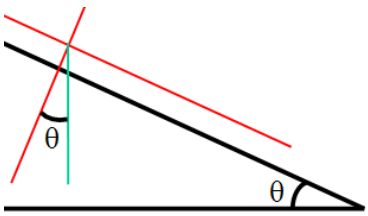
$$\bar{\omega} = \frac{\omega_f + \omega_i}{2} \qquad \tau = r_\perp F = rF_\perp$$
$$\omega = \omega_o + \alpha t$$
$$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$
$$\omega^2 - \omega_o^2 = 2\alpha(\theta - \theta_o)$$
$$I = \sum_i^{all} m_i r_i^2$$
$$\tau = I\alpha$$
$$KE = \frac{1}{2}I\omega^2$$

NL $\vec{F}_{tot} = m\vec{a}$

Defining the system

Grouping masses
Identify F – reaction F

Go around corners consistently



$$\mu N$$
$$a = \frac{v^2}{R}$$

$$x = r\,\theta$$
$$v = \omega\, r$$
$$a = \alpha\, r$$

$$L = r_\perp p = mvr_\perp \qquad L = I\omega$$
$$\tau = \frac{\Delta L}{\Delta t} \qquad \tau = 0 \Rightarrow \Delta L = 0$$

Statics

$$\sum_i^{all} \vec{F}_i = 0 \qquad \sum_i^{all} \vec{\tau}_i = 0$$

$$KE = \frac{1}{2}mv^2 \qquad W = F\,d_{\parallel} = F_{\parallel}\,d$$
$$W_{tot} = \Delta(KE) \qquad \Delta U = -W_{if}$$
$$U = mg(y - y_0)$$
$$E = KE + U$$
$$U = \frac{1}{2}kx^2$$
$$W_{nc} = \Delta E$$

$$\vec{p} = m\vec{v} \qquad \vec{P}_{init} = \vec{P}_{final} \qquad \left(\sum_j^{all} m_j \vec{v}_j\right)_{init} = \left(\sum_j^{all} m_j \vec{v}_j\right)_{final}$$

$$F = \frac{GMm}{r^2}$$

$$U = -\frac{GMm}{r}$$

$$\frac{GM_e}{R_e} = gR_e$$

$$G = 6.67(10)^{-11}\ \mathrm{Nm^2/kg^2}$$

$$M_e = 5.97(10)^{24}\ \mathrm{kg}$$

$$R_e = 6.37(10)^{6}\ \mathrm{m}$$