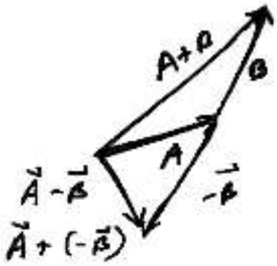
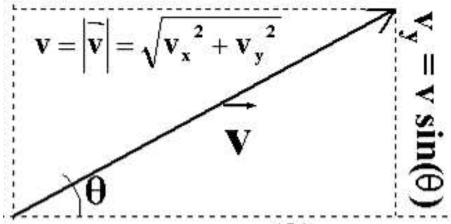
$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$





$$v = |\vec{v}| = \sqrt{v_x^{\,2} + v_y^{\,2}}$$

$$v_y = v\sin(\theta) \qquad v_x = v\cos(\theta)$$

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

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

$$x \rightarrow x,y \qquad x_o \rightarrow x_o, y_o$$
$$v \rightarrow v_x, v_y \qquad v_o \rightarrow v_{ox}, v_{oy}$$
$$a \rightarrow a_x, a_y$$

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

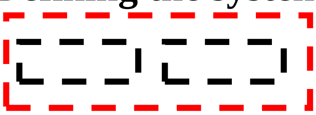
Rotation

$$\bar{\omega} = \frac{\omega_f + \omega_i}{2}$$
$$\omega = \omega_o + \alpha t$$
$$\theta = \theta_o + \omega_o t + \frac{1}{2}\alpha t^2$$
$$\omega^2 - \omega_o^2 = 2\alpha(\theta - \theta_o)$$

$$\tau = r_\perp F = rF_\perp$$
$$I = \sum_i^{all} m_i r_i^2$$
$$\tau = I\alpha$$
$$KE = \frac{1}{2}I\omega^2$$

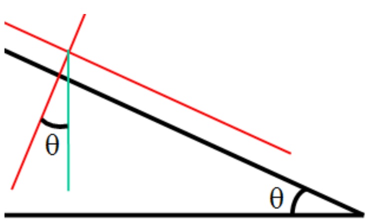
NL $\vec{F}_{tot} = m\vec{a}$

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

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

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

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

$$\vec{p} = m\vec{v} \qquad \vec{P}_{init} = \vec{P}_{final}$$

$$F = \frac{GMm}{r^2} \qquad \frac{GM_e}{R_e} = gR_e \qquad G = 6.67(10)^{-11}\ Nm^2/kg^2$$

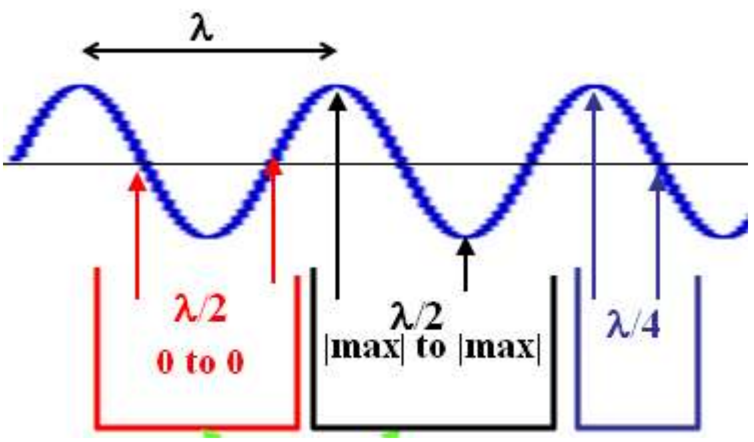
$$U = -\frac{GMm}{r} \qquad M_e = 5.97(10)^{24}\ kg \qquad R_e = 6.37(10)^6\ m$$

$$\rho = m/V \qquad P = F/A \qquad \Delta P = \rho g h \qquad B = \rho_{liq} V_{disp} g$$

$$Av = const. \qquad P + \frac{1}{2}\rho v^2 + \rho g h = const.$$

$$x = A\sin(\omega t + \delta) \qquad a = -A\omega^2 \sin(\omega t + \delta)$$

$$v = A\omega \cos(\omega t + \delta) \qquad \omega = \sqrt{k/m} \qquad \omega = \sqrt{g/\ell}$$



$$v = \lambda f$$

$$v = \sqrt{\frac{T}{\mu}}$$

$$\Delta Q = (quant.) C_{cond}\ \Delta T$$

$$\Delta Q = \ell\ \Delta(quant.)$$

$$\Delta Q_{into} = \Delta W_{by} + \Delta U$$

For IG $\begin{cases} \Delta W_{by} = P\Delta V \\ \Delta U \ \alpha\ \Delta T \\ C_P = C_V + R \end{cases}$

$$R = 8.31\ J/(mole\ K)$$

$$\frac{RT}{2}\Big|_{deg.\ freedom}$$

$$W = Q_H - Q_L \qquad e = \frac{W}{Q_H} \qquad e = 1 - \frac{T_L}{T_H} \qquad \Delta S \geq 0$$