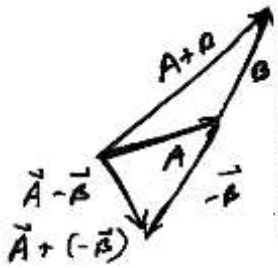
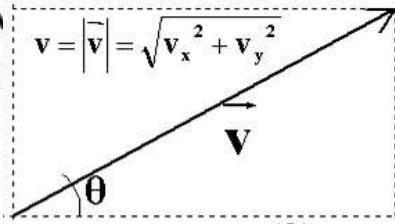
$$\vec{v} = \frac{\Delta \vec{r}}{\Delta t} \qquad \vec{a} = \frac{\Delta \vec{v}}{\Delta t}$$

1D

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





$$v = |\vec{v}| = \sqrt{v_x^{\,2} + v_y^{\,2}}$$
$$v_x = v\cos(\theta) \qquad v_y = v\sin(\theta)$$
$$\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right) \qquad \theta = \cos^{-1}\left(\frac{v_x}{v}\right) \qquad \theta = \sin^{-1}\left(\frac{v_y}{v}\right)$$

$$ax^2 + bx + c = 0 \qquad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

a = constant

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

2D

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

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

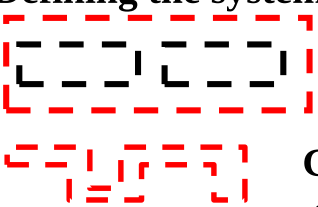
Rotation

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

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

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

Defining the system

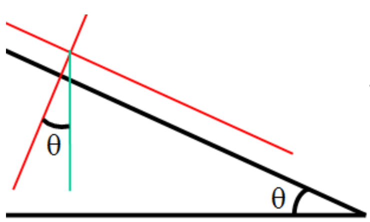


Grouping masses

Identify F – reaction F

Go around corners consistently

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



μN

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

$$F = -kx$$

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

Statics

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

Energy

$$KE = \frac{1}{2} m v^2 \qquad W = F\, d_{\|} = F_{\|}\, d$$
$$W_{tot} = \Delta(KE) \qquad \Delta U = -W_{if}$$
$$E = KE + U \qquad U = mg(y - y_0)$$
$$W_{nc} = \Delta E \qquad U = \frac{1}{2} k x^2$$

F=-kx

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

$$\vec{p} = m\vec{v} \qquad \vec{F} = \frac{\Delta \vec{P}}{\Delta t}$$

Momentum

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

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

UL Gravitation

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

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

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fluids

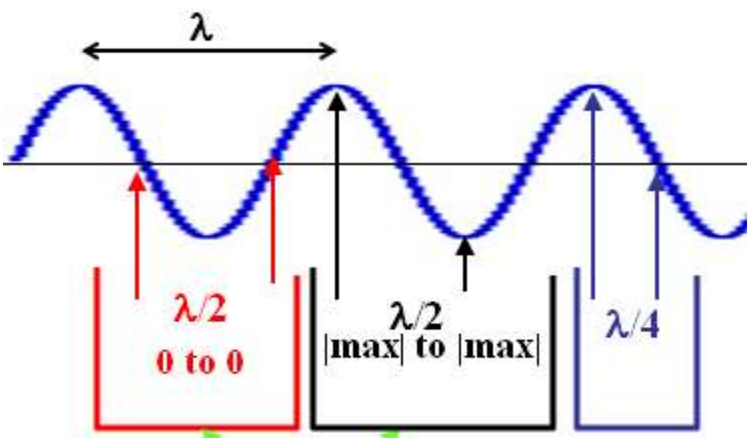
$$\rho = m/V \qquad P = F/A \qquad \Delta P = \rho g h \qquad B = \rho_{liq} V_{disp} g$$

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

SH motion

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

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



Waves

$$v = \lambda f$$

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

Thermo. Stat. Mech.

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

$$\Delta Q = \ell\ \Delta(\text{quant.})$$

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

For IG $\left\{ \begin{array}{l} \Delta W_{by} = P\Delta V \\ \Delta U\ \alpha\ \Delta T \\ C_P = C_V + R \end{array} \right.$

$$\boxed{\frac{RT}{2}\Big|_{deg.\ freedom}} \quad \text{EPE Theorem}$$

$$R = 8.31\ \mathrm{J/(mole\ K)}$$

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