1d kinematics

$$x(t) = x_0 + v\Delta t$$

$$v(t) = v_0 + a\Delta t$$

$$x(t) = x_0 + v_0\Delta t + \frac{1}{2}a(\Delta t)^2$$

$$v^2(x) = v_0^2 + 2a\Delta x$$

2d kinematics

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

$$\begin{aligned} x(t) &= x_0 + v_{0x}t + \frac{1}{2}a_x t^2 \\ y(t) &= y_0 + v_{0y}t + \frac{1}{2}a_y t^2 \end{aligned}$$

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

$$\begin{aligned} v_x(t) &= v_{0x} + a_x t \\ v_y(t) &= v_{0y} + a_y t \end{aligned}$$

Forces

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

$$\begin{aligned} \sum F_x &= ma_x \\ \sum F_y &= ma_y \end{aligned}$$

$$\left|\vec{F}_{\text{fr}}\right| = \mu_K N$$

$$\left|\vec{F}_{\text{sfr}}\right| \leq \mu_s N$$

$$F_g \equiv W = m \times \underbrace{g}_{=9.8\text{m/s}^2\text{on earth}}$$

circular motion

$$a_c = \frac{v^2}{R} \qquad \text{towards the center}$$

$$\theta = \frac{s}{R}$$

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{\Delta s}{\Delta t}\frac{1}{R} = \frac{v}{R}$$

Work

$$W = \vec{F} \cdot \vec{\Delta x} = |F|\,|\Delta x|\,cos(\theta)$$

$$\text{Power} = \frac{W}{\Delta t} = \vec{F} \cdot \vec{v}$$

$$\sum W = \Delta KE \qquad KE = \sum \frac{1}{2}m_i v_i^2$$

$$\sum W_{ext} + \underbrace{W_{\text{springs}} + W_{\text{grav}}}_{-\Delta PE_{\text{springs}} + -\Delta PE_{\text{grav}}} = \Delta KE$$

$$\sum W_{ext} = \Delta KE + \Delta PE_{\text{spring}} + \Delta PE_{\text{grav}}$$

$$PE_{\text{spring}} = \frac{1}{2}kx^2 \qquad PE_{\text{grav}} = mgh$$

Momentum& Collisons

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

$$\vec{I} = \vec{p}_f - \vec{p_i} = \int \vec{F}dt = \vec{F}_{ave}\Delta t$$

1d & 2d inelastic and elastic collisions

$$\begin{aligned} \vec{P}_{\text{total init}} &= \vec{P}_{\text{total final}} \\ m_1\vec{v}_{1i} + m_2\vec{v}_{2i} &= m_1\vec{v}_{1f} + m_2\vec{v}_{2f} \end{aligned}$$

1d & 2d elastic collisions

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

1d elastic ONLY

$$v_{1i} - v_{2i} = -(v_{1f} - v_{2f})$$