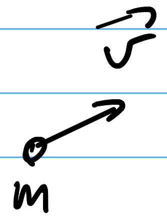
Linear momentum



$$\vec p = m\vec v$$

$$\frac{d\vec p}{dt} = \frac{d}{dt} m\vec v = m\frac{d\vec v}{dt} = m\vec a = \vec F$$

$$\boxed{\frac{d\vec P}{dt} = \vec F}$$

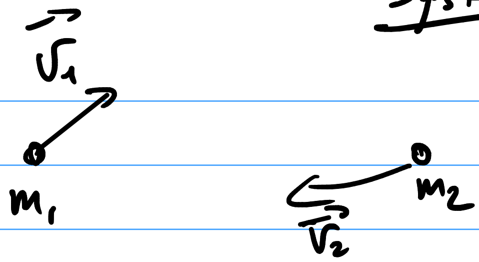
$$\vec J = \int_{t_i}^{t_f} \vec F\, dt = \int \frac{d\vec P}{\cancel{dt}}\, \cancel{dt}$$

impulse

$$= \int_i^f d\vec P = \vec P_f - \vec P_i$$

$$\boxed{\vec F_{aver}\,\Delta t = \vec F_{average}(t_f - t_i) = \vec P_f - \vec P_i}$$

System



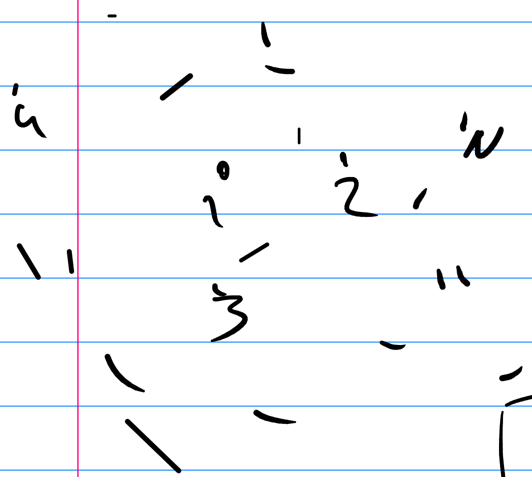
$$\frac{d}{dt}\left(\vec{P}_{total} = \vec{p}_1 + \vec{p}_2 = m_1\vec{v}_1 + m_2\vec{v}_2\right)$$

$$\frac{d\vec{P}_{total}}{dt} = \vec{F}_1 + \vec{F}_2 = \vec{F}_{1ext} + \underbrace{\vec{F}_{12} + \vec{F}_{2ext} + \vec{F}_{21}}_{\to 0}$$

$$\vec{F}_{12} = -\vec{F}_{21}$$

3rd Newton's law

$$\frac{d\vec{P}_{total}}{dt} = \vec{F}_{1ext} + \vec{F}_{2ext}$$

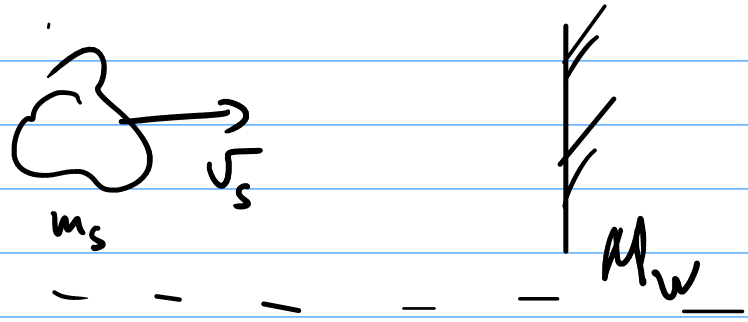


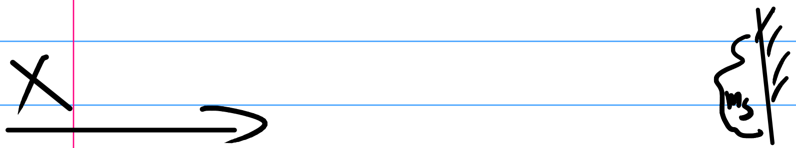
$$\boxed{\frac{d\vec{P}_{total}}{dt} = \frac{d}{dt}\sum_{i=1}^{N}\vec{p}_i = \sum_{all}\vec{F}_{ext}}$$

iff $\sum\vec{F}_{ext} = 0 \iff \frac{d\vec{P}_{total}}{dt} = 0$

$\implies \vec{P}_{total} = const$ | conservation of lin. momentum

Slime on a wall





$$m_s \vec{v}_{s_i} + M_w \cdot \vec{v}_{w_i}^{\;\nearrow 0} = m_s \vec{v}_{s_f} + M_w \vec{v}_{w_f}$$

$$= m_s \vec{v}_f + M_w \vec{v}_f$$

X: $\quad m_s v_i = (m_s + M_w)\, v_f$

$$v_f = \frac{m_s v_i}{m_s + M_w}$$

Energy

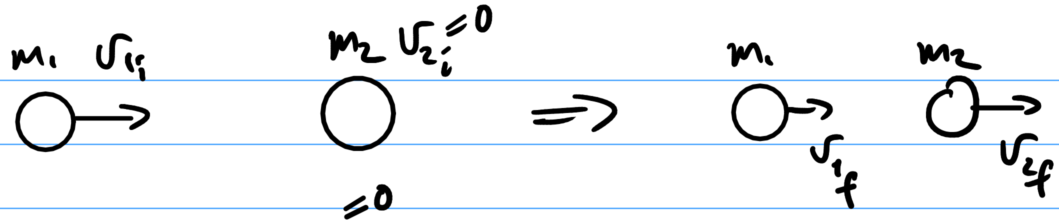
$$\frac{m_s v_i^2}{2} + \cancel{\frac{M_w v_{iw}^2}{2}}^{\,0} = \frac{m_s v_f^2}{2} + \frac{M_w v_f^2}{2}$$

inelastic

$\Updownarrow$

Energy $\neq$ const

$$\frac{m_s v_i^2}{2} \neq \frac{m_s + M_w}{2}\left(\frac{m_s v_i}{m_s + M_s}\right)^2 = \frac{m_s}{2} v_i^2 \frac{m_s}{m_s + M_w}$$

X: 

$\vec{P}$: $m_1 v_{1_i} + m_2 \overset{=0}{v_{2_i}} = m_1 v_{1_f} + m_2 v_{2_f}$

E : $\dfrac{m_1 v_{1_i}^2}{2} + 0 = \dfrac{m_1 v_{1_f}^2}{2} + \dfrac{m_2 v_{2_f}^2}{2}$

if $m_1 = m_2 = m$

E : $\dfrac{\cancel{m}}{\cancel{2}} \underline{v_{1_i}^2} = \dfrac{\cancel{m}}{\cancel{2}} \underline{v_{1_f}^2} + \dfrac{\cancel{m}}{\cancel{2}} \underline{v_{2_f}^2}$

$\vec{P}$: $\left(\cancel{m} v_{1_i} = \cancel{m} v_{1_f} + \cancel{m} v_{2_f}\right)^2$

$\underline{v_{1_i}^2} = \underline{v_{1_f}^2} + \underline{v_{2_f}^2} + 2 v_{1_f} v_{2_f}$

if $v_{1_f} = 0 \Rightarrow$ E const, $\vec{P}$ const