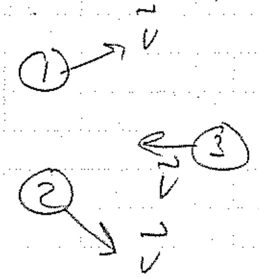
Chapter 03 — Momentum and Angular Mom

Conservation of Momentum

System of N particles interacting



$$\boxed{\vec{F}_{net,ext} = \frac{d\vec{P}}{dt}}$$

$\vec{P}$ = momentum of the system.

$$\boxed{\vec{P} = \vec{p}_1 + \vec{p}_2 + \cdots = \sum_{i=1}^{N} \vec{p}_i}$$

Also, $\boxed{\vec{P} = M\vec{v}_{cm}}$ M = total mass $= \sum_{i=1}^{N} m_i$

$$\vec{v}_{cm} = \frac{m_1\vec{v}_1 + \vec{v}_2 + \cdots}{m_1 + m_2 + \cdots}$$

$$\vec{v}_{cm} = \frac{\sum_{i=1}^{N} m_i \vec{v}_i}{\sum_{i=1}^{N} m_i}$$ $\Rightarrow$ weighted average.

$$\boxed{\vec{v}_{cm} = \frac{\sum_{i=1}^{N} m_i \vec{v}_i}{M}}$$

If $\vec{F}_{net,ext} = 0$, then $\dot{\vec{P}} = 0$ and $\vec{P}$ is constant. <u>Conservation of $\vec{P}$</u>

Then for any time interval,

$$\vec{P}_i = \vec{P}_f \quad \text{so} \quad \vec{p}_{1i} + \vec{p}_{2i} + \cdots = \vec{p}_{1f} + \vec{p}_{2f} + \cdots$$

$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} + \cdots = m_1\vec{v}_{1f} + m_2\vec{v}_{2f} + \cdots$$

Another way to state it is that

$\vec{v}_{cm}$ is constant. Thus as particles' velocities change due to internal forces, $\vec{P}_{sys}$ and $\vec{v}_{cm}$ remain constant.