

# Conservation of Momentum



During:  $\vec{I}_1 = m_1 \vec{v}_{1f} - m_1 \vec{v}_{1i}$

$$\vec{I}_2 = m_2 \vec{v}_{2f} - m_2 \vec{v}_{2i}$$

By NIII,  $\vec{I}_1 = -\vec{I}_2$ :

$$m_1 \vec{v}_{1f} - m_1 \vec{v}_{1i} = -(m_2 \vec{v}_{2f} - m_2 \vec{v}_{2i})$$

Or

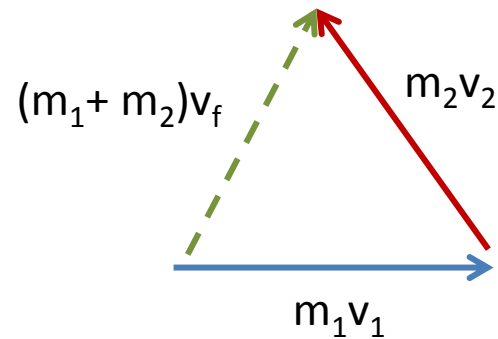
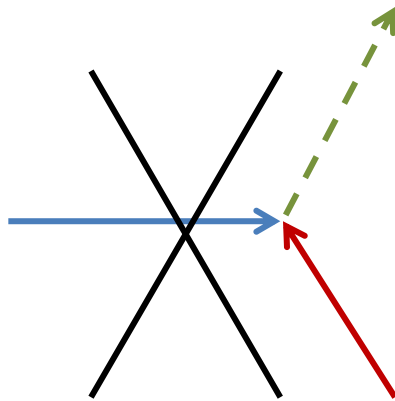
$$m_1 \vec{v}_{1f} + m_2 \vec{v}_{2f} = m_1 \vec{v}_{1i} + m_2 \vec{v}_{2i}$$

# Inelastic Collision (1D or 2D)

Stick or lock together after collision

$$(m_1 + m_2)\vec{v}_f = m_1\vec{v}_{1i} + m_2\vec{v}_{2i}$$

In 2D, draw vector diagram



# Elastic Collision in 1D

- Kinetic Energy lost to deformation, heat, sound.
- Elastic Collision,  $KE_f = KE_i$
- Mostly to occur if shapes have a little give (i.e. are elastic) and at low speed.



$$\text{CM: } m_1 v_{1f} - m_1 v_{1i} = -(m_2 v_{2f} - m_2 v_{2i})$$

$$\text{KE: } \frac{1}{2} m_1 v_{1f}^2 - \frac{1}{2} m_1 v_{1i}^2 = - \left( \frac{1}{2} m_2 v_{2f}^2 - \frac{1}{2} m_2 v_{2i}^2 \right)$$

Dropping  $\frac{1}{2}$  and expanding difference of squares

$$\begin{aligned} m_1 (v_{1f} - v_{1i})(v_{1f} + v_{1i}) \\ = -m_2 (v_{2f} - v_{2i})(v_{2f} + v_{2i}) \end{aligned}$$

$$\Rightarrow v_{1f} + v_{1i} = v_{2f} + v_{2i}$$

Usually you would write

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

Linearized conservation of energy (good 1D only). Must also use

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