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

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

Or

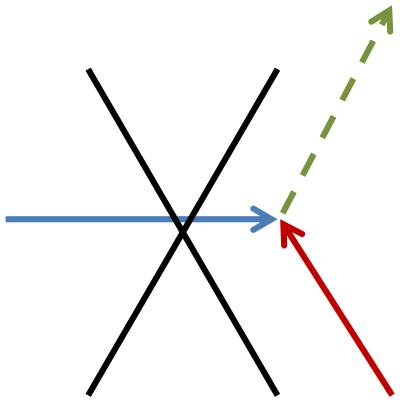
$$m_1\vec{v}_{1f} + m_2\vec{v}_{2f} = m_1\vec{v}_{1i} + m_2\vec{v}_{2i}$$

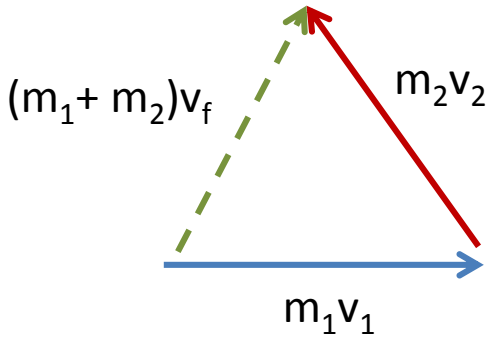
Inelastic Collision (1D or 2D)

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.

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

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 ½ and expanding difference of squares

$$m_1\left(v_{1f} - v_{1i}\right)\left(v_{1f} + v_{1i}\right) = -m_2\left(v_{2f} - v_{2i}\right)\left(v_{2f} + v_{2i}\right)$$

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

Usually you would write

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

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

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