Conservation of Linear Momentum

Linear, not Angular, Momentum: In this section, we deal with **conservation of linear momentum (mv)** of *particles* only. Another section of your book talks about conservation of **angular momentum** ($I_G\omega$) of rigid bodies.

If we write the Impulse-Momentum Eqn for a system (two or more) of colliding particles.....

$$\boxed{\Sigma(m\vec{v})_1 + \underbrace{\Sigma\left(\int \vec{F}dt\right)}_{0} = \Sigma(m\vec{v})_2}$$

During impact (a very short instant of time) the only *significant* forces are particle-to-particle impulsive forces. These are equal and opposite vectors whose sum is zero.

Conservation of Momentum Eqn

$$\boxed{\Sigma(m\vec{v})_1 = \Sigma(m\vec{v})_2}$$

Other forces (e.g. friction, weight…) act during the instant of impact, but they are much smaller than the impulsive forces. Thus, they're negligible.

Discussion: Conservation of Linear Momentum

The Conservation of Momentum Equation:

$$\boxed{\sum(m\vec{v})_1 = \sum(m\vec{v})_2}$$

This is a vector equation. We usually write scalar equations equating the momentum of the x and y (and if needed, z) components of the particles. (In this case, two particles, A and B)

$\xrightarrow{+}$
$$\boxed{m_A v_{Ax_1} + m_B v_{Bx_1} = m_A v_{Ax_2} + m_B v_{Bx_2} = (m_A + m_B) v_{2x}}$$

$+\uparrow$
$$\boxed{m_A v_{Ay_1} + m_B v_{By_1} = m_A v_{Ay_2} + m_B v_{By_2} = (m_A + m_B) v_{2y}}$$

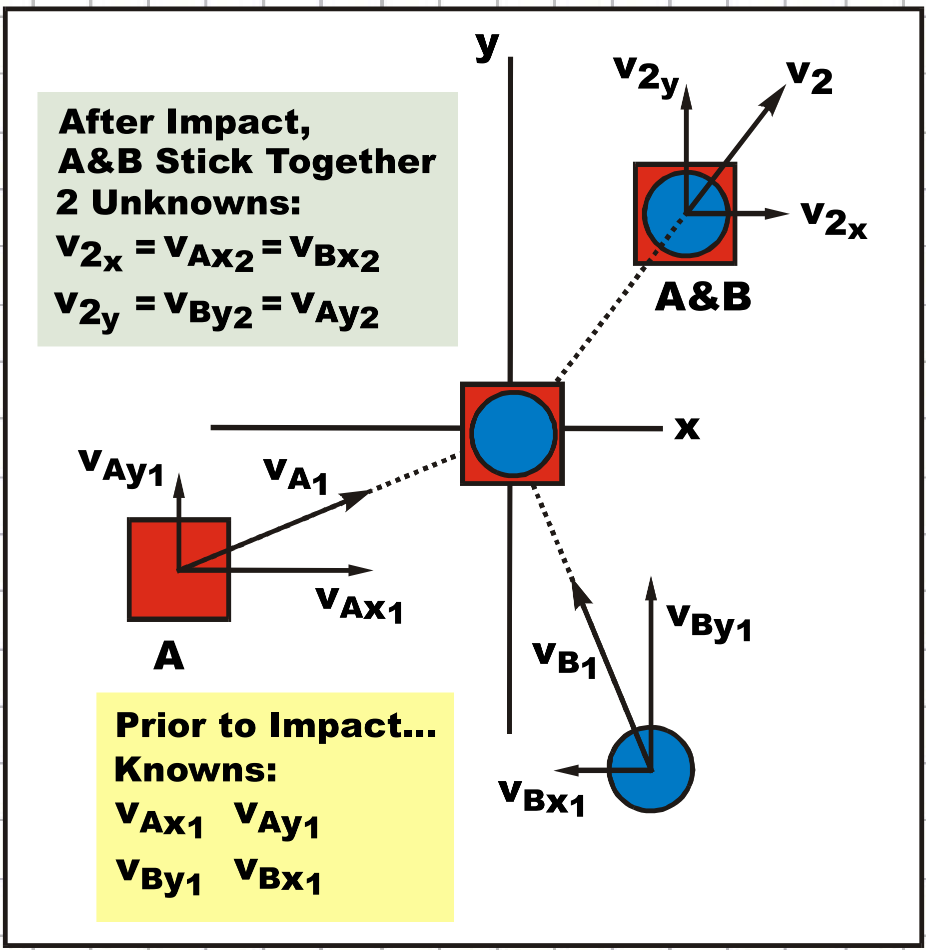
If particles "stick together" after impact

These two scalar equations can be used to determine TWO unknowns. Usually, all four initial velocity components are known (v_{AX1}, v_{Ay1}, v_{Bx1}, v_{By1}). But there are FOUR apparent unknowns on the RHS. To deal with this, many problems say that the particles "stick together" after impact, resulting in one shared pair of two unknowns: v_{2x}, v_{2y}.)

Conservation of Linear Momentum (Scalar Equations)

$$\xrightarrow{+} \quad m_A v_{Ax_1} + m_B v_{Bx_1} = m_A v_{Ax_2} + m_B v_{Bx_2} = (m_A + m_B) v_{2x}$$

$$+\uparrow \quad m_A v_{Ay_1} + m_B v_{By_1} = m_A v_{Ay_2} + m_B v_{By_2} = (m_A + m_B) v_{2y}$$



A common text (or test…) problem: Particles stick together after impact….

If the particles stick together, then the two scalar Conservation of Momentum equations can be used to find the two unknowns: v_{2x}, v_{2y}