AP Physics - Momentum - Conservation of Momentum

Note Title 10/23/2007

So far you know about two of the four conservation laws of the universe: conservation of mass, and conservation of energy. Today, you will learn a third: Conservation of Momentum

Conservation of Momentum - In the absence of an external force, the total momentum of a system will remain constant.

$$\Sigma \vec{P}_{before} = \Sigma \vec{P}_{during} = \Sigma \vec{P}_{after}$$

In one dimension with two objects (m_1 and m_2) this becomes:

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

Example: Billiard balls of mass m. One at rest, another with an initial velocity v_i. Assuming that after the collision, the first ball stops, what is the velocity of the second ball after the collision?

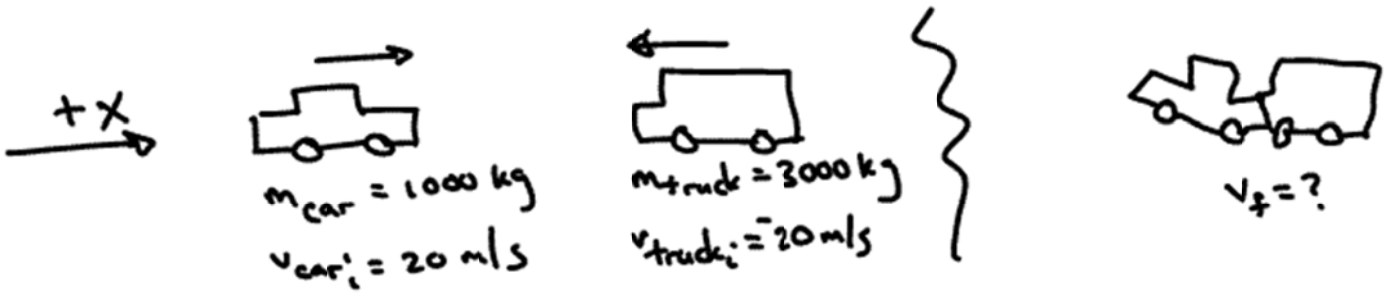
$$mv + m(0) = m(0) + mv_{2f}$$

$$mv = mv_{2f}$$

$$v_{2f} = v$$

∴ The second ball leaves with the same velocity that the first ball enters!

Example: A 1000 kg car crashes into and sticks to a 3000 kg truck. The car's initial velocity is 20 m/s to the right. The truck's initial velocity is 20 m/s to the left. What is the final velocity of the combined mass?



$$m_{car}v_{car_i} + m_{truck}v_{truck_i} = (m_{car} + m_{truck})v_f$$

$$v_f = \frac{m_{car}v_{car_i} + m_{truck}v_{truck_i}}{m_{car} + m_{truck}}$$

*Don't forget the negative velocity of the truck!!!

$$v_f = \frac{(1000)(20) + (3000)(-20)}{1000 + 3000}$$

$$v_f = -10\ m/s$$

∴ The combined mass travels at 10 m/s to the left (the truck wins)