Impact Force

Demonstration 1	Demonstration 2
eggs have same m and $\vec{v}$	
same	$\vec{p}$
raw egg thrown at wall	raw egg thrown at sheet
$F \cdot t$	$= f \cdot T$

1. Compare the change in momentum of the egg in each case.

same $\Delta \vec{p}$

2. Compare the impulse exerted on each egg.

same $\vec{J}$

3. Explain the differences in results.

Demo 1: Larger force because contact time is smaller.
Demo 2: Smaller force because contact time is larger.

4. If your brakes fail in your car, would you rather drive into a brick wall or a haystack? Why?

haystack - increase contact time + decreasing force

5. Why are airbags used in cars? What are some other safety devices that operate on the same principle?

Airbags increase contact time, so they reduce impact force. Also crumple zones + bumpers.

6. What are some other examples of this principle?

Jump + land w/ bent knees
Catching balls + bringing toward body
Boxing gloves, catcher's mitt

7. Compare the impact force, contact time, impulse, acceleration, and change in momentum for each vehicle in the impending collision.

Newton's 3rd Law

$F_{T on C} = F_{C on T}$

$m_T > m_C$

$\Delta \vec{v}_T < \Delta \vec{v}_C$

Newton's 2nd Law

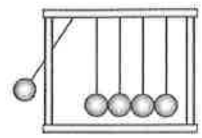
$m_1 a_1 = m_2 a_2$

$m_1 \frac{\vec{v}_1}{t} = m_2 \cdot \frac{\vec{v}_2}{t}$

Conservation of Momentum

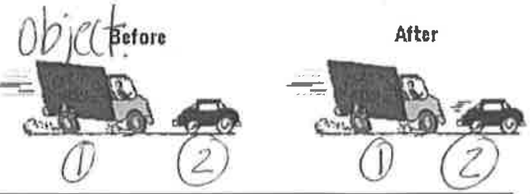
Principle of Conservation of Momentum

The total momentum of an isolated system remains constant.



Isolated system: or closed system - no external forces

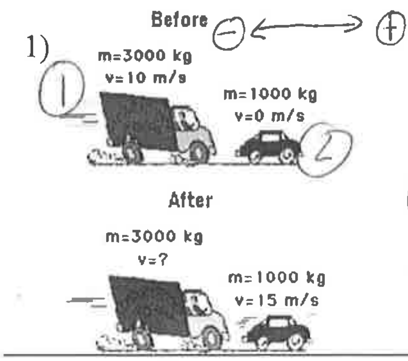
Meaning of principle: Momentum isn't created or destroyed; it is transferred from object to object.



Formula:

$\sum \vec{p}_i = \sum \vec{p}_f \qquad m_1\vec{v}_{1_0} + m_2\vec{v}_{2_0} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

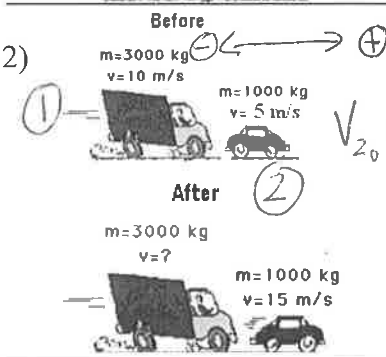
1)



$m_1\vec{v}_{1_0} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

$\frac{(3000\,kg)(10\,\frac{m}{s}) - (1000\,kg)(15\,\frac{m}{s})}{(3000\,kg)} = \boxed{5\,m/s = \vec{v}_{1f}}$

2)

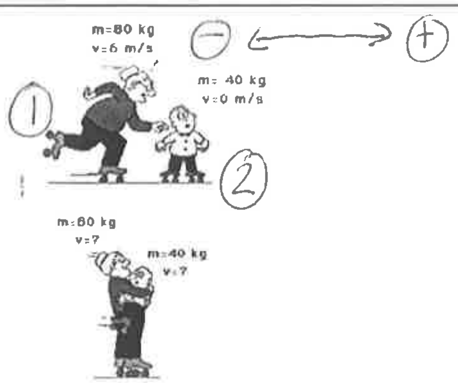


$v_{2_0} = -5\,m/s$

$\vec{v}_{1f} = \frac{m_1\vec{v}_{1_0} + m_2\vec{v}_{2_0} - (m_2\vec{v}_{2f})}{m_1}$

$\boxed{\vec{v}_{1f} = 3.3\,\frac{m}{s}}$

3)



$m_1\vec{v}_{1_0} + \cancel{m_2\vec{v}_{2_0}}^{\,0} = (m_1 + m_2)\vec{v}_f$

$\frac{m_1\vec{v}_{1_0}}{(m_1+m_2)} = \boxed{\vec{v}_{f_{1+2}} = 4\,\frac{m}{s}}$

4)

$0\,kg\,\frac{m}{s} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$

$\boxed{\vec{v}_{1f} = -3\,\frac{m}{s}}$