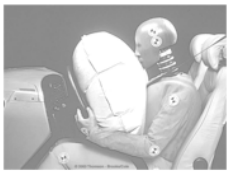
4. If your brakes fail in your car, would you rather drive into a brick wall or a haystack? Why?


OR


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



6. What are some other examples of this principle?

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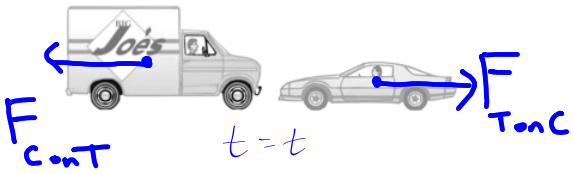
7. Compare the impact force, contact time, impulse, acceleration, and change in momentum for each vehicle in the impending collision.



$a = \Delta V / t$

$\vec{F}_{T\,on\,C} = -\vec{F}_{Con\,T}$ 3rd

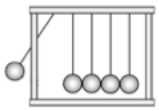
$m\vec{a}_c = -m\vec{a}_T$ 2nd

$m_c \frac{\Delta V_c}{t} = -m_T \frac{\Delta V_T}{t}$

$\Delta \vec{P}_c = -\Delta \vec{P}_T$

Principle of Conservation of Momentum

the total momentum of an isolated system is constant



Isolated system: no external forces

Meaning of principle: momentum is neither created nor destroyed, only transferred

Formula: $\Sigma \vec{P}_o = \Sigma \vec{P}_f$

$m_1\vec{V}_{1o} + m_2\vec{V}_{2o} = m_1\vec{V}_{1f} + m_2\vec{V}_{2f}$

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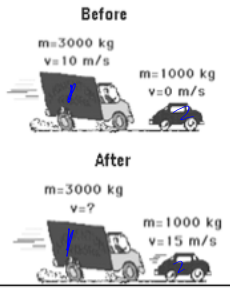
1)

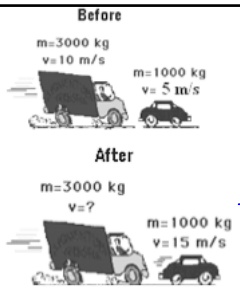


$m_1\vec{V}_{1o} + m_2\vec{V}_{2o} = m_1\vec{V}_{1f} + m_2\vec{V}_{2f}$

$\vec{V}_{1f} = \frac{m_1\vec{V}_{1o} - m_2\vec{V}_{2f}}{m_1} = \frac{3000\,kg \cdot 10\,m/s - 1000\,kg \cdot 15\,m/s}{3000\,kg}$

$= 5\,m/s$

2)

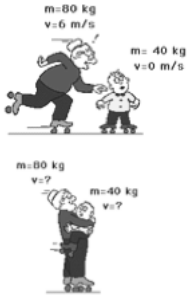


$m_1\vec{v}_{1_0} + m_2\vec{v}_{2_0} = m_1\vec{v}_{1_f} + m_2\vec{v}_{2_f}$

$\vec{v}_{1_f} = \frac{m_1\vec{v}_{1_0} + m_2\vec{v}_{2_0} - m_2\vec{v}_{2_f}}{m_1} = \frac{3000kg \cdot 10m/s + 1000kg(-5m/s) - 1000kg \cdot 15m/s}{3000kg}$

$= 3.3 m/s$

3)



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

$m_1\vec{v}_{1_0} = m_{H2}\vec{v}_f$

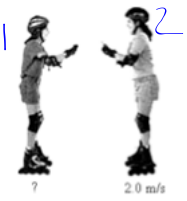
$v_f = \frac{80kg \cdot 6m/s}{120kg} = 4 m/s$

4)

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

$\vec{v}_{1_f} = \frac{-m_2\vec{v}_{2_f}}{m_1} = \frac{-60kg \cdot 2m/s}{40kg}$

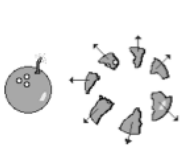
$= -3 m/s$

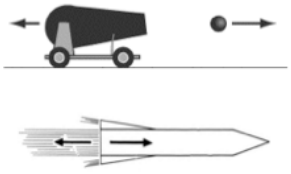


Bouncy Collision

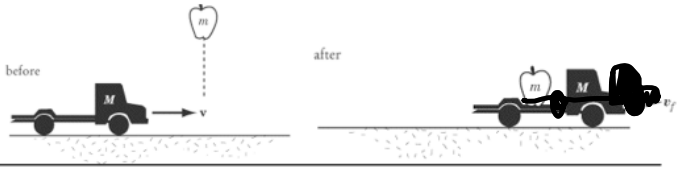
Sticky Collision

Explosion





Momentum is conserved in each direction.



1. A 1850 kg luxury sedan stopped at a traffic light is struck from the rear by a compact car with a mass of 975 kg. The two cars become entangled as a result of the collision. If the compact car was moving at a velocity of 22.0 m/s to the north before the collision, what is the velocity of the entangled mass after the collision?

$m_1\vec{V}_{1_0} + m_2\vec{V}_{2_0} = m_1\vec{V}_{1_f} + m_2\vec{V}_{2_f} = (m_1 + m_2)\vec{V}_f$

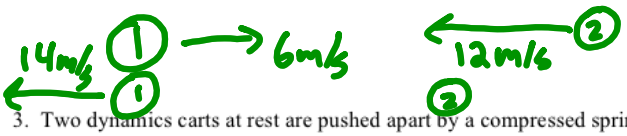
$(m_{1+2})\,V_f$

7.59 m/s

2. A 1.0 kg ball traveling at 6.0 m/s collides head-on with a 2.0 kg ball moving in the opposite direction at a speed of 12 m/s. The 1.0 kg ball rebounds at a speed of 14 m/s after the collision. Find the velocity of the second ball.

$m_1\vec{V}_{1_0} + m_2\vec{V}_{2_0} = m_1\vec{V}_{1_f} + m_2\vec{V}_{2_f}$

-2 m/s



3. Two dynamics carts at rest are pushed apart by a compressed spring. The 1.5 kg cart moves off with a speed of 0.27 m/s. What is the velocity of the 4.5 kg cart after the spring is sprung?

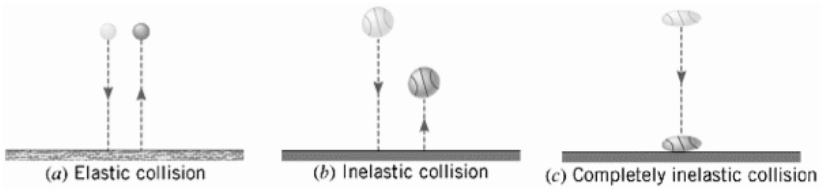
0.09 m/s

4. A 0.105 kg hockey puck moving at 48 m/s is caught by a 75 kg goalie at rest. With what speed does the goalie slide on the ice?

Elastic and Inelastic Collisions

Elastic collision: no KE is lost

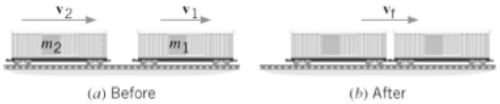
Inelastic collision: some KE is lost in collision



Where does some of the mechanical energy go in an inelastic collision?

heat, sound, deformation

1. Find the final velocity of the two train cars after they latch together. Car 1 has a mass of 65,000 kg and moves at a velocity of 0.80 m/s. Car 2, with a mass of 92,000 kg, has a velocity of 1.3 m/s.



(a) Before (b) After

$$m_1\vec{V}_{1_0} + m_2\vec{V}_{2_0} = m_1\vec{V}_{1_f} + m_2\vec{V}_{2_f}$$

$$V_f = \ldots$$

2. Is this collision elastic or inelastic? Justify your answer.

$$\frac{1}{2}mV_{1_0}^2 + \frac{1}{2}mV_{2_0}^2 = KE_0$$

$$\frac{1}{2}(m_1+m_2)V_f^2 = KE_f$$