Introduction to Physical Science

Conservation of Momentum

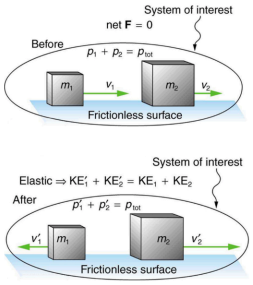
Presented by Robert Wagner

Conservation of Momentum

- Momentum is conserved in an isolated system
  - Net force ( ) = 0
- When = 0,
  - Or,

Elastic Collisions

- Internal kinetic energy is conserved in an elastic collision
  -
- Momentum is also conserved
  -



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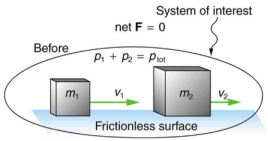
Example

- Calculate the velocities of two objects following an elastic collision, given that m_1= 0.500 kg ; m_2=3.5 kg, v_1 = 4.00 m/s, v_2 = 0. And v'_1=-3.00 m/s
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve



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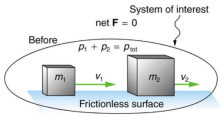
Example



- Calculate the velocities of two objects following an elastic collision, given that m_1= 0.500 kg ; m_2=3.5 kg, v_1 = 4.00 m/s, v_2 = 0. And v'$_1$=-3.00 m/s
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

$$m_1 = 0.500\,kg\,;\ m_2 = 3.50\,kg\,;\ v_1 = 4.00\,m/s$$
$$v_2 = 0\,;\ v_1{}' = -3.00\,m/s$$

$$m_1v_1 + m_2v_2 = m_1v_1{}' + m_2v_2{}'$$

$$v_2{}' = \frac{m_1v_1 + m_2v_2 - m_1v_1{}'}{m_2}$$

$$v_2{}' = \frac{(0.500\,kg)(4.00\,m/s) - (0.500\,kg)(-3.00\,m/s)}{3.50\,kg}$$

$$v_2{}' = 1.00\,m/s$$

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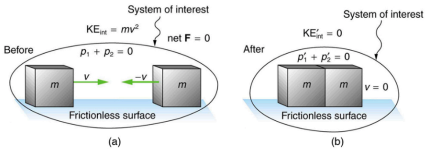
Inelastic Collisions

- In an inelastic collision, the internal kinetic energy is not conserved
- Perfectly inelastic collision is one where the two objects stick together after the collision



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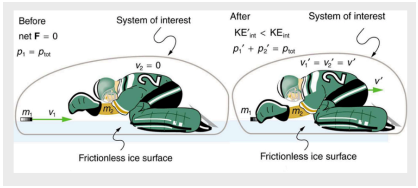
Example

- Find the recoil of a 70.0 kg ice hockey goalie, who at rest catches a 0.150 kg hockey puck traveling at a velocity of 35.0 m/s
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve



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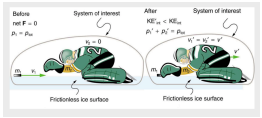
Example



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  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve

$$m_1 = 70.0\,kg\,;\ m_2 = 0.150\,kg\,;\ v_1 = 0\,;\ v_2 = 35.0\,m/s$$

$$v_1{}' = v_2{}' = v'$$

$$m_1v_1 + m_2v_2 = m_1v_1{}' + m_2v_2{}'$$

$$m_1v_1 = (m_1 + m_2)v'$$

$$v' = \frac{m_1}{m_1 + m_2}v_1$$

$$v' = \frac{0.150kg}{0.150kg + 70.0kg}(35.0\,m/s) = 0.0748m/s$$

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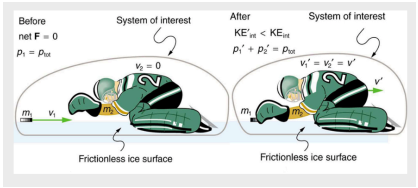
Example

- For the previous problem - what was the kinetic energy lost in the collision?
  - Draw a sketch
  - Identify known values
  - Identify equation
  - Enter values in the equation and solve



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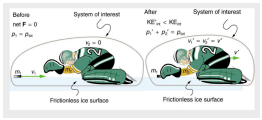

$m_1 = 70.0\,kg\,;\ m_2 = 0.150\,kg\,;\ v_1 = 0\,;\ v_2 = 35.0\,m/s$

$$KE_{int} = \frac{1}{2}m_2 v_2^2 = \frac{1}{2}(0.150kg)(35.0m/s)^2$$

$$KE_{int} = 91.9\,Joules$$

$$KE'_{int} = \frac{1}{2}(m_1 + m_2)v'^2$$

$$KE'_{int} = \frac{1}{2}(70.0kg + 0.015kg)(0.0748m/s)^2$$

$$KE'_{int} = 0.196\,Joules$$

$$KE'_{int} - KE_{int} = 0.196\,J - 91.9\,J = -91.7\,J$$

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Summary

- Momentum is conserved in an isolated system ( )
- The internal kinetic energy of the system will be conserved in an elastic collision
- The internal kinetic energy of a system will not be conserved in an inelastic collision