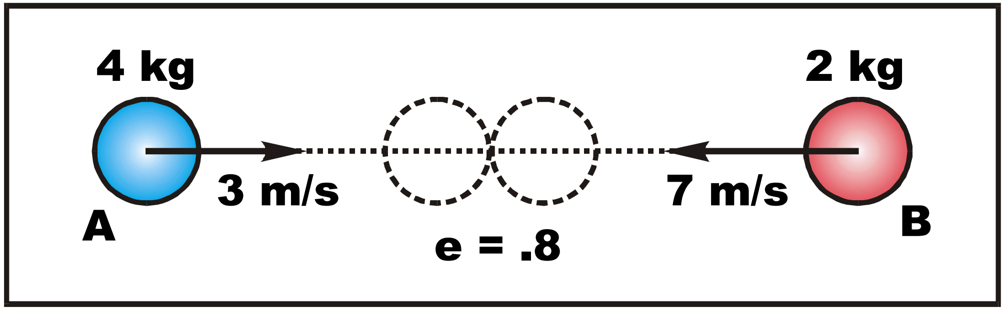
Particle Impact: Example Problem 1

For the straight line impact problem shown below, please determine:

(a) The velocities after impact.

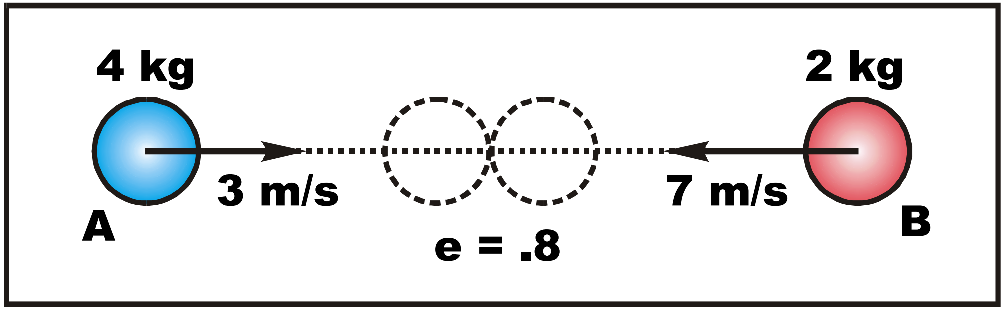
(b) The kinetic energy lost in the impact.



We'll write these two equations:

$$\xrightarrow{+} \quad \boxed{m_A v_{Ax_1} + m_B v_{Bx_1} = m_A v_{Ax_2} + m_B v_{Bx_2}}$$

$$\xrightarrow{+} \quad \boxed{e = \frac{(v_{Bx_2} - v_{Ax_2})}{(v_{Ax_1} - v_{Bx_1})}}$$



Since this is a straight line problem, drop the x subscript (for simpler notation)

$$\xrightarrow{+} \quad \boxed{m_A v_{A_1} + m_B v_{B_1} = m_A v_{A_2} + m_B v_{B_2}}$$

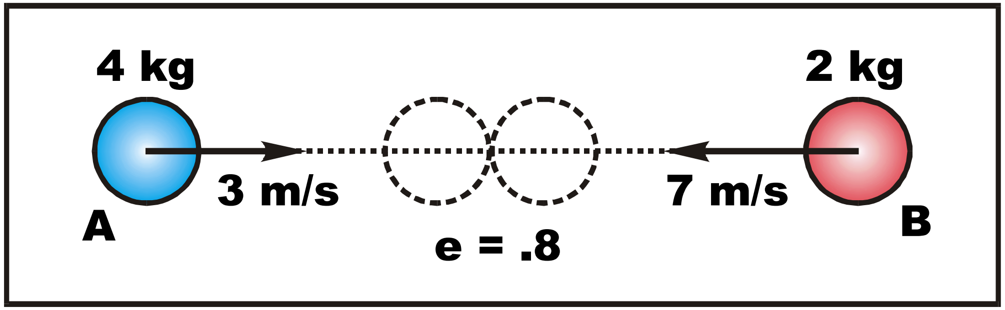
$$\xrightarrow{+} \quad \boxed{e = \frac{(v_{B_2} - v_{A_2})}{(v_{A_1} - v_{B_1})}}$$

$$\xrightarrow{+} \quad (4)(+3) + (2)(-7) = 4v_{A_2} + 2v_{B_2}$$

$$\boxed{-2 = 4v_{A_2} + 2v_{B_2}} \quad (1)$$

$$\xrightarrow{+} \quad \boxed{e = \frac{(v_{B_2} - v_{A_2})}{(v_{A_1} - v_{B_1})}} \qquad .8 = \frac{v_{B_2} - v_{A_2}}{+3 - (-7)}$$

$$10(.8) = \boxed{8 = v_{B_2} - v_{A_2}} \quad (2)$$



Cons of Momentum:

$$\boxed{-2 = 4v_{A_2} + 2v_{B_2}} \quad (1)$$

e Equation:

$$\boxed{8 = v_{B_2} - v_{A_2}} \quad (2)$$

Solve equations (1) and (2):

$$\boxed{v_{A_2} = -3\ \text{m/s} = 3\ \text{m/s} \leftarrow}$$

$$\boxed{v_{B_2} = +5\ \text{m/s} \rightarrow}$$

Kinetic Energies:

Before impact:

$T = \frac{1}{2}(4)(3^2) + \frac{1}{2}(2)(7^2) = 67$ Joule

After impact:

$T = \frac{1}{2}(4)(3^2) + \frac{1}{2}(2)(5^2) = 43$ Joule

% KE Change =

$$\left[\frac{43 - 67}{67}\right](100) = -35.8\%$$

$$\boxed{\Delta KE = -35.8\%}$$

An interesting result.

We're seeing for these problems that….

Momentum is conserved.
(Initial Momentum = Final Momentum)

Kinetic Energy is lost, however.
What happens to the Kinetic Energy?

KE is is converted into other forms of energy such as heat, vibration (a kind of KE), potential energy, noise, and others.

Total energy is "conserved", but it has been converted into other, less useful, less available, forms of energy. This is a statement of the 2nd Law of Thermodynamics.