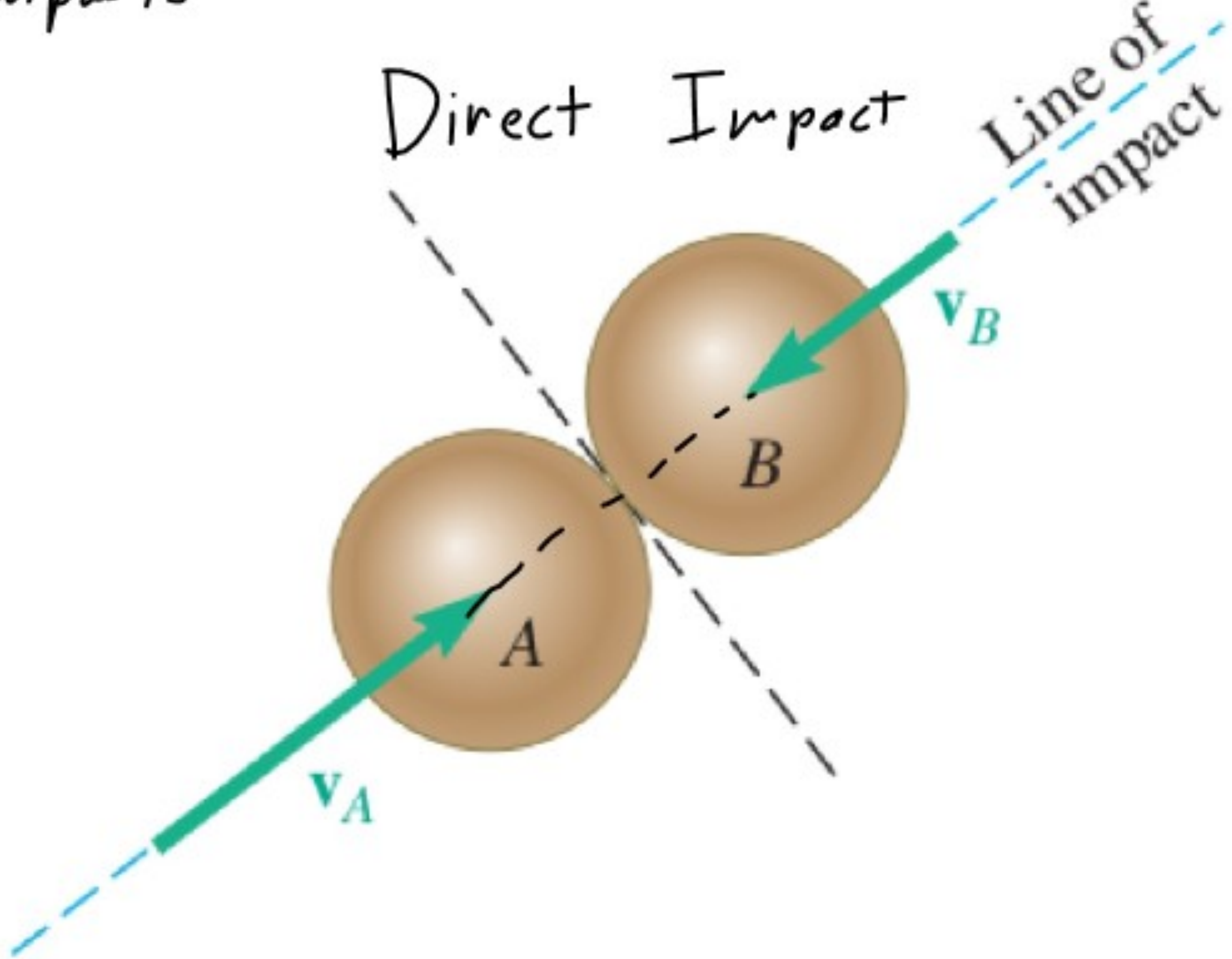
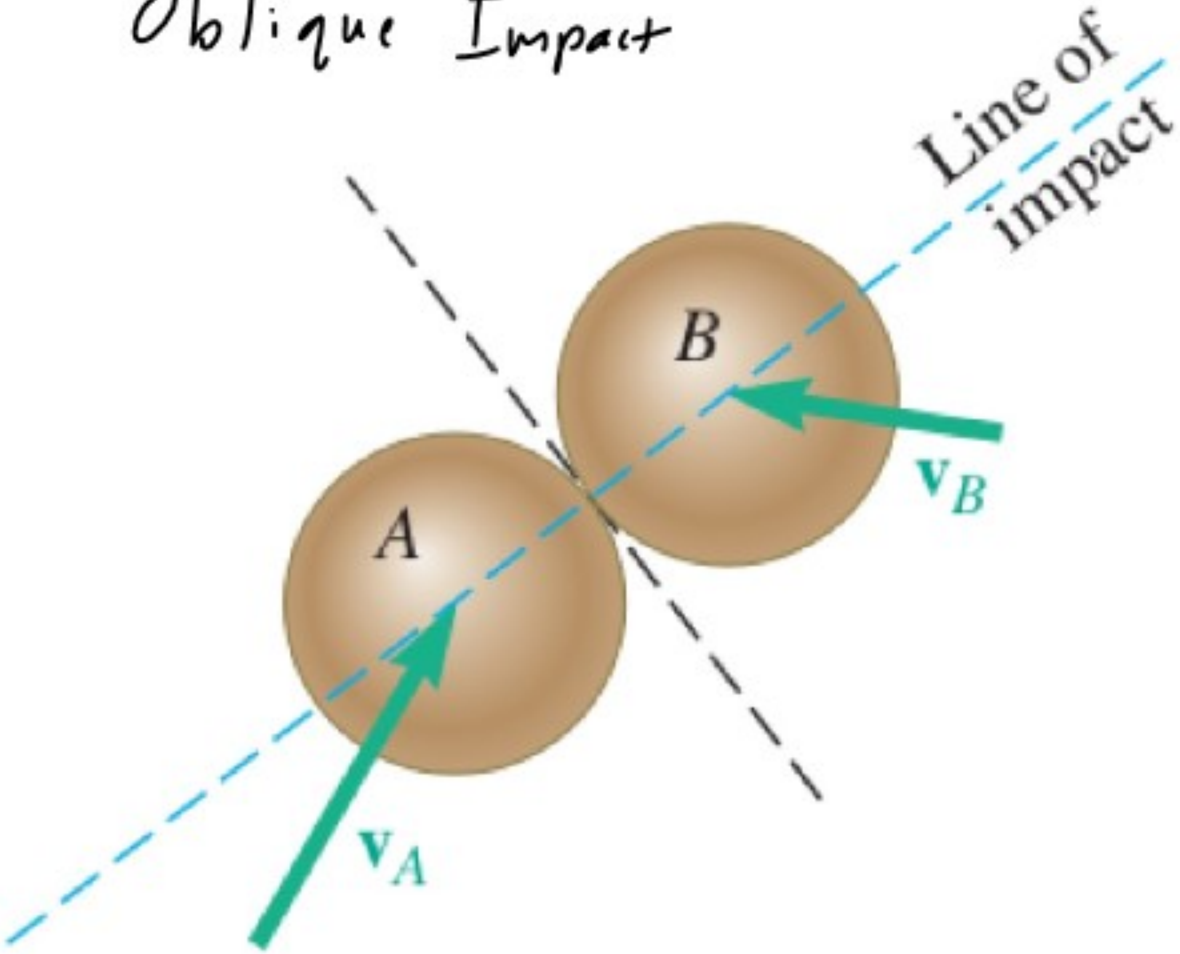
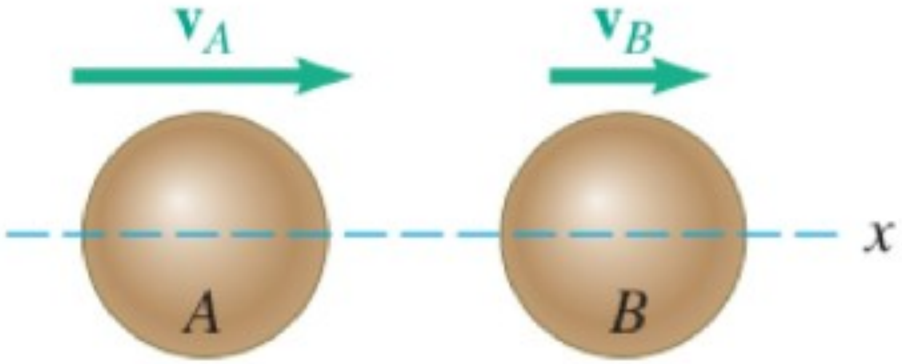
Impacts

Direct Impact



Oblique Impact

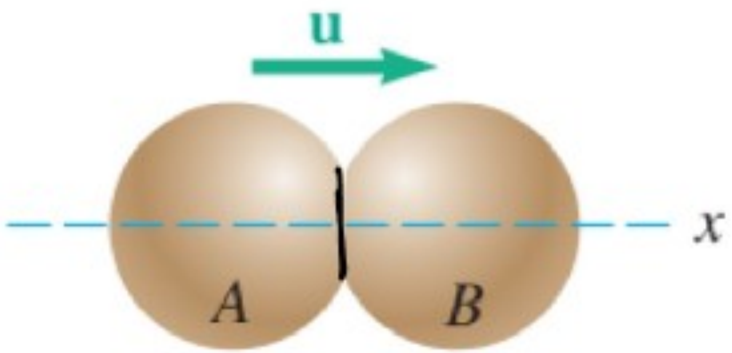




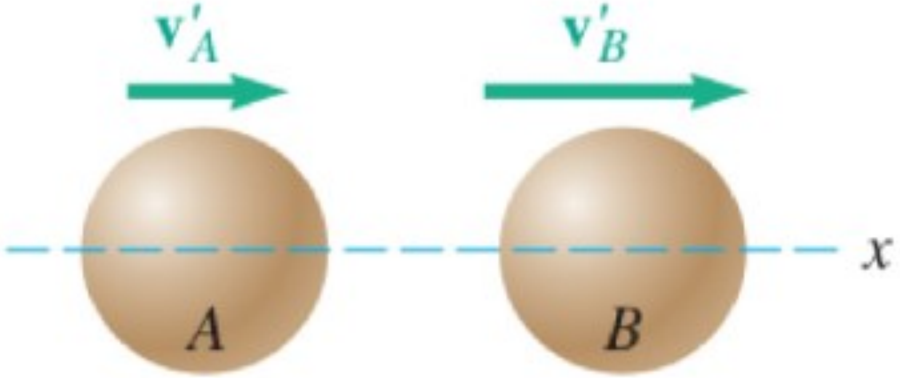
(a) Before impact

$$m_A v_A + m_B v_B = m_A v_A' + m_B v_B'$$

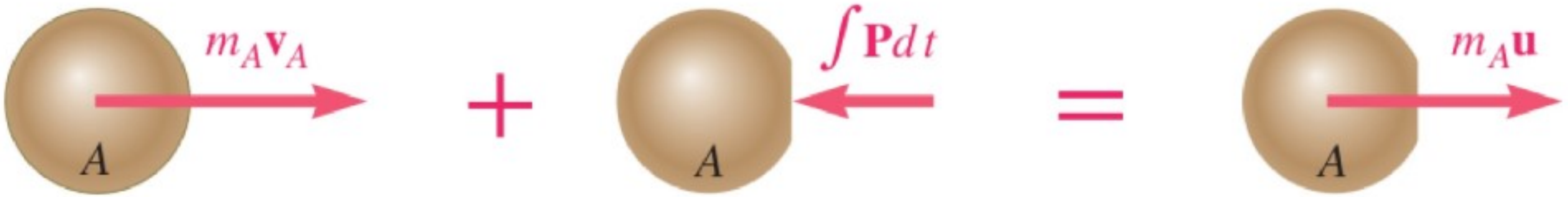
$$L_A + L_B = L_A' + L_B'$$



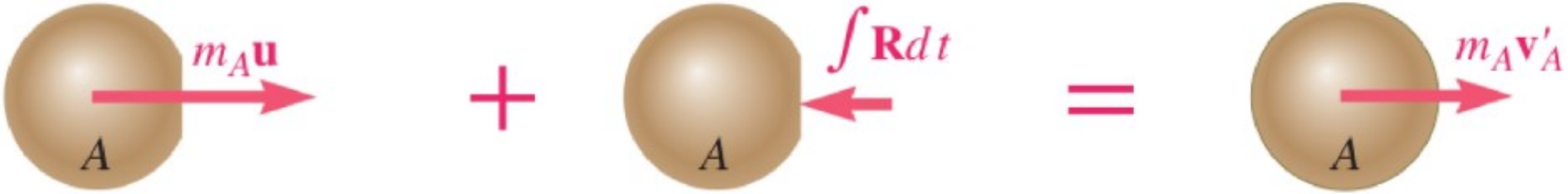
(b) At maximum deformation



(c) After impact



(*a*) Period of deformation



(*b*) Period of restitution

$$e = \frac{\int R\,dt}{\int P\,dt} = \frac{u - v_A'}{v_A - u} = \frac{v_B' - u}{u - v_B} = \frac{v_B' - v_A'}{v_A - v_B}$$

coefficient of restitution

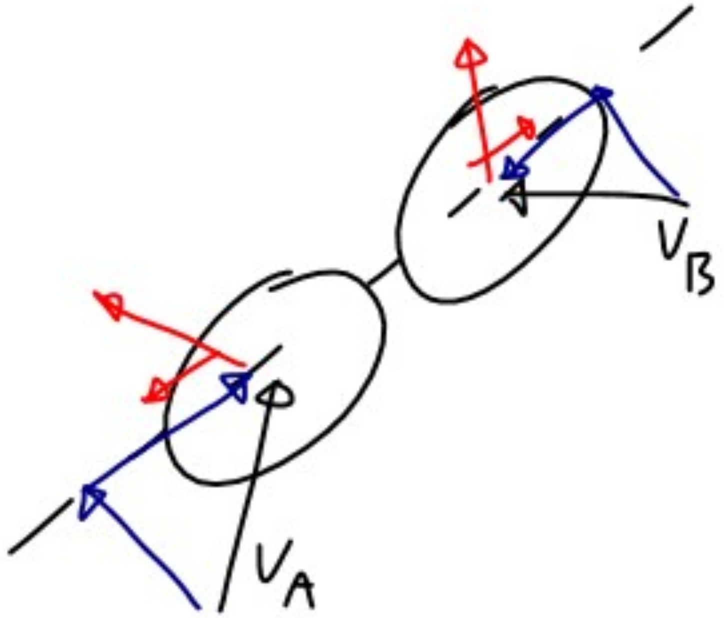
$$v_B' - v_A' = e(v_A - v_B)$$

$e = 0$ pefectly plastic impact

$$V_B' - V_A' = 0 \qquad V_B' = V_A'$$

$e = 1$ perfectly elastic impact

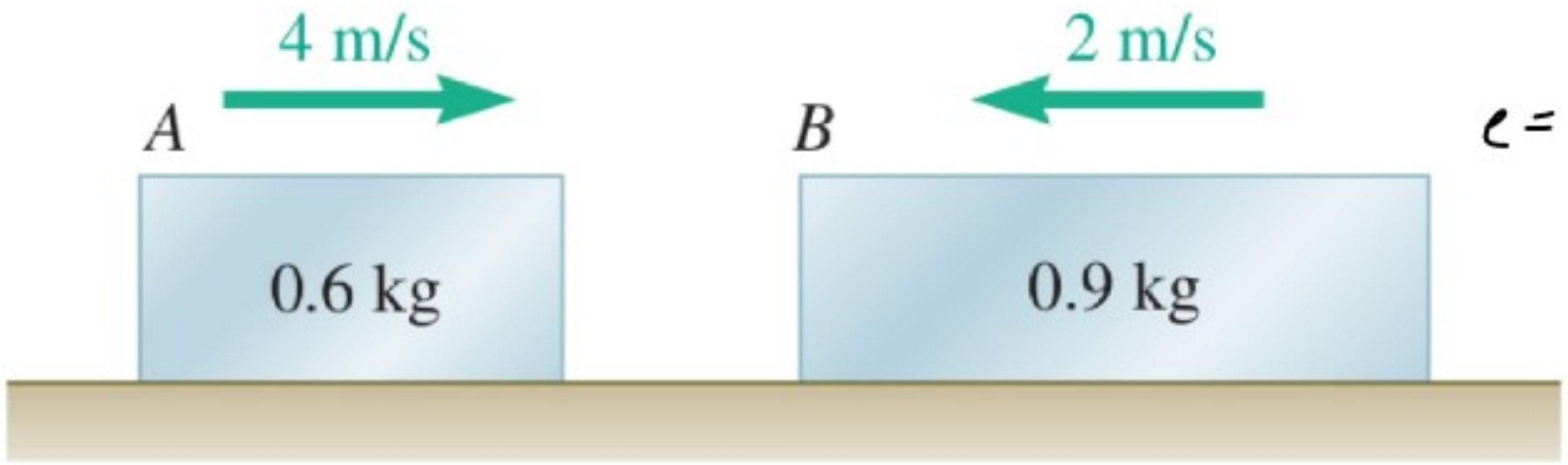
$$V_B' - V_A' = V_A - V_B$$



V_B
V_A

The velocities of two steel blocks before impact are as shown. Knowing that the velocity of block *B* after the impact is observed to be 2.5 m/s to the right, determine the coefficient of restitution between the two blocks.

$\xrightarrow{+}$



$V_A = 4 \text{ m/s}$

$V_B = -2 \text{ m/s}$

$V_B' = 2.5 \text{ m/s}$

$$e = \frac{V_B' - V_A'}{V_A - V_B} = \frac{2.5 + 2.75}{4 + 2}$$

$$= 0.875$$

$$m_A V_A + m_B V_B = m_A V_A' + m_B V_B'$$

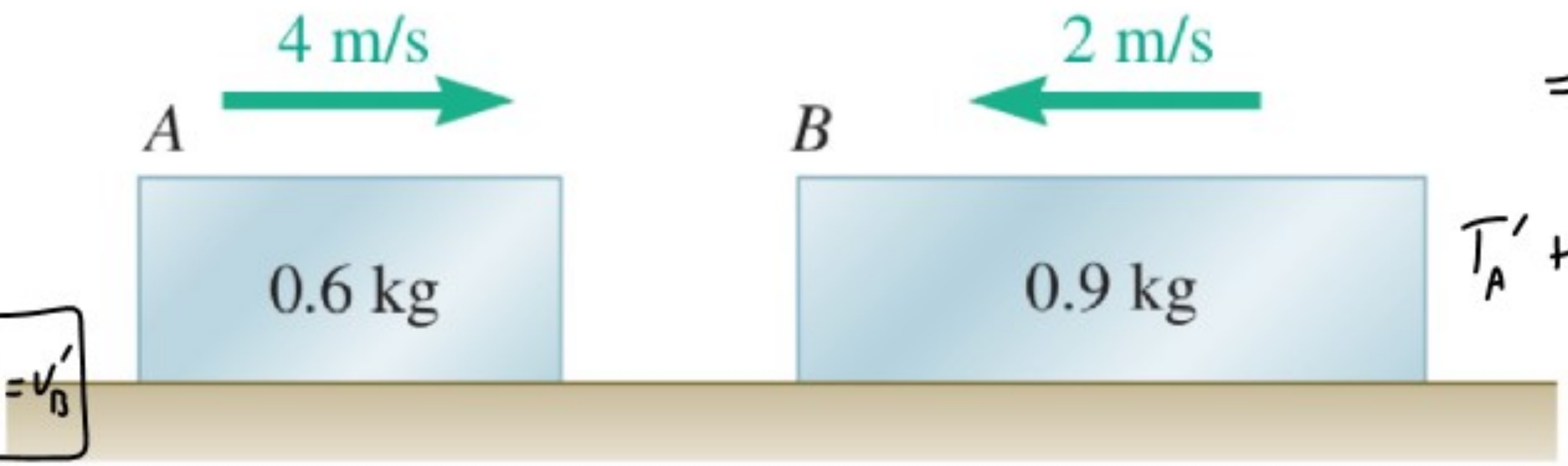
$$0.6 \cdot 4 + 0.9(-2) = 0.6 V_A' + 0.9 \cdot 2.5$$

$$0.6 \cdot 4 + 0.9(-2) - 0.9 \cdot 2.5 = 0.6 V_A'$$

$$\frac{0.6 \cdot 4 + 0.9(-2) - 0.9 \cdot 2.5}{0.6} = -2.75$$

Two steel blocks slide without friction on a horizontal surface; immediately before impact their velocities are as shown. Knowing that $e = 0.75$, determine (*a*) their velocities after impact, (*b*) the energy loss during impact.

$\xrightarrow{+}$



$V_B' - V_A' = e(V_A - V_B)$

$= 0.75(4+2)$

$V_B' - V_A' = 4.5 \text{ m/s}$

$V_B' = 4.5 + V_A' = 4.5 - 2.3 = 2.2 \text{ m/s} = V_B'$

$m_A V_A + m_B V_B = m_A V_A' + m_B V_B'$

$0.6 \cdot 4 + 0.9(-2) = 0.6 V_A' + 0.9 V_B' = 0.6 V_A' + 0.9(4.5 + V_A')$

$= 0.6 V_A' + 0.9 \cdot 4.5 + 0.9 V_A'$

$0.6 \cdot 4 + 0.9(-2) - 0.9 \cdot 4.5 = 0.6 V_A' + 0.9 V_A' = 1.5 V_A'$

$\frac{0.6 \cdot 4 + 0.9(-2) - 0.9 \cdot 4.5}{1.5} = V_A' = -2.3 \text{ m/s}$

$T_A + T_B = \frac{1}{2} m_A V_A^2 + \frac{1}{2} m_B V_B^2$

$= \frac{1}{2} 0.6(4)^2 + \frac{1}{2} 0.9(2)^2 = 6.6$

$T_A' + T_B' = \frac{1}{2} m_A V_A'^2 + \frac{1}{2} m_B V_B'^2$

$= \frac{1}{2} 0.6(2.3)^2 + \frac{1}{2} 0.9(2.2)^2$

$= 3.8$

$\Delta U = 2.8$