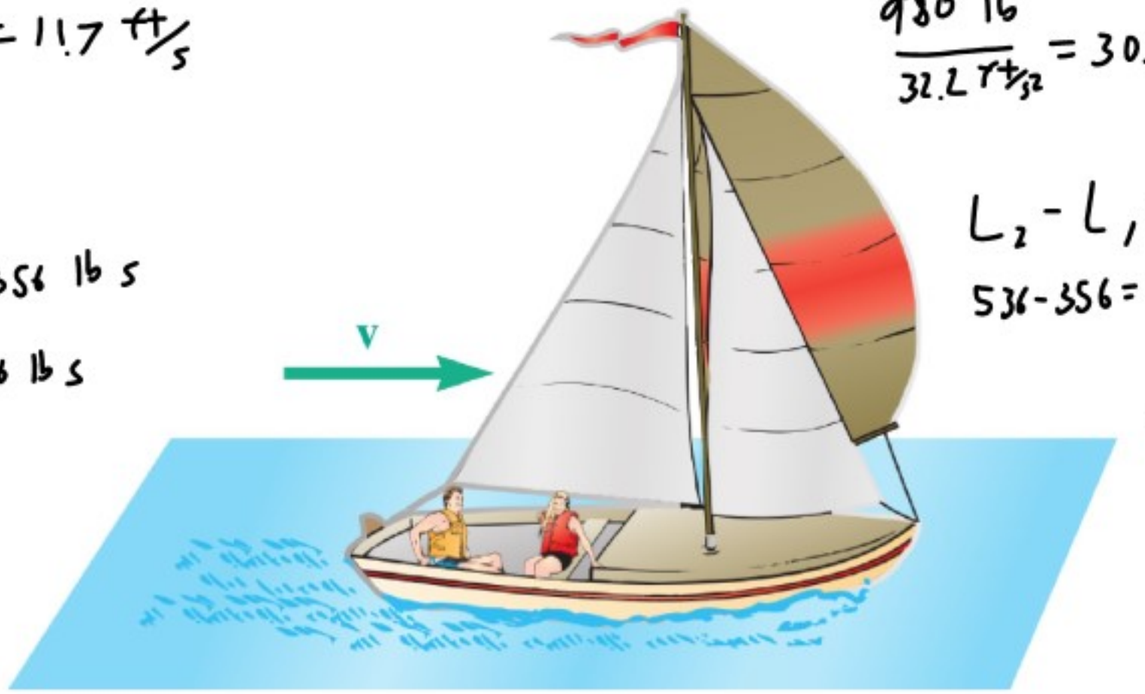
A sailboat weighing 980 lb with its occupants is running downwind at 8 mi/h when its spinnaker is raised to increase its speed. Determine the net force provided by the spinnaker over the 10-s interval that it takes for the boat to reach a speed of 12 mi/h.

$8 \frac{mi}{h} \frac{1 h}{3600 s} \frac{5280 ft}{1 mi} = 11.7 \frac{ft}{s}$

$12 \frac{mi}{h} = 17.6 \frac{ft}{s}$

$L_1 = 11.7 \frac{ft}{s} \, 30.43 \frac{lb\,s^2}{ft} = 356 \; lb\,s$

$L_2 = 17.6 \frac{ft}{s} \, 30.43 \frac{lb\,s^2}{ft} = 536 \; lb\,s$



$\frac{980 \; lb}{32.2 \frac{ft}{s^2}} = 30.43 \frac{lb\,s^2}{ft}$

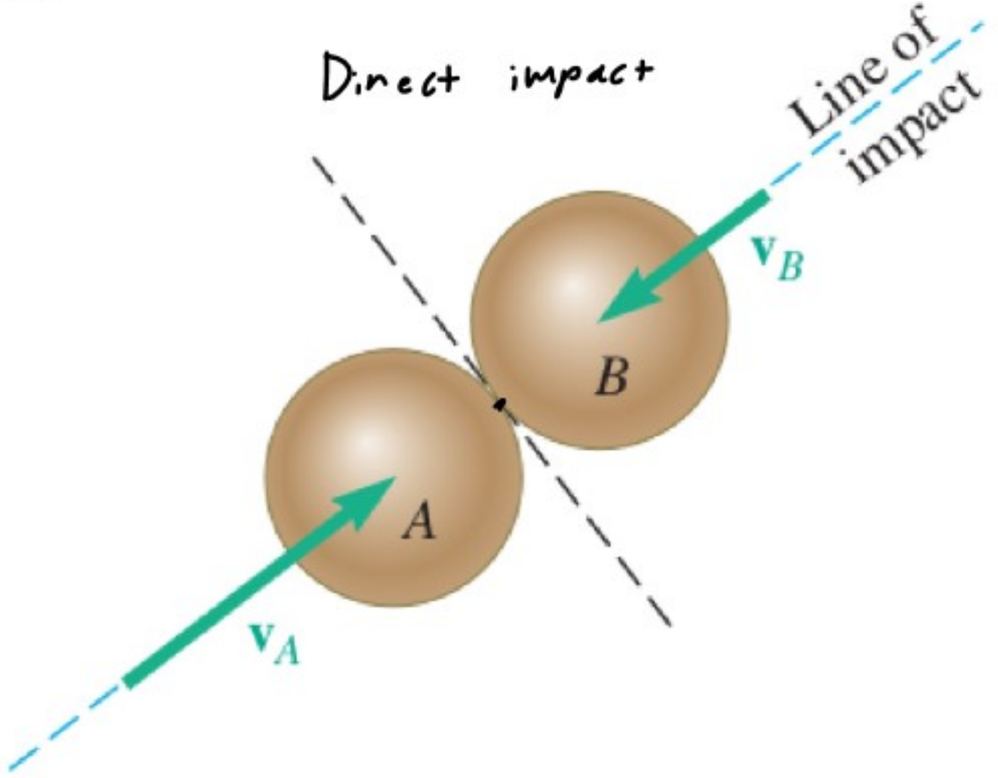
$L_2 - L_1 = Imp_{1 \to 2} = F \Delta t$

$536 - 356 = 179 \; lb\,s = F \Delta t = F \, 10 \, s$

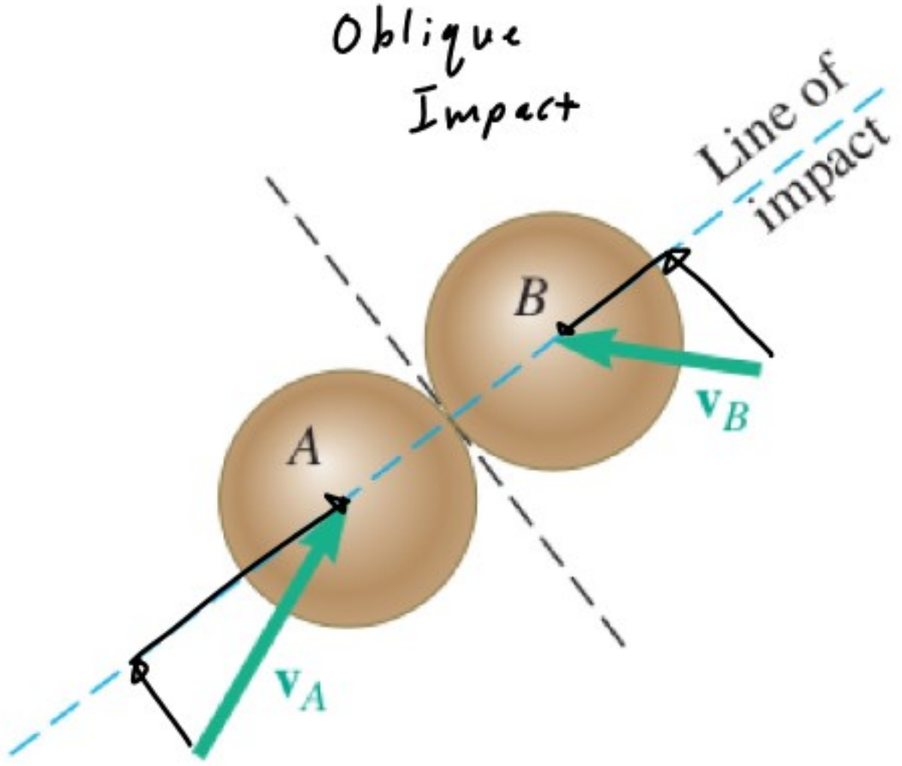
$\frac{179 \; lb\,s}{10 \, s} = \boxed{17.9 \; lb}$

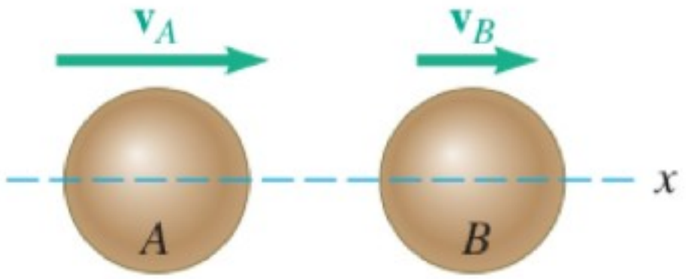
Impact

Direct impact



Oblique Impact

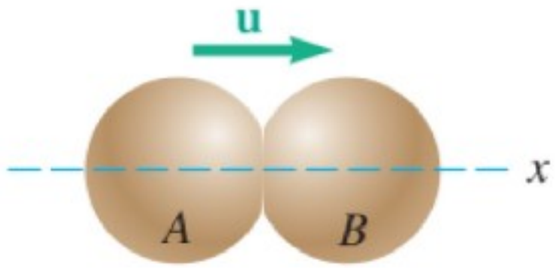




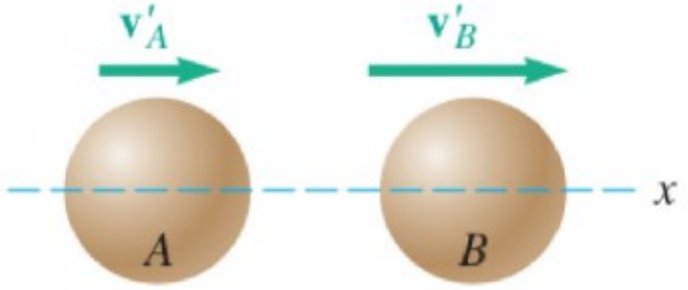
(*a*) Before impact

$$m_A v_A + m_B v_B = m_A v'_A + m_B v'_B$$

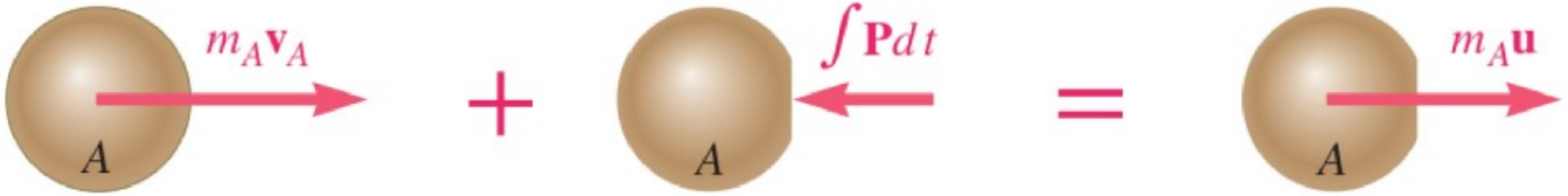
$$L_A + L_B = L'_A + L'_B$$



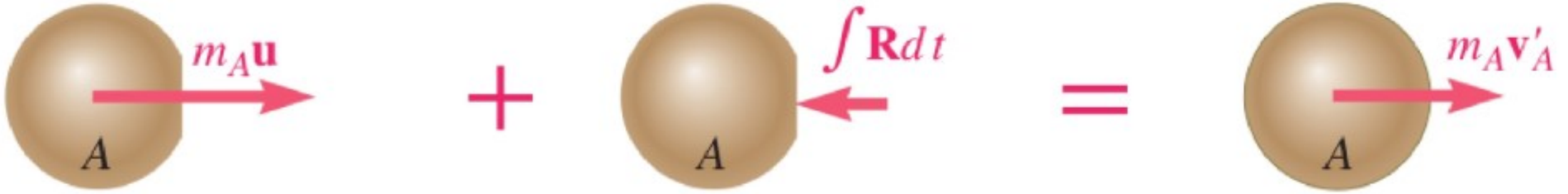
(*b*) At maximum deformation



(*c*) After impact



(*a*) Period of deformation



(*b*) Period of restitution

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

$V_B' - V_A' = e(V_A - V_B)$ e coefficient of restitution

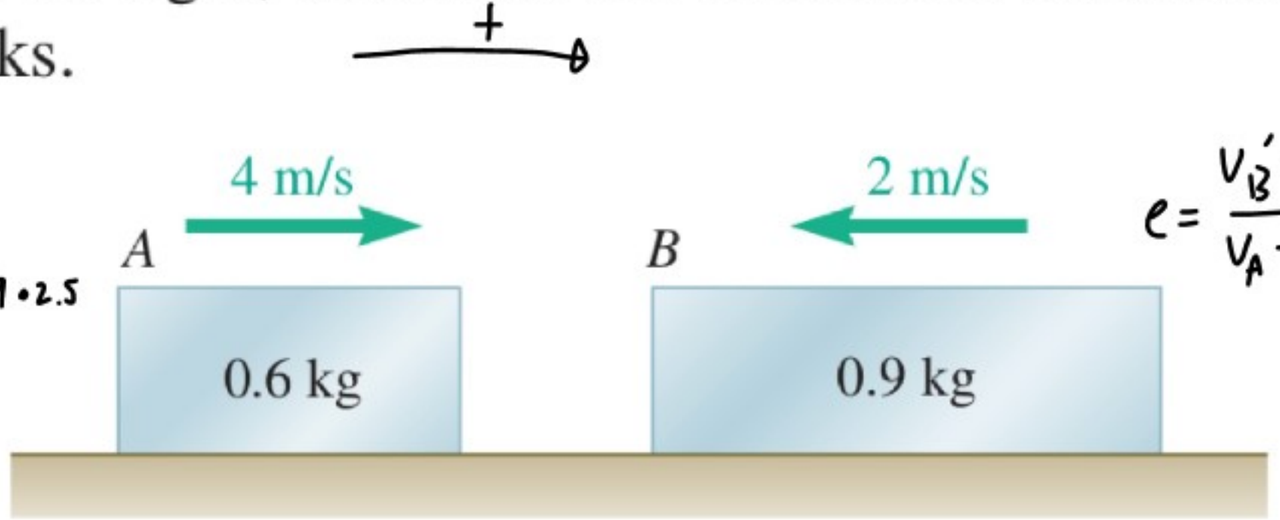
$e = 0$ perfectly plastic impact

$V_B' - V_A' = 0$ $V_B' = V_A'$

$e = 1$ perfectly elastic impact

$V_B' - V_A' = V_A - V_B$

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.



$$L_A + L_B = L'_A + L'_B$$

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

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

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

$$V_A' = -2.75 \text{ m/s}$$

$$e = \frac{V_B' - V_A'}{V_A - V_B} = \frac{2.5 + 2.75}{4 + 2} = 0.375$$

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.