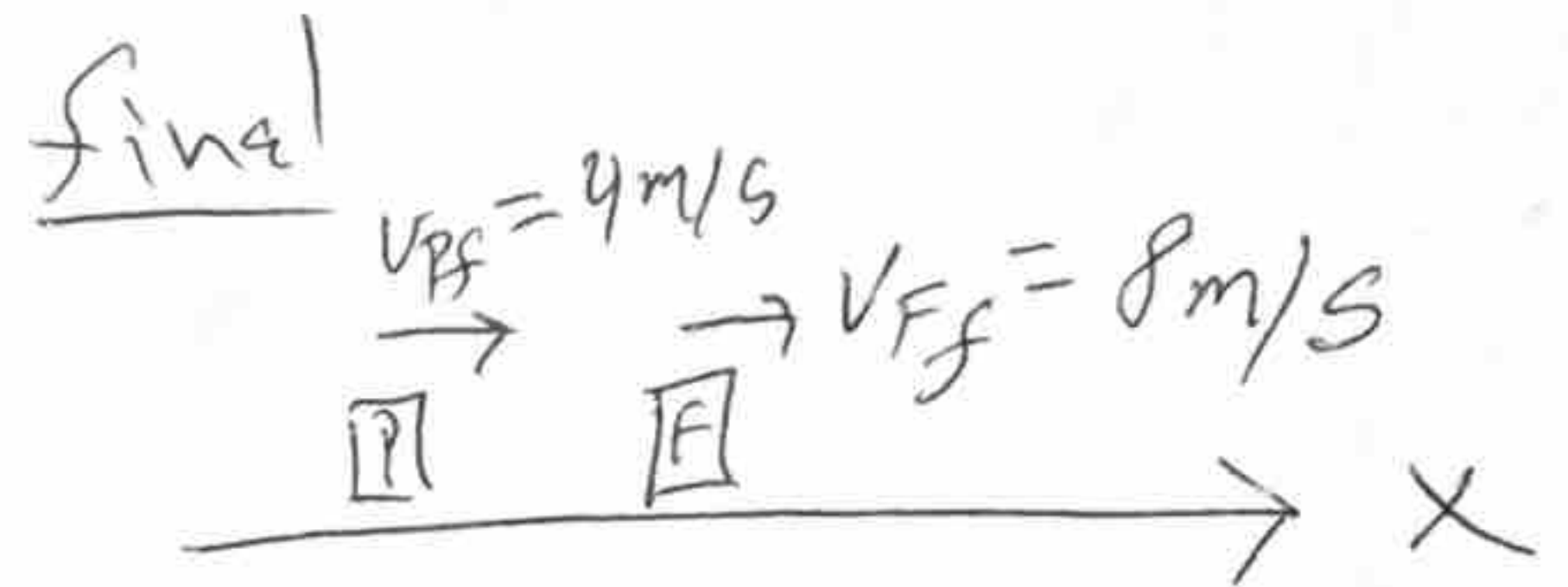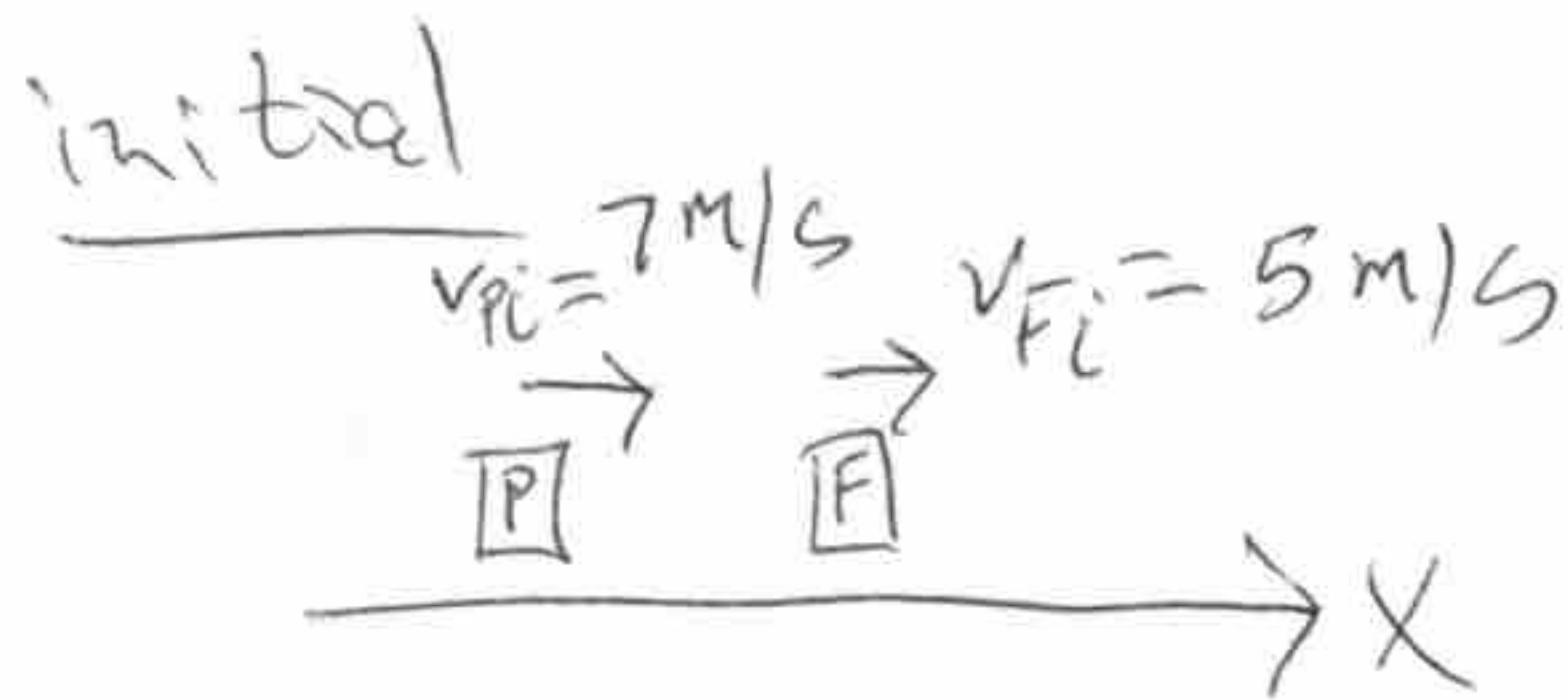**4.59** An 80 kg physicist and a friend are ice skating. The physicist, distracted, collides from behind at 7.0 m/s with his friend, who is skating at 5.0 m/s in the same direction. After the collision, the physicist continues in the same direction at 4.0 m/s, but his friend is now moving (still in the same direction) at 8.0 m/s. What is her inertia?

initial

$v_{Pi} = 7 m/s$ $v_{Fi} = 5 m/s$

$\boxed{P} \rightarrow$ $\boxed{F} \rightarrow$

$\longrightarrow X$

final

$v_{Pf} = 4 m/s$

$\boxed{P} \rightarrow$ $\boxed{F} \rightarrow v_{Ff} = 8 m/s$

$\longrightarrow X$

$m_P = 80\ kg$

$m_F = ?$

$\Delta \vec{p} = \vec{0} \implies \Delta \vec{p}_P + \Delta \vec{p}_F = \vec{0}$

$\implies \Delta p_x = 0 \implies \Delta p_{Px} + \Delta p_{Fx} = 0$

$\quad\quad \Delta p_y = 0 \implies \Delta p_{Py} + \Delta p_{Fy} = 0$

$\Delta p_{Px} = p_{Px,f} - p_{Px,i} = m_P (v_{Px,f} - v_{Px,i})$

$\Delta p_{Fy} = p_{Fx,f} - p_{Fx,i} = m_F (v_{Fx,f} - v_{Fx,i})$

$\therefore m_F(v_{Fx,f} - v_{Fx,i}) + m_P(v_{Px,f} - v_{Px,i}) = 0$

$\implies m_F = -m_P \dfrac{v_{Px,f} - v_{Px,i}}{v_{Fx,f} - v_{Fx,i}}$

$= -(80\ kg) \dfrac{4 m/s - 7 m/s}{8 m/s - 5 m/s}$

$= -80\ kg \left(\dfrac{-3 m/s}{3 m/s} \right)$

$= 80\ kg$