Solution to Example 5:

Before Collision

\[ \vec{P}_{\text{A bef}} = m_A \cdot \vec{U}_A = 500 \text{ kg} \cdot 20 \text{ m/s} = 1 \times 10^4 \text{ Ns West} \]

\[ \vec{P}_{\text{B bef}} = m_B \cdot \vec{U}_B = 650 \text{ kg} \cdot 25 \text{ m/s} = 1.625 \times 10^4 \text{ Ns North} \]

(c) Total momentum before collision, \( \vec{P}_{\text{T bef}} = \vec{P}_{\text{A bef}} + \vec{P}_{\text{B bef}} \)

This is a vector addition + has been done above in the "After Collision" section. Clearly:

\[ \vec{P}_{\text{T bef}} = \sqrt{(1 \times 10^4)^2 + (1.625 \times 10^4)^2} \]

\[ = 1.908 \times 10^4 \text{ Ns} \]

\[ \theta = \tan^{-1} \left( \frac{1.625 \times 10^4}{1 \times 10^4} \right) = 58.4^\circ \]

\[ \therefore \text{Total momentum before collision} = 1.908 \times 10^4 \text{ Ns in a direction N31.6^\circ W}. \]
(d) Since this system may be considered an isolated one, since external forces would be negligible compared to size of the collision force, we may assume the law of conservation of momentum holds true in this case.

\[ \text{Total Momentum before collision} = \text{Total Momentum after collision} \]

\[ \text{Total momentum after collision} = 1.908 \times 10^4 \text{ Ns in a direction N}31.6^\circ \text{W}. \]

(e) Velocity with which wreckage moves off after collision:

\[ \vec{V}_{\text{aft}} = \frac{\vec{P}_{\text{aft}}}{M_{\text{aft}}} \]

\[ \vec{V}_{\text{aft}} = \frac{1.908 \times 10^4}{500 + 650} = 16.59 \text{ m/s} \]

\[ \text{Final KE} = \frac{1}{2} m_{\text{aft}} v_{\text{aft}}^2 = \frac{1}{2} \times 1150 \times 16.59^2 \]

\[ = 1.5828 \times 10^5 \text{ J} \]

\[ \text{Initial KE} = \frac{1}{2} m_{\text{i}} v_{\text{i}}^2 + \frac{1}{2} m_{\text{b}} v_{\text{b}}^2 \]

\[ = 100000 + 203125 \]

\[ = 303125 \text{ J} \]

\[ \text{Loss of KE during collision} = \text{KE}_{\text{initial}} - \text{KE}_{\text{final}} \]

\[ = 144845 \text{ J} \]

\[ = 1.448 \times 10^5 \text{ J} \]

Note: The subscripts i (for initial) and f (for final) are quicker ways than before and after to indicate the same thing.