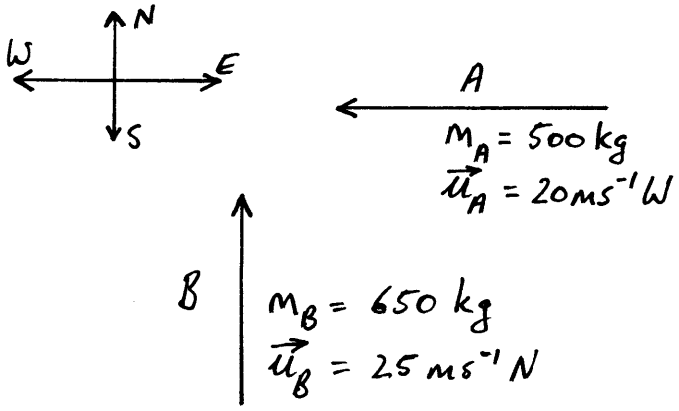
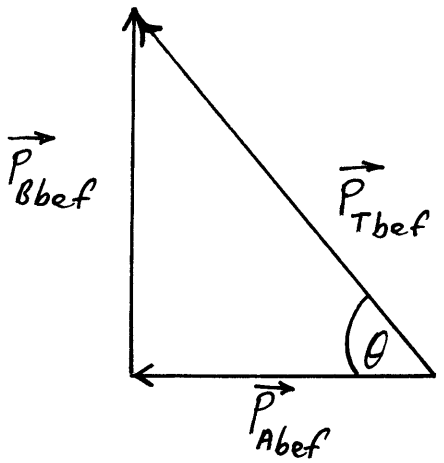
Solution to Example 5:

Before Collision



After Collision



(a) $\vec{P}_{Abef} = m_A \cdot \vec{u}_A$

$= 500 \times 20$

$= 1 \times 10^4$ Ns West

(Note: $\vec{P}_{Abef}$ = momentum of A before collision)

(b) $\vec{P}_{Bbef} = m_B \cdot \vec{u}_B$

$= 1.625 \times 10^4$ Ns North

(c) Total momentum before collision, $\vec{P}_{Tbef} = \vec{P}_{Abef} + \vec{P}_{Bbef}$.

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

$$P_{Tbef} = \sqrt{(1\times10^4)^2 + (1.625\times10^4)^2}$$

$$= 1.908 \times 10^4\ Ns$$

$$\theta = \tan^{-1}\left(\frac{1.625\times10^4}{1\times10^4}\right) = 58.4^\circ$$

$\therefore$ Total momentum before collision = 1.908×10^4 Ns in a direction N31.6°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.

∴ Total Momentum ~~of~~ after collision = Total momentum before collision.

∴ Total momentum after collision = 1.908×10^4 Ns in a direction N31.6°W.

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

$$\vec{P}_{Taft} = m_{Taft} \cdot \vec{V}_{aft}$$

$$\therefore \vec{V}_{aft} = \frac{\vec{P}_{Taft}}{m_{Taft}} = \frac{1.908 \times 10^4}{(500 + 650)} = 16.59 \text{ ms}^{-1} \text{ N31.6°W}$$

∴ Final KE $= \frac{1}{2} m v^2 = \frac{1}{2} \times 1150 \times 16.59^2$

$= 1.5828 \times 10^5$ J

Initial KE $= \frac{1}{2} m_A u_A^2 + \frac{1}{2} m_B u_B^2$

$= 100000 + 203125$

$= 303125$ J

∴ Loss of KE during collision = $KE_{initial} - KE_{final}$

$= 144845$ J

$= 1.448 \times 10^5$ J

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