

**21-P-MOM-AG-045**

A ninja and a cowboy are having a duel. The cowboy shoots his pistol at the ninja. The bullet flies towards the ninja at  $V \frac{m}{s}$ . The ninja manages to bring her katana up to split the bullet into two pieces, A and B, weighing  $m_1$  grams and  $m_2$  grams, respectively. If the two pieces travel on the trajectories shown, determine the magnitude of the velocity of each piece.

ANSWER:

First, we write the equations for conservation of momentum in the x and y axes.

$$m_i v_x = (m_1 + m_2) \cdot V = m_1 v_{1,x} + m_2 v_{2,x} = m_1 v_1 \cos(\theta_1) + m_2 v_2 \cos(\theta_2)$$

$$m_i v_y = 0 = m_1 v_{1,y} + m_2 v_{2,y} = m_1 v_1 \sin(\theta_1) + m_2 v_2 \sin(\theta_2)$$

Then, we rearrange to solve for one of the two velocities.

$$v_2 = \frac{-m_1 v_1 \sin(\theta_1)}{m_2 \sin(\theta_2)}$$

$$v_2 = \frac{m_1 V + m_2 V - m_1 v_1 \cos(\theta_1)}{m_2 \cos(\theta_2)}$$

Then, we equate the two equations obtained above and solve for the velocity of one piece, and therefore the velocity of the other piece.

$$v_1 = \frac{(m_1 V + m_2 V) m_2 \sin(\theta_2)}{m_1 \cos(\theta_1) - m_1 m_2 \sin(\theta_1) \cos(\theta_2)} \frac{m}{s}$$

$$v_2 = \frac{-m_1 v_1 \sin(\theta_1)}{m_2 \sin(\theta_2)} \frac{m}{s}$$