Answer on Question #39104, Physics, Mechanics

Question:

Two air track gliders experience an elastic head-on collision. A 0.28 kg glider is heading at 2.13 m/s when it collides with a 2.58 kg glider which is moving at -3.58 m/s.

What is the velocity of the 0.28 kg object after the collision?

What is the velocity of the 2.58 kg object after the collision?

Answer:

The law of conservation of momentum:

$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$m_1(v_1 - v_1') = m_2(v'_2 - v_2)$$

where $m_1 = 0.28\ kg, m_2 = 2.58$, v_1, v_2 are speeds before collision, v_1', v_2' - after.

The law of conservation of energy:

$$\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2} = \frac{m_1 {v_1'}^2}{2} + \frac{m_2 {v_2'}^2}{2}$$

$$\frac{m_1 v_1^2}{2} - \frac{m_1 {v_1'}^2}{2} = \frac{m_2 {v_2'}^2}{2} - \frac{m_2 v_2^2}{2}$$

$$m_1(v_1 - v_2)(v_1 + v_2) = m_2(v'_2 - v_2)(v'_2 + v_2)$$

So, we have system of equations:

$$\begin{cases} m_1(v_1 - v_1') = m_2(v'_2 - v_2) \\ m_1(v_1 - v_1')(v_1 + v_1') = m_2(v'_2 - v_2)(v'_2 + v_2) \end{cases}$$

Or:

$$\begin{cases} m_1(v_1 - v_1') = m_2(v'_2 - v_2) \\ (v_1 + v_1') = (v'_2 + v_2) \end{cases}$$

Solving for v_1' and v_2':

$$v_1' = \frac{2m_2 v_2 + (m_1 - m_2)v_1}{m_1 + m_2} = -8.17\frac{m}{s}$$

$$v_2' = \frac{2m_1v_1 - (m_1 - m_2)v_2}{m_1 + m_2} = -2.46\frac{m}{s}$$

Answer: $v_1' = -8.17\frac{m}{s}$, $v_2' = -2.46\frac{m}{s}$