

### Answer on Question#39105 – Physics – Mechanics

A 27.6-g object moving to the right with a speed of 23.9 cm/s overtakes and collides elastically with a 18.1-g object moving in the same direction with a speed of 14.9 cm/s. Find the velocity (in cm/s) of 18.1-g object after the collision.

#### Solution:

$m_1 = 27.6g$  is mass of the first object;

$v_1 = 23.9 \frac{cm}{s}$  is the initial velocity of 27.6g object

$v_1'$  is final velocity of 27.6g object

$m_2 = 18.1g$  is mass of the second object;

$v_2 = 14.9 \frac{cm}{s}$  is the initial velocity of 18.1g object

$v_2'$  is final velocity of 18.1g object

This is a conservation of momentum and energy problem.

Conservation of momentum before and after collision:

$$\begin{aligned}x: m_1 v_1 + m_2 v_2 &= m_1 v_1' + m_2 v_2' \\ m_1(v_1 - v_1') &= m_2(v_2' - v_2) \quad (1)\end{aligned}$$

Conservation of kinetic energy before and after collision:

$$\begin{aligned}\frac{m_1 v_1^2}{2} + \frac{m_2 v_2^2}{2} &= \frac{m_1 v_1'^2}{2} + \frac{m_2 v_2'^2}{2} \\ m_1(v_1^2 - v_1'^2) &= m_2(v_2'^2 - v_2^2)\end{aligned}$$

Using the difference of squares formula:

$$m_1(v_1 - v_1')(v_1 + v_1') = m_2(v_2' - v_2)(v_2' + v_2) \quad (2)$$

$$(2) \div (1)$$

$$\frac{m_1(v_1 - v_1')(v_1 + v_1')}{m_1(v_1 - v_1')} = \frac{m_2(v_2' - v_2)(v_2' + v_2)}{m_2(v_2' - v_2)}$$

$$v_1 + v_1' = v_2' + v_2$$

$$v_1' = v_2' + v_2 - v_1 \quad (3)$$

(3)in(1):

$$\begin{aligned}m_1(v_1 - (v_2' + v_2 - v_1)) &= m_2(v_2' - v_2) \\ m_1 v_1 - m_1 v_2' - m_1 v_2 + m_1 v_1 &= m_2 v_2' - m_2 v_2 \\ v_2'(m_1 + m_2) &= v_2(m_1 - m_2) - 2m_1 v_1\end{aligned}$$

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

$$= \frac{14.9 \frac{cm}{s} (27.6g - 18.1g) - 2 \cdot 27.6g \cdot 23.9 \frac{cm}{s}}{27.6g + 18.1g} = -25.8 \frac{cm}{s}$$

**Answer:** the velocity of 18.1-g object after the collision is equal to  $25.8 \frac{cm}{s}$ .