Answer on Question #76288, Physics Mechanics Relativity

A ball P of mass 2 kg undergoes an elastic collision with another ball Q at rest. After collision, ball P continues to move in its original direction with a speed one fourth of its original speed. What is the mass of ball Q?

Solution.

From the law of conservation of momentum

$$\mathrm{m}_1\mathrm{v}_1 + \mathrm{m}_2 v_2 = m_1 v_1' + m_2 v_2'$$

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

From the law of conservation of energy

$$\frac{\mathrm{m}_1\mathrm{v}_1^2}{2} + \frac{\mathrm{m}_2 v_2^2}{2} = \frac{m_1 v_1'^2}{2} + \frac{m_2 v_2'^2}{2}$$

or $m_1(v_1^2 - v_1'^2) = m_2(v_2'^2 - v_2^2)$

or $m_1(v_1 - v_1')(v_1 + v_1') = m_2(v_2' - v_2)(v_2' + v_2)$

Take advantage of the law of conservation of momentum

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

$$v_1 + \frac{v_1}{4} = v_2' + 0$$

where $v_1' = \frac{v_1}{4}$, $v_2 = 0$

$$v_2' = \frac{5v_1}{4}$$

Substitute the values obtained in the law of conservation of energy

$$\mathrm{m}_1\mathrm{v}_1 + \mathrm{m}_2 v_2 = m_1 v_1' + m_2 v_2'$$

$$\mathrm{m}_1\mathrm{v}_1 + \mathrm{m}_2 \cdot 0 = m_1 \frac{v_1}{4} + m_2 \frac{5 \cdot v_1}{4}$$

$$\frac{3 \cdot m_1 v_1}{4} = m_2 \frac{5 \cdot v_1}{4}$$

$$\mathrm{m}_2 = \frac{3\mathrm{m}_1}{5} = \frac{3 \cdot 2\ \mathrm{kg}}{5} = 1.2\ \mathrm{kg}$$

Answer: The mass of ball Q is 1.2 kg