

Conservation of Momentum

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During a collision or explosion momentum may be transferred from one object to another but the total momentum of the objects is conserved.

$$P_{\text{before}} = P_{\text{after}}$$

3 Types of Problems

1) 2 separate objects collide and stick together

$$P_b = P_a$$

$$m_1 v_1 + m_2 v_2 = (m_1 + m_2) v_f$$

2) 2 separate objects collide and bounce off each other

$$P_b = P_a$$

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

← after →

3) Explosion: one object separates into 2

$$P_b = P_a$$

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

$$m = m_1 + m_2$$

Ex: A 0.2 kg golf ball hits a stationary 1.4 kg apple and sticks in it. If they travel together at 3.0 m/s, what was the initial velocity of the golf ball?

$$P_b = P_a$$

$$m_1 v_1 + m_2 v_2 = m v_f$$

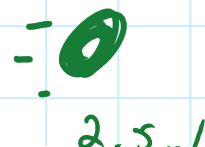
$$(.2 \text{ kg})(v_1) + (1.4)(0) = (1.6 \text{ kg})(3.0 \text{ m/s})$$

$$.2 v_1 = 4.8 \text{ kg m/s}$$

$$v_1 = 24 \text{ m/s}$$

Ex A 1.0 kg red ball travelling at 6.0 m/s [R] hits a 3.0 kg green ball travelling at 4.0 m/s [L]. They hit and bounce off with green travelling at 2.5 m/s [R]. What is the velocity of the red ball?

$$P_b = P_a$$



$$\begin{array}{cccc} \overline{6\text{ m/s}} & \overline{4\text{ m/s}} & ? & \overline{2.5\text{ m/s}} \\ & & & \end{array}$$

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

$$(1.0\text{ kg})(6\text{ m/s}) + (3\text{ kg})(-4\text{ m/s}) = 1(v_1') + 3(2.5\text{ m/s})$$

$$6 - 12 = 1v + 7.5$$

$$-6 = 1v + 7.5$$

$$-7.5 - 7.5 = 1v - 7.5$$

$$-13.5 = 1v \quad v = -13.5\text{ m/s}$$

↑
left

Ex A defective 4.0 kg bowling ball travelling at 10 m/s [N] spontaneously explodes into 2 pieces. A 1.5 kg piece continues at 30 m/s [N]. what is the velocity of the other piece?

$$P_b = P_a$$

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

$$(4\text{ kg})(10\text{ m/s}) = (1.5)(30\text{ m/s}) + (2.5\text{ kg})v_2'$$

$$40 = 45 + 2.5 v_2'$$

$$-45 - 45 = 2.5 v_2' - 45$$

$$\frac{-5}{2.5} = \frac{2.5 v_2'}{2.5}$$

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$$v = -2.0 \text{ m/s}$$

↑
south