1-D Conservation of Momentum

It's possible to measure the momentum of any number of objects before and after they collide.

- For now we will only look at how to figure out problems with two objects in a head-on collision, called either ***1 dimensional*** or ***linear*** collisions.
- It was noticed in Newton's time that the total momentum of all objects before a collision equals the total momentum of all objects after.
    - To this day the **Conservation of Momentum** remains a fundamental law of physics.

Note: We will be using the symbol "prime" (a little tick like this **'**) to represent "after the collision."

Before the Collision	***After the Collision***
momentum of object "a" = p_a	momentum of object "a" = p_a'
momentum of object "b" = p_b	momentum of object "b" = p_b'

So, a formula for two objects that collide would look like…

$$p_{total} = p_{total}'$$
$$p_a + p_b = p_a' + p_b'$$
$$m_a v_a + m_b v_b = m_a v_a' + m_b v_b'$$

You do have to be careful with how you solve these collision problems

- After the collision the two objects might bounce apart (**Example 1**)
- Or the objects might stick together (**Example 2**).

Example 1: Objects bounce apart

A 0.15kg blue billiard ball moving at 8.0m/s to the right hits a similar red billiard ball at rest. If the blue ball continues to move to the right at 2.5m/s, **determine** the velocity of the red ball.

$$p_{total} = p_{total}'$$
$$p_b + p_r = p_b' + p_r'$$
$$m_b v_b + m_r v_r = m_b v_b' + m_r v_r'$$
$$0.15kg(8.0m/s) + 0.15kg(0m/s) = 0.15kg(2.5m/s) + 0.15kg(v_r')$$
$$v_r' = 5.5m/s\ [right]$$

Example 2: Objects stick together

Two balls of clay, a blue one being 2.3kg and the second red one being 5.6kg, hit each other and stick together. If the blue one was moving to the right at 12m/s, and the red was moving at 8.1m/s to the left, **determine** their final velocity.

> Since the two lumps are stuck together, you add the masses together after the collision. Also, since they are one big lump now, they must have the same velocity, so you only have v'.

$$p_{total} = p_{total}'$$
$$p_b + p_r = p_b' + p_r'$$
$$m_b v_b + m_r v_r = m_b v_b' + m_r v_r'$$
$$m_b v_b + m_r v_r = v'\ (m_b + m_r)$$
$$2.3kg\ (+12m/s) + 5.6kg\ (-8.1m/s) = v`\ (2.3kg + 5.6kg)$$
$$v' = -\ 2.2\ m/s\ [left]$$