Simple 1D Collisions and Momentum Conservation

Introduction: When objects move, they have *momentum*. **Momentum, p, is simply the product of an object's mass (kg) and its velocity (m/s).** The unit for momentum, p, is kg·m/s. When two objects collide each will experience the same size force, caused by the other object (Third Law). If the force experienced is the only force on the object, it will be unbalanced, resulting in a net force on the object and will cause and impulse (change in momentum). This happens for both objects involved in the collision. In this activity you will explore how momentum can be transferred between objects, resulting in the law of conservation of momentum. There are two different types of collisions: (1) elastic: objects bounce off of each other and (2) inelastic: objects stick together.

Where: Go to the pHet Collision Lab simulation website. Stay on the Introduction tab.

What: You will be observing various 1D collisions. Please note that a positive motion is to the right and a negative motion is to the left.

- Take some time to familiarize yourself with the simulation and collisions. (No more than 5 minutes and "Reset all" before moving on)
- Use the simulation to complete the data tables on the back of this paper, read the following first:
  1. Check the "Show Values" box...Click the "More Data" button.
  2. Starting with the first collision (row 1) you will need to enter the given mass and velocity values for each ball into the data table in the simulation.
  3. Before collision: In the simulation the velocity and momentum of each ball is shown.
     a. Record the momenta for Ball 1 and 2 in your data table.
     b. Calculate the total momentum before the collision by adding the individual momenta (note the +/- values). Record this in your data table.
  4. After collision: Pause the simulation while both balls are still on screen...the individual velocities and momenta probably changed,
     a. Record these new velocities and momenta in your data table.
     b. Calculate the total momentum by adding the individual momenta (note the +/- values). Record this in your data table.

Conclusions: Based on the results answer the following

1. Explain why the momentum of each ball changes due to the collision. Use one of the collisions to help with your explanation.

2. Was the total momentum (ball 1 and 2 together) after each collision the same as it was before each collision?

3. Write what you think the "Law of Conservation of Momentum" would say:

Part 1 — Elastic collisions (move the elasticity slider all the way to the right, 100%)
Objects will bounce after the collision

Collision	Ball 1 Before collision			Ball 2 Before collision			Before collision	Ball 1 After collision		Ball 2 After collision		After collision
	m	$\vec{v}$	$\vec{p}$	m	$\vec{v}$	$\vec{p}$	$\vec{p}_{total}$	$\vec{v}$	$\vec{p}$	$\vec{v}$	$\vec{p}$	$\vec{p}_{total}$
1	3 kg	+2 m/s		3 kg	0 m/s							
2	3 kg	+2 m/s		1 kg	0 m/s							
3	1 kg	+2 m/s		3 kg	0 m/s							
4	3 kg	+2 m/s		3 kg	-2 m/s							
5	5 kg	+2 m/s		3 kg	-2 m/s							

Part 2 — Inelastic collisions (move the elasticity slider all the way to the left, 0%)
Objects will stick after the collision

Collision	Ball 1 Before collision			Ball 2 Before collision			Before collision	Ball 1 After collision		Ball 2 After collision		After collision
	m	$\vec{v}$	$\vec{p}$	m	$\vec{v}$	$\vec{p}$	$\vec{p}_{total}$	$\vec{v}$	$\vec{p}$	$\vec{v'}$	$\vec{p'}$	$\vec{p}_{total}$
6	3 kg	+2 m/s		3 kg	0 m/s							
7	3 kg	+2 m/s		6 kg	0 m/s							
8	6 kg	+2 m/s		3 kg	0 m/s							