Conservation of Momentum

Introduction:

According to the Law of Conservation of Linear Momentum, the total momentum of a system of objects is constant whenever the net outside force is zero. To paraphrase, calculate the momentum of each object using the formula

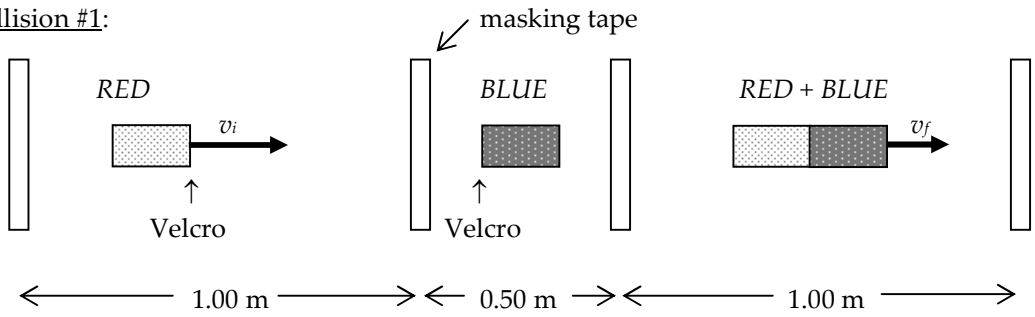
$$\text{Momentum} = mv$$

Then add them together. This *vector sum* remains the same so long as there are no outside forces present (a rare event!) or they cancel out.

The purpose of this experiment is to test whether this conservation law holds in a simple experiment. Make sure your group has a set of PAScars (one red and one blue), two 250-gram mass bars, two stopwatches, a scientific calculator, a meterstick, and masking tape.

Data Collection:

Collision #1:



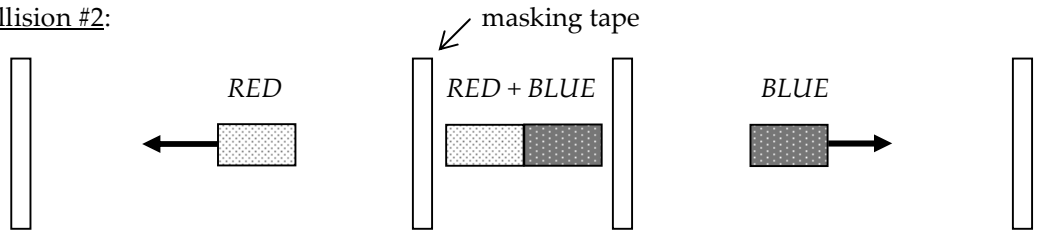
1) Apply parallel strips of masking tape to the floor as shown in the diagram.
2) Place the blue car in the middle. Be sure that the Velcro end faces the left and that it remains at rest before the collision.
3) Start the red car a few centimeters to the left of the first strip of tape. Be sure that the Velcro end faces the right (toward the blue car). Push the red car toward the blue car. The two cars should stick together and move as one after the collision. It is wise to practice this collision before you begin timing.
4) Once you are confident of your technique, you will need one group member to push the red car, another to time its motion between the first and second strips of tape, and a third to time the motion of the two cars stuck together as they travel between the third and fourth strips of tape. Record your data in the table below.
5) Add one mass bar to the blue car and repeat Steps 2 – 4.
6) Add the second mass bar to the blue car and repeat Steps 2 – 4.
7) Calculate the initial and final velocities (i.e. $v = 1.00\ \text{m}/t$) and the initial and final momenta.

	Initial time for red car [sec]	Final time for red + blue [sec]
Red hits Blue		
Red hits Blue + 1 mass bar		
Red hits Blue + 2 mass bars		

Mass of red car	Initial velocity of red car [m/s]	Initial momentum of red car [kg-m/s]
0.250 kg		
0.250 kg		
0.250 kg		

Mass of red + blue	Final velocity of red + blue [m/s]	Final momentum of red + blue [kg-m/s]
0.500 kg		
0.750 kg		
1.000 kg		

Collision #2:



1) Using the same tape strip configuration, place the red and blue cars next to each other in the middle as shown in the diagram. Be sure that the blue car's spring-loaded plunger (in the fully cocked position) makes contact with the red car.
2) Push the plunger release button on the top of the blue car. The two cars should recoil in opposite directions. It is wise to practice this recoil motion before you begin timing.
3) Once you are confident of your technique, you will need one group member to push the blue plunger release button, another to time the red car's motion between the first and second strips of tape, and a third to time the blue car's motion between the third and fourth strips of tape. Record your data in the table below.
4) Add one mass bar to the blue car and repeat Steps 1 – 3.
5) Add the second mass bar to the red car and repeat Steps 1 – 3.
6) Calculate the velocities and the momenta of the two cars.

	Travel time for red car [sec]	Travel time for blue car [sec]
Red / Blue		
Red / Blue + 1 mass bar		
Red + 1 bar / Blue + 1 bar		

Mass of red car	Final velocity of red car [m/s]	Final momentum of red car [kg-m/s]
0.250 kg		
0.250 kg		
0.500 kg		

Mass of blue car	Final velocity of blue car [m/s]	Final momentum of blue car [kg-m/s]
0.250 kg		
0.500 kg		
0.500 kg		

Questions: Please answer neatly in complete sentences.

1) How do your initial momenta compare with your final momenta in Collision #1? Based on your data, can you conclude that the Law of Conservation of Linear Momentum holds in this collision? Why?

2) How do your final momenta compare in Collision #2? Based on your data, can you conclude that the Law of Conservation of Linear Momentum holds in this collision? Why?

3) Describe at least two ways to improve the precision of this experiment.