Simulated Conservation of Momentum Lab

In science we talk about laws of conservation of mass, energy, or momentum. These are all laws that examine the state or status of a quantity before and after an event and they predict that within a confined system, the state will not have changed. Conservation of momentum means that the total momentum of any group of objects before an event is the same as it is afterwards. No momentum has been lost and none has been gained. Although collisions may be elastic or inelastic, and even if some balls bounce off at greater velocity than they started with, energy really is conserved, and total momentum remains constant.

Procedure

1. Start Virtual Physics and select Conservation of Momentum from the list of assignments. The lab will open in the Mechanics laboratory.

2. The laboratory will be set up with two balls of same mass on a table. You will perform four experiments to look at the momentum of the system by looking at the momentum of each ball within the system.

3. **Trial 1: Two moving balls.** The masses of the balls are the same. The velocities of the balls are also the same magnitude but in opposite directions, towards each other. The balls start out separated by 10 meters. Click the Start button to watch them collide and click the Pause button a few seconds after they bounce off each other. Record the final velocity for each ball from the display panel below the table in the data table below. You can display the velocity of the second ball by clicking on the ball, or clicking on the Tracking arrows to change the display.

Trial 1	Mass (kg)	Velocity Before (m/s)	Velocity After (m/s)	Momentum Before (kg m/s)	Momentum After (kg m/s)
Ball 1	10	10	-10	100	-100
Ball 2	10	-10	10	-100	100
Total Momentum				0	0

4. **Trial 2: One initially moving ball.** Click the Reset button to reset the experiment. Using the Parameters Palette, change the mass of Ball 1 to 15 kg, and the mass of Ball 2 to 5 kg. Uncheck the Balls Same Mass and Diameter box to be able to change each mass separately. Set the velocity of Ball 1 to 10 m/s and the velocity of Ball 2 to 0 m/s. Click the Start button to watch the balls collide. Click the Pause button a few seconds after they bounce off each other. Record the final velocity of each ball in the data table below.

Trial 2	Mass (kg)	Velocity Before (m/s)	Velocity After (m/s)	Momentum Before (kg m/s)	Momentum After (kg m/s)
Ball 1	15	10	5	150	75
Ball 2	5	0	15	0	75

Total Momentum	150	150

5. **Trial 3: Two connected balls.** Click the Reset button to reset the experiment. Set the velocity of ball 2 to 0 m/s, and change the Elasticity to 0 to make the balls inelastic. Click the Start button to watch the balls collide. Click the Pause button a few seconds after they bounce off each other. Record the final velocity of each ball in the data table below.

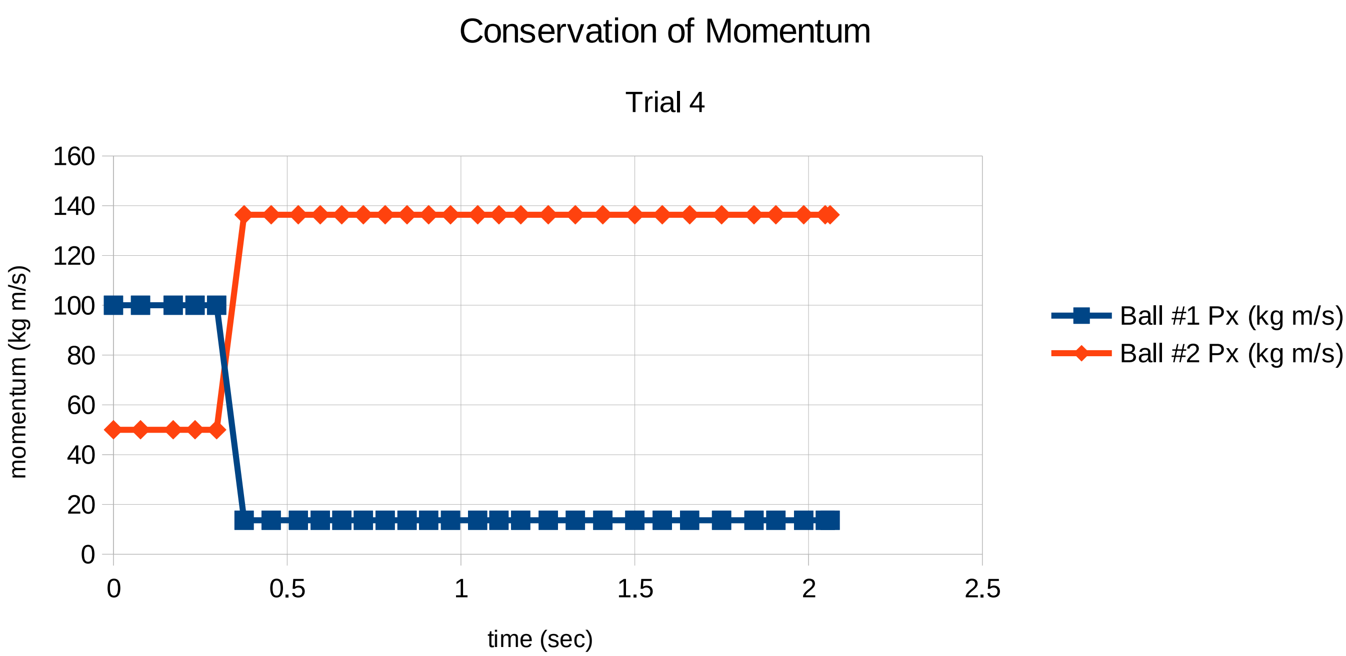
Trial 3	Mass (kg)	Velocity Before (m/s)	Velocity After (m/s)	Momentum Before (kg m/s)	Momentum After (kg m/s)
Ball 1	10	10	5	100	50
Ball 2	10	0	5	0	50
Total Momentum				100	100

6. **Trial 4: Choose your own variables.** Click the Reset button to reset the experiment. Click on the red Recording button to start recording data. Choose your own masses and velocities for each ball. Try it with the balls initially traveling in the same direction, but with one of the balls traveling faster than the other. Switch the elasticity to 0 again to observe an inelastic collision. Predict what you think the resulting velocities might be. Test this prediction. Record the data.

Trial 4	Mass (kg)	Velocity Before (m/s)	Velocity After (m/s)	Momentum Before (kg m/s)	Momentum After (kg m/s)
Ball 1	5	20	2.727	100	13.636
Ball 2	50	1	2.727	50	136.364
Total Momentum				150	150

Questions and Data Analysis

1. Graph the momentum of each ball from Trial 4 over the course of the experiment. When you pause the trial after your observations, a data link will appear in the Lab Book. Click on that link to display the momentum over time for each ball. Use the #1 p_x data to graph the momentum of the first ball over time. Your graph should have time on the x-axis and momentum on the y-axis. Also graph the momentum data of the second ball on the same graph. You can do this by simply copying one graph and pasting it onto the other in Excel. Make sure your graph has the proper titles, units, and a legend. Paste your graph below.



2. Use the graph in question 1 to determine whether the momentum is conserved throughout the trial.

The graph shows us that the momntum is conserved.

3. Explain how the graph helped you determine whether the momentum is conserved throughout the trial.

We se that as the momentum of one ball decreases, the momewntum of the other ball increases by the same amount.

4. Is it possible for a ball with a small mass to have the same momentum as a ball with a large mass? Explain your answer.

Yes the ball with smaller mass can have the same momentum as a larger mass if it is travelling at a greater speed.

This is because momentum is defined as follows: $p=mv$

5. In your own words, describe why conserved quantities such as momentum are useful in physics.

From an engineering or numerical perspective, conserved quantities help solve equations with just final and initial states as opposed to the path used to get to those states. From a theoritical perspective, a conserved property indicates a deeper symmetry in the physical system (noether's theorem).