1 Introduction

This lab will deal with the concept of momentum through the lens of collisions, both elastic and inelastic. As always, please read through the theory section of the attached lab manual before attempting the simulation.

1.1 Tools

When ready to attempt the lab, navigate to `https://phet.colorado.edu/sims/html/collision-lab/latest/collision-lab_en.html` and go to the "introduction" tab.

2 Elastic Collisions Procedure

2.1 Setup

1. Check the velocity vectors box in the top right.
2. Click on the "more data" button on the bottom of the screen.
3. Set the elasticity to 100 percent.
4. Set the initial position of the first ball to 0m.
5. Set the initial position of the second ball to 1m.
6. Set the initial velocity of the first ball to 1 m/s.
7. Set the initial velocity of the second ball to 0m/s.

2.2 Procedure

1. Set the mass of the first ball to 2kg.
2. Set the mass of the second ball to 1kg.
3. Given the above configuration, calculate the following:
   (a) The initial momentum and kinetic energy of the first ball.
   (b) The initial momentum and kinetic energy of the second ball.
4. With the above configuration, press "play" and watch the simulation to get an idea of how things will play out.
5. Press "restart."
6. Press "play" and then "pause" the simulation before the 1st ball hits the second ball.
7. Click "show values" in the top right box and record both ball's momentum and velocity.
8. Uncheck "show values"
9. Resume the simulation, allow the balls to collide, and then pause the simulation after half a second or so.

10. Check "show values" and record the balls' velocity and momentum after the collision.
11. Calculate the following:
    (a) The final momentum and kinetic energy of the first ball.
    (b) The final momentum and kinetic energy of the second ball.
12. Repeat steps 3-11 with the first ball now 1kg and the second ball now 2kg.

3 Inelastic Collisions Procedure

3.1 Setup

The setup for this section is the same as the previous section, except: - Slide the elasticity to 0 percent.

3.2 Procedure

1. Set the mass of the first ball to 2kg.
2. Set the mass of the second ball to 1kg.
3. Given the above configuration, calculate the following (noting that since this is an inelastic collision, you can now figure out all of the following before the collision):
    (a) The initial momentum and kinetic energy of the first ball.
    (b) The initial momentum and kinetic energy of the second ball.
    (c) The final momentum and kinetic energy of the first ball.
    (d) The final momentum and kinetic energy of the second ball.
4. With the above configuration, press "play" and watch the simulation to get an idea of how things will play out.
5. Press "restart."
6. Press "play" and then "pause" the simulation before the 1st ball hits the second ball.
7. Click "show values" in the top right box and record both ball's momentum and velocity.
8. Uncheck "show values"
9. Resume the simulation, allow the balls to collide, and then pause the simulation after half a second or so.
10. Check "show values" and record the balls' velocity and momentum after the collision.
11. Repeat steps 3-10 with the first ball now 1kg and the second ball now 2kg.

4 Data Analysis

1. For each collision, find the change in total momentum as a percentage of the total using Eq. 4 from the original lab manual.
2. For each collision find the total change in kinetic energy as a percentage of the total using Eq. 7 from the original lab manual.
3. For the inelastic portion of the lab, calculate the percent error between your calculated initial and final kinetic energy/momenta and the measured values
4. Comment on your percent errors from above and discuss how doing this lab in a simulated format could have affected your results.

5 Questions

Answer the following:

1. If you were presented with percentage changes in kinetic energy from a collision experiment like this one, could you tell whether it was an elastic or inelastic collision? Describe how you would tell the difference, or why you could not tell the difference.
2. Compare the momentum change from the motion of the single ball to the momentum change during the inelastic collision. Does the momentum loss as measured when the single car moved account for the difference in momentum conservation?