Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_\_\_\_\_

**Momentum Investigation**

**Visit:** <http://phet.colorado.edu/en/simulation/collision-lab> Click “Run Now”.

**Part 1: Qualitative Investigation into Collisions**

* Set the up the simulation so that both balls have the same mass. In the box on the right, make sure the elasticity is set to 100%. These type of collisions are called “elastic” collisions. Click play and watch what happens. *(hint: click restart to return the simulation to this setting so you can play it again. You can also slow down the simulation speed if needed).*

1. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:
2. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 2…
   1. before the collision:
   2. after the collision:

* Click “Restart” and then set the up the simulation so that ball 1 has a mass that is double the mass of ball 2. Click play.

1. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:
2. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 2…
   1. before the collision:
   2. after the collision:

* Click “Restart” and then set the up the simulation so that ball 2 has mass that is double the mass of ball 1. Click play.

1. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:
2. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:

* Click “Reset All” and then set up the simulation so that ball 1 and ball 2 have the same mass. In the box on the right, make sure that the elasticity is set to “O”. These type of collisions are called “inelastic” collisions. Click play.

1. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:
2. Describe the **SPEED** (fast, slow, not moving) AND **DIRECTION** (right, left) of ball 1…
   1. before the collision:
   2. after the collision:
3. Are the balls moving the same speed after the collision? Why or why not?
4. Based on your observations, how would you describe the difference between elastic and inelastic collisions?

**Part 2: Quantitative Investigation into Collisions**

* For this part of the investigation, you are going to collect some data about elastic collisions. To get started, click “Reset All”, then in the box on the right click “Show Values” so that boxes with information about velocity and momentum appear. Set the elasticity to 100%.
* **Make sure to click “Reset All” between each trial and to set up the simulation as needed!**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **ELASTIC COLLISIONS** | | | | | | | | | | | |
| Mass | | Before Collision | | | | | After Collision | | | | |
| m1  (kg) | m2  (kg) | vo1 (m/s) | vo2 (m/s) | po1 (kgm/s) | po2 (kgm/s) | po total (kgm/s) | vf1 (m/s) | vf2  (m/s) | pf1 (kgm/s) | pf2  (kgm/s) | pf total  (kgm/s) |
| 1.5 | 1.5 |  |  |  |  |  |  |  |  |  |  |
| 3.0 | 1.0 |  |  |  |  |  |  |  |  |  |  |
| 0.5 | 2.0 |  |  |  |  |  |  |  |  |  |  |
|  |  | 1.0 | 0.5 |  |  |  |  |  |  |  |  |
|  |  | 1.0 | -0.5 |  |  |  |  |  |  |  |  |

1. Make a statement based on your data table about the total momentum before the collision compared to the total momentum after the collision for an elastic collision. Use your data to support your answer.

* Click “Reset All”, then in the box on the right click “Show Values” so that boxes with information about velocity and momentum appear. Set the elasticity to 0%.
* **Make sure to click “Reset All” between each trial and to set up the simulation as needed!**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mass | | Before Collision | | | | | After Collision | | |
| m1  (kg) | m2  (kg) | vo1 (m/s) | vo2 (m/s) | po1 (kgm/s) | po2 (kgm/s) | po total (kgm/s) | mtotal  (m1+m2)  (kg) | vf  (m/s) | pf total  (pf1+pf2)  (kgm/s) |
| 1.5 | 1.5 |  |  |  |  |  |  |  |  |
| 3.0 | 1.0 |  |  |  |  |  |  |  |  |
| 0.5 | 2.0 |  |  |  |  |  |  |  |  |
|  |  | 1.0 | 0.5 |  |  |  |  |  |  |
|  |  | 1.0 | -0.5 |  |  |  |  |  |  |

1. Make a statement based on your data table about the total momentum before the collision compared to the total momentum after the collision for an inelastic collision.

**Conclusion Questions:**

1. During elastic collisions, momentum *is*/*is not* conserved.
2. During inelastic collisions, momentum *is*/*is not* conserved.
3. A 500. gram cart moving at **.**360 m/s has how much momentum?
4. If the above 500. gram cart was to bounce back and return with a velocity of -**.**240 m/s, what is its change in momentum?

1. A 10 kg toy car initially moving at 2 m/s to the right collides with a 15 kg toy truck initially at rest. After the collision, the 10 kg toy car bounces backwards with a speed of 1.0 m/s. (*hint: watch direction!)*
   1. What is the total momentum of this system before the collision?
   2. What is the total momentum of this system after the collision?
   3. What is the momentum of each object after the collision?
   4. What is the velocity of the 15 kg truck after the collision?