**Virtual Collisions Lab**

**Objective:**

To experiment with and gain a better understanding of collisions and the Conservation of Momentum.

**Equations:**

Conservation of Momentum states that the total initial momentum is equal to the total final momentum in the absence of IMPULSE (ΔP = FΔt). That is to say if there is no net force the total initial momentum equals the total final momentum.

ΣPi = ΣPf

Pai +Pbi = Paf +Pbf

mavai +mbvbi = mavaf +mbvbf

**Getting Started:**

* Turn on the computer and open an Firefox, or Internet Explorer.
* In the URL address type: **http://phet.colorado.edu/en/simulation/collision-lab** 
  + If this URL does not work properly go to http://phet.colorado.edu
  + Select: Play with sims
  + Select: Physics
  + Scroll down and select: Collisions Lab
* Select: **Run Now!**
  + You may be prompted to download the program or if you would like to run the program, select okay, or run.
* The *Collisions Lab Simulator* program should now be open.
* Select the 1 dimension setting on the panel in the upper right corner of the screen. The following boxes should be checked: Velocity Vectors, Reflecting Border, Momenta Diagram, and Show Paths.
* To start set the elasticity set at 1.0
* Select the More Data Button at the bottom of the screen.

**Perfectly Elastic Collision:**

* Investigate the action of a **more-massive attacking object striking a less-massive target object**.
  + What happens to the more-massive attacking object?
  + What happens to the less-massive target object?
* Investigate the action of a **less-massive attacking object striking a more-massive target object**.
  + What happens to the less-massive attacking object?
  + What happens to the more-massive target object?

Complete the below tables with the by imputing knowns and pressing the play button.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Object** | **Mass (kg)** | **Vinitial (m/s)** | **Vfinal (m/s)** | **Pinital (kg m/s)** | **Pfinal (kg m/s)** | **KE ( J )** |
| 1 | 1.20 | 1.50 |  |  |  | Total Initial: |
| 2 | 1.20 | -1.80 |  |  |  | Total Final: |

Does conservation of energy occur in this collision? How about conservation of momentum? Why?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Object** | **Mass (kg)** | **Vinitial (m/s)** | **Vfinal (m/s)** | **Pinital (kg m/s)** | **Pfinal (kg m/s)** | **KE ( J )** |
| 1 | 2.40 | 1.30 |  |  |  | Total Initial: |
| 2 | 4.80 | 0.0 |  |  |  | Total Final: |

Does conservation of energy occur in this collision? How about conservation of momentum? Why?

The total initial momentum for the collision below is 11.5. What is the initial velocity of object 1?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Object** | **Mass (kg)** | **Vinitial (m/s)** | **Vfinal (m/s)** | **Pinital (kg m/s)** | **Pfinal (kg m/s)** | **KE ( J )** |
| 1 | 2.50 |  |  |  |  | Total Initial: |
| 2 | 3.90 | 0.850 |  |  |  | Total Final: |

Does conservation of energy occur in this collision? How about conservation of momentum? Why?

**Perfectly Inelastic Collision:**

Set the elasticity setting in the upper right corner panel to 0.0. Play with the simulator and note a few observations comparing an elastic and inelastic collision.

Complete the below tables with the by imputing knowns and pressing the play button.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Object** | **Mass (kg)** | **Vinitial (m/s)** | **Vfinal (m/s)** | **Pinital (kg m/s)** | **Pfinal (kg m/s)** | **KE ( J )** |
| 1 | 1.20 | 1.50 |  |  |  | Total Initial: |
| 2 | 1.20 | -1.80 |  |  |  | Total Final: |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Object** | **Mass (kg)** | **Vinitial (m/s)** | **Vfinal (m/s)** | **Pinital (kg m/s)** | **Pfinal (kg m/s)** | **KE ( J )** |
| 1 | 2.40 | 1.30 |  |  |  | Total Initial: |
| 2 | 4.80 | 0.0 |  |  |  | Total Final: |

Does conservation of energy occur in the collisions above? How about conservation of momentum? Why?

**Conclusion Questions:**

1. A collision where both momentum and kinetic energy are conserved is an *elastic / inelastic* collision.
2. A 500. gram cart moving at **.**360 m/s, what is its momentum?

If the cart was to bounce off a wall and return with a velocity of -**.**240 m/s, what is its Impulse be?

1. How fast must a 250. gram cart be traveling to have a momentum of .450 kgm/s?
2. A .230 kg baseball is thrown with a speed of 41 m/s. What is the ball’s momentum?

If the above ball comes to rest in the catcher’s mitt in .085 seconds, how much force does the ball apply on the catcher’s mitt? (hint: use the impulse-momentum theorem )

1. Imagine you are ice skating with your BFF. Both of you at rest, when you shove him/her away from you. You have a mass of 65 kg and he/she has a mass of 55kg. When you shove off, you move away with a velocity of 2.0 m/s. With what velocity does your BFF move away from you?

1. If a 250. gram cart moving to the right with a velocity of +.31 m/s collides inelastically with a 500. gram cart traveling to the left with a velocity of **-**.22 m/s, what is the total momentum of the system before the collision?

What is the resulting velocity of the above two-car system (stuck together)?

1. A 9.0 kg bowling ball races down the lane at 15 m/s before striking a bowling pin (at rest) with a mass of .85 kg. If the .85 kg pin bounces backward with a velocity of 45 m/s, what is the velocity of the bowling ball after the collision?
2. If two automobiles collide, they usually do not stick together. Does this mean the collision is elastic? Explain.

1. What happens when two objects collide at an angle? How does conservation of momentum come into play with 2-dimensions? Use the simulator to experiment with this.