**Momentum and Simple 1D Collisions PhET Lab**

**Introduction:** When objects move, they have *momentum*. **Momentum, p, is simply the product of an object’s mass (kg) and its velocity (m/s).** The unit for momentum, p, is kgm/s. During a collision, an object’s momentum can be transferred to **impulse**, which is the product of force (N) and time (s) over which the force acts. This allows us to write the momentum-impulse theorem:

**Procedure:** *Play with the Sims 🡪 Physics🡪 Motion 🡪 Collision Lab* 

Work with **1D collisions** at this level.

Check your work in the simulation after you have completed the tables.

**Important Formulas:**  

**Perfectly *Elastic* Collisions:  ** To begin a collision: To restart a collision:

* Take some time to familiarize yourself with the simulation and *perfect* collisions. Play. Investigate. Learn.
* 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 table without the simulation and **check your work in the simulation**.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **m1** | **m2** | **v1** | **v2** | **ptotal** | **v1’** | **v2’** |
| 1.20 kg | 1.20 kg | +1.50 m/s | -1.80 m/s |  | -1.80 m/s |  |
| 2.40 kg | 4.80 kg | +1.30 m/s | 0.0 m/s |  | -.433 m/s |  |
| 2.50 kg | 3.90 kg |  | .850 m/s | 11.5 kgm/s |  | 2.68 m/s |
| 5.10 kg | 1.00 kg | 0.900 m/s | -4.60 m/s |  |  | 4.60 m/s |

KE stands for Kinetic Energy  and is measured in joules. Note that kinetic energy is not a vector quantity. Describe the effect of an **inelastic** collision on the total kinetic energy of a two-object system.

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**Perfectly *Inelastic* Collisions: ** To begin a collision: To restart a collision:

* Take some time to familiarize yourself with 1D perfectly **inelastic** collisions. Play. Investigate. Learn.
* Contrast an inelastic collision with an elastic collision. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Complete the below table without the simulation and **check your work in the simulation**.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **m1** | **m2** | **v1** | **v2** | **ptotal** | **v12’** |
| 1.20 kg | 1.20 kg | +1.50 m/s | -1.80 m/s |  |  |
| 2.40 kg | 4.80 kg | +1.30 m/s |  | 7.00 kgm/s |  |
| 1.50 kg | 5.50 kg | +3.20 m/s | +.800 m/s |  |  |
| 2.50 kg |  | 1.20 m/s | 3 m/s |  | 0.0 m/s |

Describe the effect of an **inelastic** collision on the total kinetic energy of the two-object system.

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**Conclusion Questions:**

1. A collision where both momentum and kinetic energy are conserved is *perfectly elastic / inelastic* collision.
2. A 500. gram cart moving at **.**360 m/s has how much momentum? **(careful...units!)** \_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. 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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. How fast must a 250. gram cart be traveling to have a momentum of .450 kgm/s? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. A .230 kg baseball is thrown with a speed of 41 m/s. What is the ball’s momentum? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. 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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. 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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. What is the resulting velocity of the above two-car system (stuck together)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. 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? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_