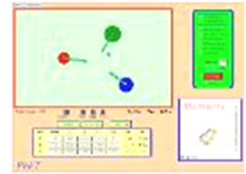


Momentum and Simple 1D Collisions PhET Lab



Collision 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 the momentum-impulse theorem:

$$\Delta p = m\Delta v = F\Delta t$$

Procedure: Play with the Sims → Physics → Motion → Collision Lab Run Now!

Work with **1D collisions** at this level. Later (AP Physics) you'll use trigonometry to solve 2D collisions. Velocity to the right is positive, left is negative. Check your work in the simulation after you have completed the tables.

Important Formulas:

$$m_1\vec{v}_1 + m_2\vec{v}_2 = p_{total} = m_1\vec{v}'_1 + m_2\vec{v}'_2 \quad v'_{12} = \frac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$$

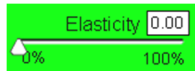


Perfectly Elastic Collisions: To begin a collision: To restart a collision:

- 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**.

m ₁	m ₂	v ₁	v ₂	p _{total}	v ₁ '	v ₂ '
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 $KE = \frac{1}{2}mv^2$ and is measured in joules. Note that kinetic energy is not a vector quantity. Describe the effect of an **elastic** collision on the total kinetic energy of the two-object system.



Perfectly *Inelastic* Collisions:

To begin a collision: To restart a collision:

- Take some time to familiarize yourself with 1D **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**.

m_1	m_2	v_1	v_2	p_{total}	v_{12}'
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	+0.800 m/s		
2.50 kg		1.20 m/s			0.0 m/s

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

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 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. 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) _____
7. 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? _____
8. 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? _____
9. What is the resulting velocity of the above two-car system (stuck together)? _____
10. 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? _____