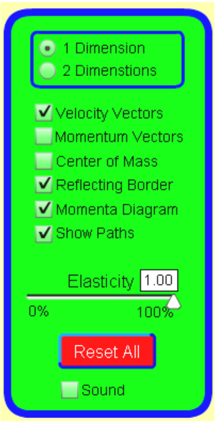
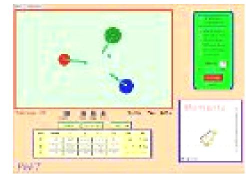


Momentum and Simple 1D Collisions PhET Lab



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 $\Delta p = m\Delta v = F\Delta t$ s us to write the momentum-impulse theorem:

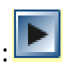
Procedure: *Play with the Sims → Physics → Motion → Collision Lab*

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

Check your work in the simulation <u>after</u> you have completed the tables.

Important Formulas: $m_1\vec{v}_1 + m_2\vec{v}_2 = p_{total} = m_1\vec{v}_1' + m_2\vec{v}_2'$ $v'_{12} = \dfrac{m_1\vec{v}_1 + m_2\vec{v}_2}{m_1 + m_2}$

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 **inelastic** collision on the total kinetic energy of a two-object system.

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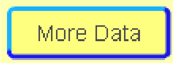
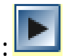
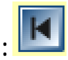
Perfectly *Inelastic* Collisions: 



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**.

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	+.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?

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