

Website: <http://phet.colorado.edu/>

Play with the Sims → Physics → Motion → Collision Lab

**Run Now!**

**Introduction:**

When objects move, they have *momentum*. Momentum,  $p$ , is the product of an object's mass (kg) and its velocity (m/s). The unit for momentum,  $p$ , is  $\text{kg}\cdot\text{m/s}$ . During a collision objects transfer momentum to each other, resulting in different motions than before the collision. In this activity you will study the motion colliding objects.

$$\text{momentum} = m \times v$$

**ELASTIC Collisions**

$$m_1 v_{1\text{before}} + m_2 v_{2\text{before}} = m_1 v_{1\text{after}} + m_2 v_{2\text{after}}$$

Ball	Mass kg	Position m	Velocity m/s	Momentum kg m/s
1	0.50	1.00	1.00	0.50
2	1.50	2.00	0.00	0.00

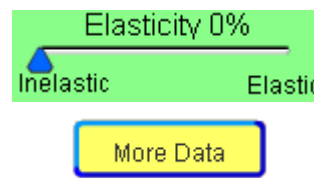
1. What defines a collision as being elastic?
2. Simulate the four elastic collisions below. Complete the table using math formulas and the simulation.

#	$m_1$	$m_2$	BEFORE COLLISION		$p_{\text{total}}$	AFTER COLLISION	
			$v_1$	$v_2$		$v_1$	$v_2$
1	2.0 kg	2.0 kg	1.5 m/s		0 $\text{kg}\cdot\text{m/s}$		
2	2.5 kg	5.0 kg		-1.0 m/s	0 $\text{kg}\cdot\text{m/s}$		
3	3.0 kg	6.0 kg	2.0 m/s	0.0 m/s			
4	6.0 kg		2.0 m/s	-1.0 m/s	8.0 $\text{kg}\cdot\text{m/s}$		

3. Two objects with the same mass move toward each other with the same speed and experience an elastic collision. Compare the **final velocities** of each object to their **initial velocities**.
4. A less-massive moving object has an elastic collision with a more-massive object that is not moving. Compare the **initial velocity** (speed and direction) of the less-massive object to its **final velocity**.

## INELASTIC Collisions

$$m_1 v_{1\text{before}} + m_2 v_{2\text{before}} = (m_1 + m_2) v_{\text{after}}$$



- What defines a collision as being inelastic?
- Simulate the four inelastic collisions below. Complete the table using math formulas and the simulation.

#	m <sub>1</sub>	m <sub>2</sub>	BEFORE COLLISION		p <sub>total</sub>	AFTER COLLISION
			v <sub>1</sub>	v <sub>2</sub>		v <sub>1</sub> and v <sub>2</sub>
1	2.0 kg	2.0 kg	1.5 m/s	0		
2	3.0 kg	6.0 kg	1.5 m/s	-0.75 m/s		
3	1.5 kg	5.0 kg	2.0 m/s	0.2 m/s		
4	10.0 kg		2.0 m/s	-1.0 m/s	10.0 kg·m/s	

- Two objects moving toward each other with **different** momentums experience an inelastic collision. In which direction will both objects travel after the collision?
- A less-massive object is moving in the same direction as a more-massive object, but with a higher speed. They experience an inelastic collision. Describe the **speed** of the **more-massive** object after the collision.
- Objects 1 has half the mass of object 2 and the objects move toward each other and experience an inelastic collision. If both objects do **not** move after the collision compare the velocity of **both** objects **before** the collision.
- Show **mathematically** the total momentum before the collision in trial #1 is conserved after the collision.