

Elective 4: Utilizing Simulations

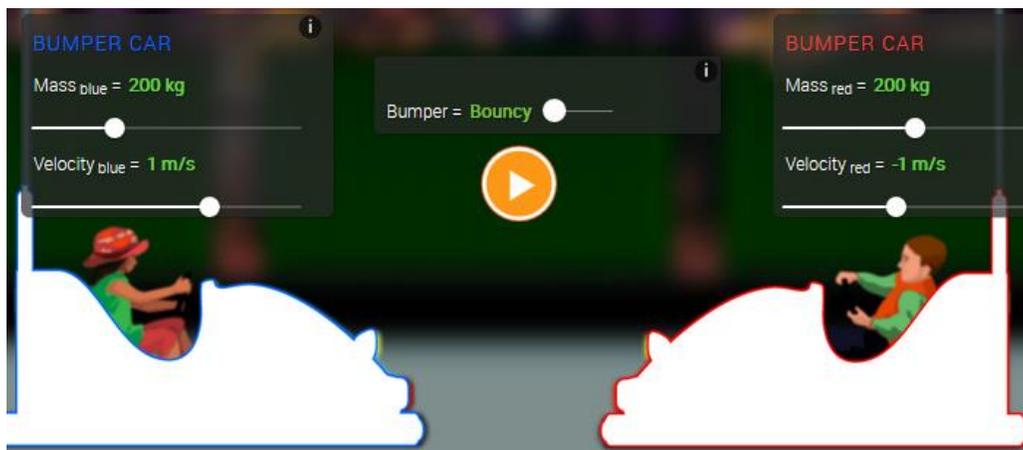
Simulation: [Bumper Cars](#)

Simulation Description:

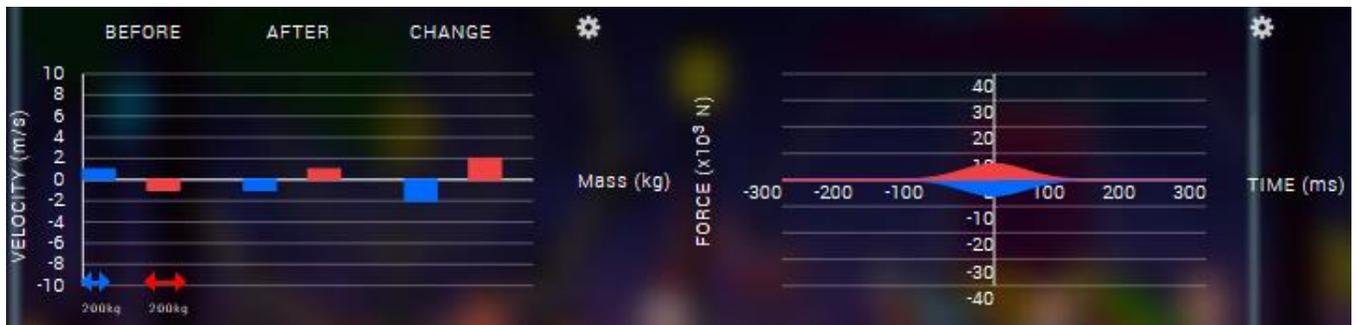
The Bumper Cars interactive is provided by ck12.org. This simulation can be used to address the concepts of momentum, impulse, conservation of momentum in one direction, elastic/inelastic collisions, and Newton's third law of motion.

The interactive begins with a brief introduction of the mass and velocity of two bumper cars before and after they collide. Students then have the opportunity to adjust the mass and velocity of each car. Students are also able to change the bounciness of the cars. The simulation records the data from the bumper car collision on a mass vs. velocity and time vs. force graph for interpretation.

Adjustable Settings:



Example Collision Data:



Physics Content:

NGSS Science Standard: MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.

PA Science Standard: S8.C.3.1 Describe the effect of multiple forces on the movement, speed, or direction of an object.

This interactive allows students to observe that for every action there is an equal and opposite reaction (Newton's third law of motion). By manipulating the initial mass and velocity of the bumper cars in the simulation, students also observe the effect of mass and velocity on the acceleration and overall motion of the bumper cars after a collision.

How to Use Simulation for Learning:

This simulation would best be used at the start or middle of the learning sequence. I am primarily focusing on this simulation in terms of Newton's Laws of Motion even though it could also be used to address momentum and impulse.

- Start of the learning sequence: Before students learn about Newton's laws of motion, this simulation could be used as a discovery activity. I would have the students make changes to the mass and velocity of the bumper cars and see the results. After many trials, students will begin to see patterns in the outcomes of the collisions. As a class, we would discuss the patterns they observe and then introduce them to the concept of Newton's third law of motion. If students already know about Newton's second law of motion, this simulation reinforces the idea that mass influences the acceleration of an object.
- Middle of learning sequence: After an introduction to Newton's third law of motion, this simulation could be used to reinforce the principles of this law. I would have students collect data from the collisions of the various bumper cars to "prove" or justify Newton's third law of motion with evidence. This could be done in the format of a CER writing assignment.

Student Insights:

From the interactive, students should notice the following patterns:

- For every action there is an equal and opposite reaction as evident in the time vs. force graph of each collision.
- Velocity is a vector measurement. The negative/positive value of velocity determines which direction the bumper cars travel.
- When a large mass bumper car collides with a small mass bumper car traveling at the same velocity, the velocity decreases for the larger mass car and increases for the smaller mass car after a collision.
- When two cars of the same mass but one car is traveling faster than the other collide, the velocity decreases for the faster car and increases for the slower car after the collision.

Pros & Cons of Simulation:

Pros	Cons
<ul style="list-style-type: none">• Easy to navigate and change variables• Age-appropriate for middle school students• Engaging and relatable context for students (bumper cars)• Graphical representation of results generated• Simulation may be used for many topics- momentum, impulse, Newton's Laws of Motion• Can make collisions elastic or inelastic by adjusting the bounciness of the collision• Student Worksheet provided for guided exploration• Challenge questions provided (see below)• Simulation Tutorial Walkthrough available	<ul style="list-style-type: none">• Teacher and students must have a ck12.org account in order to use the simulation• Graphs are very small and can be difficult to read• Mass vs Velocity graph may be challenging for students to interpret. Additional instruction may be needed• No sound or audio in the simulation to make the collisions more realistic or to read text to lower level learners

CK12 Content 3 Community Contributed 3

[+](#) Create new question

ck-12 A 100 kg cart moving rightward at 2 m/s collides elastically with a second cart. Both carts end up bouncing off with the same speed (just in the opposite direction) than they had before they collided. What was the mass and speed of the second cart?

ck-12 A 300 kg cart is moving rightward at 3 m/s and collides elastically with another cart. What must the speed and mass of the second cart be so that the first cart comes to a stop?

ck-12 A 200 kg cart is moving rightward at 3 m/s. What speed should a leftward moving 300 kg cart have so that the two collide and come to a stop?