BUMPER CARS

Interactive Physics Simulation

To visit this simulation:
http://interactives.ck12.org/simulations/physics/bumper-cars/app/
Intriguing Question

Can you bump your friend's car harder than she bumps yours?

Illustrative Video

It is common to think that bigger, heavier and more quickly moving objects “hit harder” than smaller, lighter or slowly moving objects. Let’s have a close look at the mass, velocity and direction of motion of bumper cars in the collision. Let’s also look closely at the forces acting on the cars during these collisions. What relationships can we uncover?

To access this physics simulation visit: http://goo.gl/15Km45
Interactive Simulation

**Bumper car**: This slider adjusts the mass of the car. Cars with more mass have more kinetic energy and more momentum at a given speed.

**Bumper**: If the bumpers are “bouncy” then the collision is said to be elastic - the two cars bounce off each other. They might exchange kinetic energy and momentum, but the total amount of kinetic energy and momentum remains constant through the collision. If, instead, the bumpers are “locking” then the collision is said to be inelastic - the two cars lock together and travel as a single unit. Momentum will still be conserved, but some of the initial kinetic energy of the system will be dissipated in the collision.

**Bumper Car**: This slider adjusts the mass of the car. Cars with more mass have more kinetic energy and more momentum at a given speed

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**Velocity vs mass**: This type of plot is known as a momentum column graph. The width of each column is proportional to the mass of the car. The height of the column is proportional to the velocity of the car - with leftward velocities negative. The area, then, of the column is proportional to the product of mass and velocity - the momentum! Three sets of bars are shown: before the collision, after the collision, and the change as a result of the collision. If momentum is conserved, the two cars must exchange momenta in equal amounts.

**Force vs time**: This is a plot of the force acting on the two cars as a function of time in the collision. The area of the graph is known as the force-impulse, and is equal to the change in momentum of each car. Since the two cars exert equal and opposite forces on one another (per Newton's 3rd Law), the areas of these graphs must be equal and opposite. And this means the change in momentum for each car must be equal and opposite in a collision.

To access this physics simulation visit: [http://goo.gl/1SKm45](http://goo.gl/1SKm45)
Interpreting Results

A 100 kg car moving rightward at 2 m/s collides elastically with a second car. Both cars 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 car? (Adjust the Blue car mass to 100 kg and its velocity to +2 m/s. Set the bumper to Bouncy. For what value of Red car mass and velocity will the two bounce off without changing speed?)

A 300 kg car is moving rightward at 3 m/s and collides elastically with another car. What must the speed and mass of the second car be so that the first car comes to a stop? (Adjust the Blue car mass to 300 kg and its velocity to +3 m/s. Set the bumper type to Bouncy. Adjust the speed and mass of the Red car so that, when they collide, the Blue car comes to a stop).

A 200 kg car is moving rightward at 3 m/s. What speed should a leftward moving 300 kg car have so that the two collide and come to a stop? (Set the Blue bumper car mass to 200 kg and velocity to +3 m/s. Set the Red bumper car mass to 300 kg and the bumper type to Locking. Adjust the Red car velocity so that the two come to a stop after they collide).

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Challenge ME!

- If you add up the total velocities before and after the collision, does the total stay the same?

- What quantity is CONSERVED (i.e., stays unchanged) in both types of collisions?

- In a given collision, which car feels the stronger maximum force?

- What is the relationship between the area bounded by the force vs time diagram and the change in momentum of a car?

Need Help?

Check out the Bumper Cars Walkthrough video at: [https://youtu.be/JVyzZ4uGCtw](https://youtu.be/JVyzZ4uGCtw)
Interesting Questions

**Where does the momentum come from when a firecracker explodes?**

Nowhere! Before the explosion there is zero total momentum. After the collision, pieces of the firecracker fly in different directions, each carrying some (vector) amount of momentum. If some pieces fly leftward and others fly rightward, the total momentum will be zero, because vectors can cancel.

**Where does the momentum of a car come from when it accelerates from a stop?**

Nowhere! The total momentum of the system comprised of the Earth and car is zero when the car is at rest. As the car accelerates, it pushes back on the Earth - the impulse delivered to both the Earth and car is equal and opposite. The Earth carries an equal amount of momentum backward that the car carries forward. We don't notice the Earth's momentum change because it is so massive.

**Why do boxers wear gloves?**

When a boxer punches another boxer, equal and opposite forces act on both the boxer's hand and his opponent's body - the hand needs to be protected from that force too!

**How does a plane fly?**

The interaction between the wing of a plane and the air is complex, but part of the answer involves collisions between air particles and the wing. The air particles bounce off and downward from the wing, thus the wing feels an upward force as a result, allowing the plane to fly.
Physics Concepts | Click on the link below to learn more.


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