Glancing Collisions

Purpose: To investigate momentum conservation for a glancing collision.

Getting Ready: Navigate to the **Two-Dimensional Collision Simulator** found in the **Physics Interactives** section at **The Physics Classroom**.

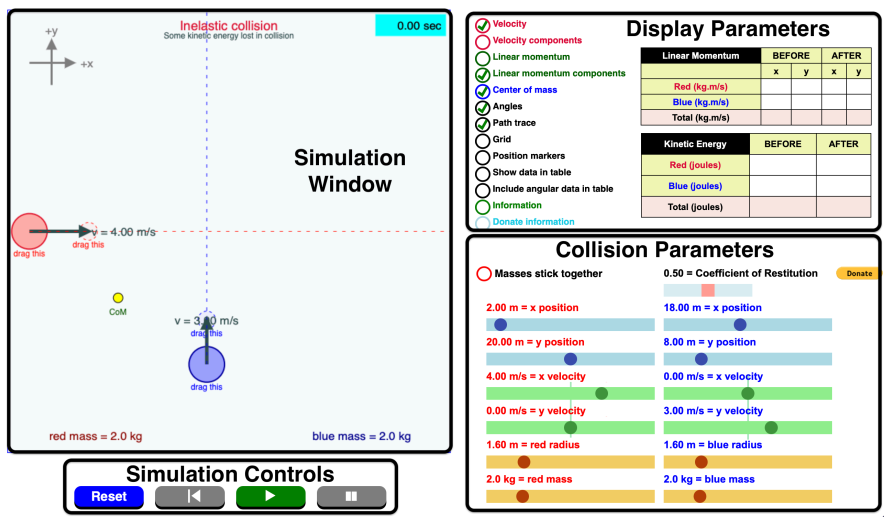
https://www.physicsclassroom.com/Physics-Interactives/Momentum-and-Collisions/Two-D-Collisions-Simulator

Navigation:

www.physicsclassroom.com => Physics Interactives => Momentum and Collisions => Two-Dimensional Collision Simulator

Getting Acquainted/Play:

This interactive consists of a Simulation Window on the left side of the screen, some **Simulation Controls** below it, a collection of **Display Parameters** on the right side of the screen, and a **Collision Parameters** shown below it. The Parameters section include **radio buttons**, and **sliders**. Experiment with each of these parameters.



Observe the **radio buttons** control the various displays. Experiment with the various display options, turning each on and off by tapping on the check boxes and observing what they do.

The **sliders** control the values of the motion parameters for the two colliding objects. Experiment with the sliders by dragging them left and right and observing their effect upon the simulated collision. Also note that the velocity vectors can be changed by dragging the arrowhead in the Simulation window. The object positions can be changed by dragging the circles on the screen.

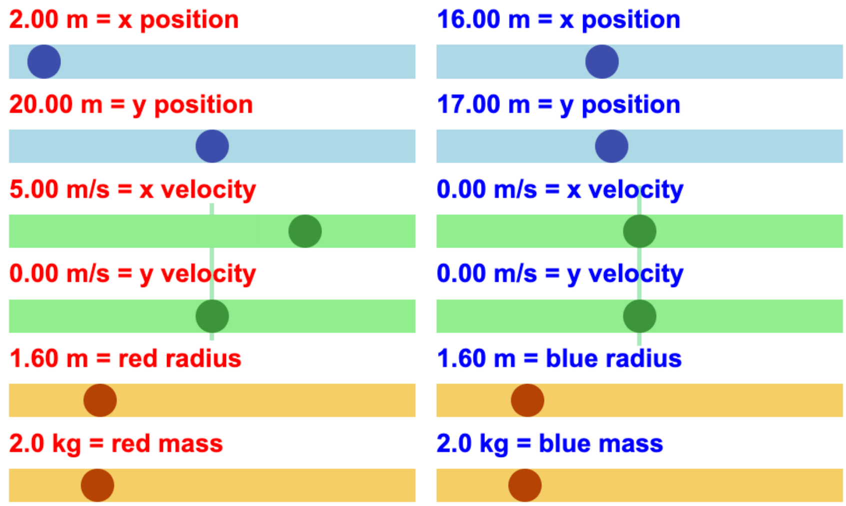
The **Reset** button returns all Collision Parameters to their start-up value. More often than not you will want to be using the **Rewind** button which returns the most recent simulation to its time = 0 s state. Take some time to get acquainted with the interface and various parameters.

Background

We have observed that momentum is conserved for a collision occurring in an isolated system. But our studies were restricted to collisions occurring in one-dimension. That is, the colliding objects were moving along the same line of motion before and after the collision. What happens when a collision occurs in two dimensions? In this activity, you will conduct studies of collisions in which the objects move in two dimensions after the collision. You will vary parameters such as the coefficient of restitution (COR), the objects' masses, and the directness of the collisions.

Part 1: Perfectly Elastic Collisions

1. Enable or check the **Linear Momentum**, **Linear Momentum Components**, **Angles,** and the **Show data in table** parameters in the Display Parameters section of the window. Leave all other parameters unchecked.
2. Use the slider to set the **Coefficient of Restitution** to **1.00**. We refer to this as the **COR**.
3. Set the remaining Collision Parameters to the values shown at the right.



4. Press the green **Play** button. Record pre-collision momentum and post-collision momentum and angle info in the Data Table below. Repeat for Trials 2 and 3 using a different y-position. See values listed above the Data Tables.

Part 1 Data Tables

Trial 1: y-Position of Blue Object = 17.00 m

	Before Collision		After Collision		
Object	**p_x (kg•m/s)**	**p_y (kg•m/s)**	**Angle (° w.r.t. x)**	**p_x (kg•m/s)**	**p_y (kg•m/s)**
Red					
Blue	**0.00**	**0.00**			
System Total					

Trial 2: y-Position of Blue Object = 18.00 m

	Before Collision		After Collision		
Object	**p_x (kg•m/s)**	**p_y (kg•m/s)**	**Angle (° w.r.t. x)**	**p_x (kg•m/s)**	**p_y (kg•m/s)**
Red					
Blue	**0.00**	**0.00**			
System Total					

Trial 3: y-Position of Blue Object = 19.00 m

	Before Collision		After Collision		
Object	**p_x** (kg•m/s)	**p_y** (kg•m/s)	**Angle** (° w.r.t. x)	**p_x** (kg•m/s)	**p_y** (kg•m/s)
Red					
Blue	**0.00**	**0.00**			
System Total					

Part 1 Analysis

1. Now inspect your data for the three trials and think about momentum conservation. Make a clearly stated claim regarding what is conserved in a collision. Then use some data as evidence to provide logical support for the *reasonable-ness* of your claim.

2. All collisions above had the following characteristics:

Equal mass objects	Perfectly elastic collision (COR = 1.00)
Object 2 initially at rest	Object 1 collides off-center with Object 2

Inspect the angle values for each of the three trials. Make a claim regarding the sum of the post-collision angles for collisions with these characteristics. Provide one piece of supporting evidence to justify your claim.

Part 2: Variations in COR

1. As before, enable or check the **Linear Momentum**, **Linear Momentum Components**, **Angles,** and the **Show data in table** parameters in the Display Parameters section of the window. Leave all other parameters unchecked.
2. Run three trials with COR values of 0.80, 0.50, and 0.00. Keep other parameters constant from trial to trial. Record your values of y-position (blue), masses, and initial speeds.
3. Record pre-collision momentum and post-collision momentum and angle info in the Data Tables.

y-position (blue) = ____________ m_{red} = ____________ m_{blue} = ____________

v_{red} = ____________ v_{blue} = 0.00 m/s

Trial 4: COR = 0.80

	Before Collision		After Collision		
Object	**p_x** (kg•m/s)	**p_y** (kg•m/s)	**Angle** (° w.r.t. x)	**p_x** (kg•m/s)	**p_y** (kg•m/s)
Red					
Blue	**0.00**	**0.00**			
System Total					

Trial 5: COR = 0.50

	Before Collision		After Collision		
Object	**p_x** (kg•m/s)	**p_y** (kg•m/s)	**Angle** (° w.r.t. x)	**p_x** (kg•m/s)	**p_y** (kg•m/s)
Red					
Blue	**0.00**	**0.00**			
System Total					

Trial 6: COR = 0.00

	Before Collision		After Collision		
Object	**p_x** (kg•m/s)	**p_y** (kg•m/s)	**Angle** (° w.r.t. x)	**p_x** (kg•m/s)	**p_y** (kg•m/s)
Red					
Blue	**0.00**	**0.00**			
System Total					

Part 2 Analysis

1. The **angle of departure** in such a collision is the angle between the line of motion of the two objects after the collision. It would be the sum of the two indicated angles. What effect does decreasing COR have upon the angle of departure? Support your answer with evidence and reasoning.

2. Does the COR value have an effect upon whether or not total system momentum is conserved in a collision? Explain your answer.

3. Does the COR value have an effect upon whether or not the kinetic energy of the system is conserved in a collision? Explain your answer and generate some data from one of the Part 2 trials to support your answer.