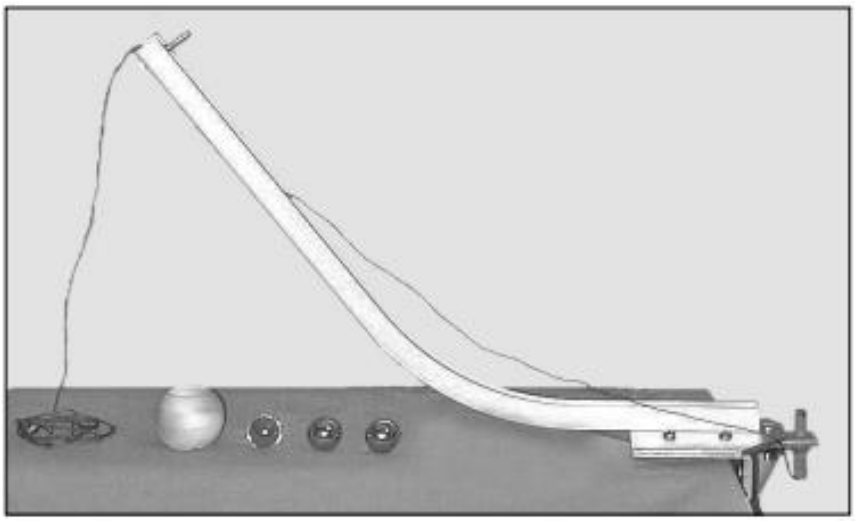
Name(s) > _____

Collisions! → Law of Conservation of Momentum
Conceptual Physics Lab

In this lab, you will use the ***Collision in Two Dimensions Apparatus*** to investigate the concept of **Conservation of Momentum** during collisions. A metal curved ramp is attached by a table clamp with an adjustable target support and a plumb line attached to the bottom of the target support. (See diagram below)
The kit includes two identical steel balls, a glass ball of the same diameter, and a larger hollow wooden ball.



Lab Concepts and Objective

A target ball will be placed on the target support, and a second ball is placed on the track at the top of the inclined ramp, resting against the "starting" peg. When the upper ball is released, it will run down the ramp and strike the target ball, both which will follow a parabolic trajectory and land on the floor. Vectors will be drawn for both balls from the plumb line point (directly below the impact/target holder) to the impact points for each ball. From those experiments, you will be able to conceptually confirm the Law of Conservation of Momentum for each trial in this lab. Example Vector diagrams will be illustrated later in the lab.

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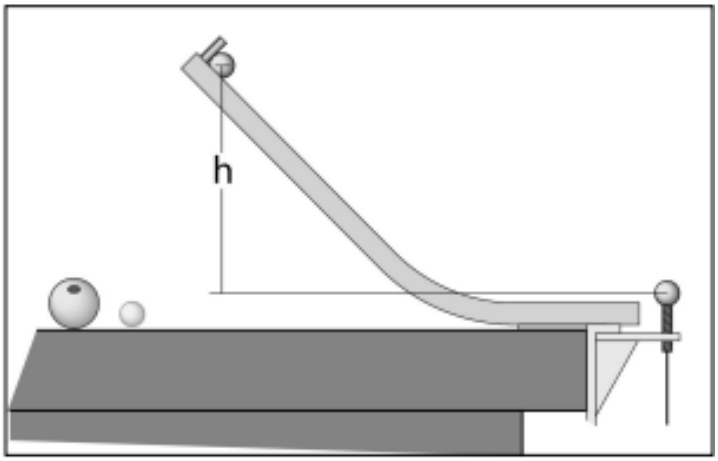
Materials

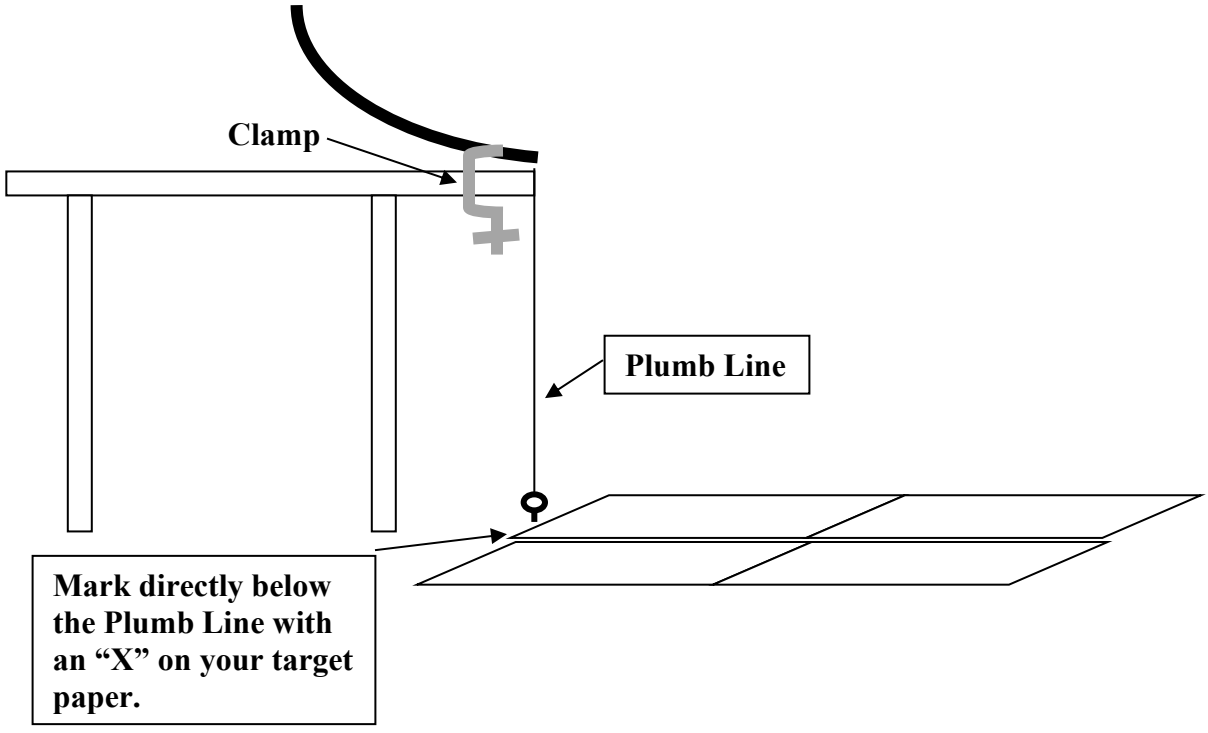
- *Collision in Two Dimensions Apparatus*
- Steel/Glass/Wood balls
- Metric measuring tape/meter stick
- Plain white paper
- Scotch tape
- *Double-sided* masking tape
- Graphite Transfer Paper

…formally Carbon paper)



Set-Up

1. Set up the ramp and clamp to the lab table as shown in the diagram (Page #1).
3. Take **4 sheets of paper** and tape them together. Secure them to the floor with a piece of tape. (…as shown in the schematic below). This is your **Target Paper**. You will need to do this for **EACH** trial. There are **3 trials** so you will need to create Target Papers for **each trial**! Be certain that the **plumb line** is directly over the paper and "mark" its position on the paper just below the plumb line. This will be used later in the experiment when you draw your Vectors.



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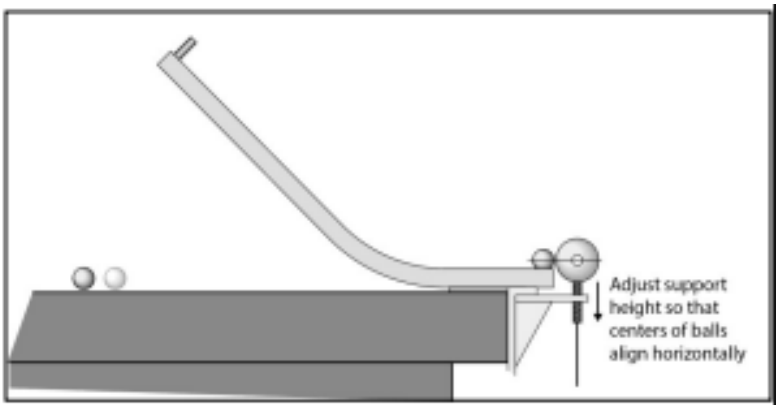
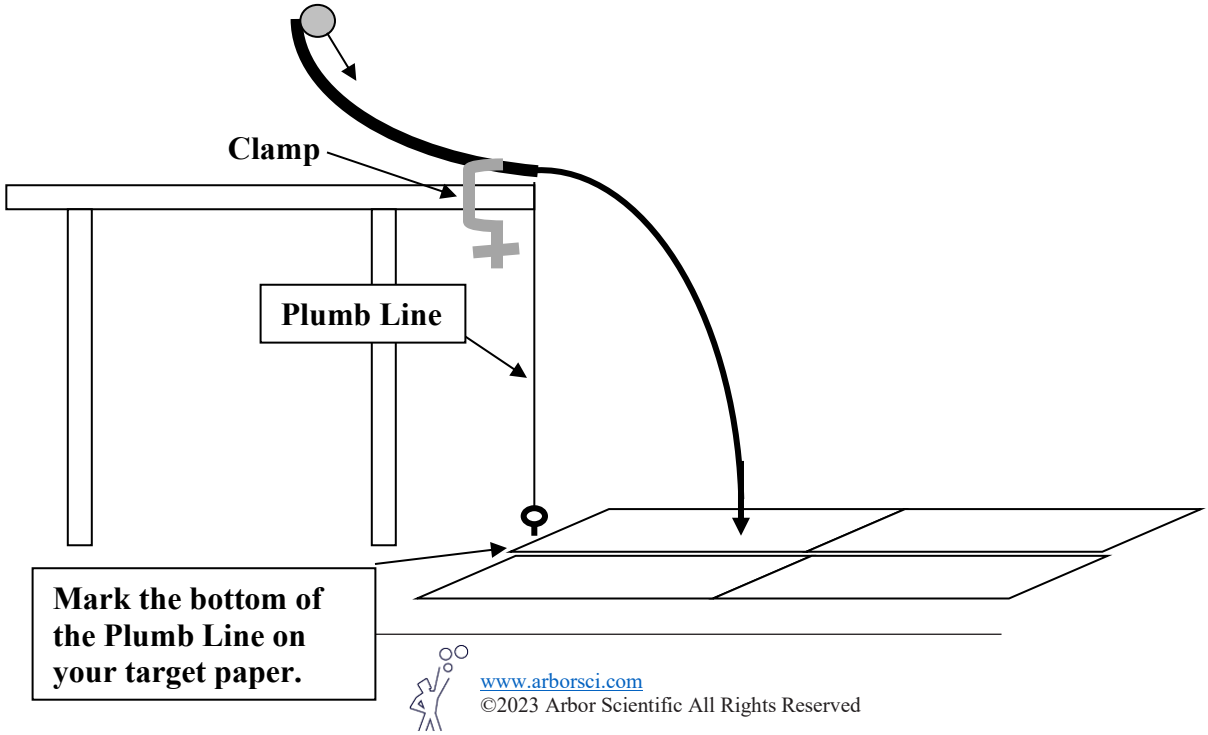
Experiment

1. Set the **Steel Ball** on the **Target Support** and place the other **Steel Ball** at the end of the track NEXT to the Target Ball to make sure that their centers are at the same height. Adjust the height of the Target Support if necessary.
   You will have to change the Target Support height when using the Wood Ball because the Wood Ball is much larger. For each experiment, it is always vital that each Steel-to-Steel/Steel-to-Wood Ball collisions, occur at the **Centers of each ball**.



2. Release the Steel Ball (as shown below) from the Starting peg with **NO Target ball** on the Target peg. Allow the steel ball to fall on the Target Paper, making certain that the steel ball lands hits in approximately the same spot on the Target paper. Place a piece of **Graphite Transfer Paper** over the spot where the ball landed consistently so that the steel Ball makes a "mark" on the paper each time. If the steel Ball does not hit the Graphite paper, then adjust the paper and repeat the experiment. Make certain the ball doesn't overshoot the paper.



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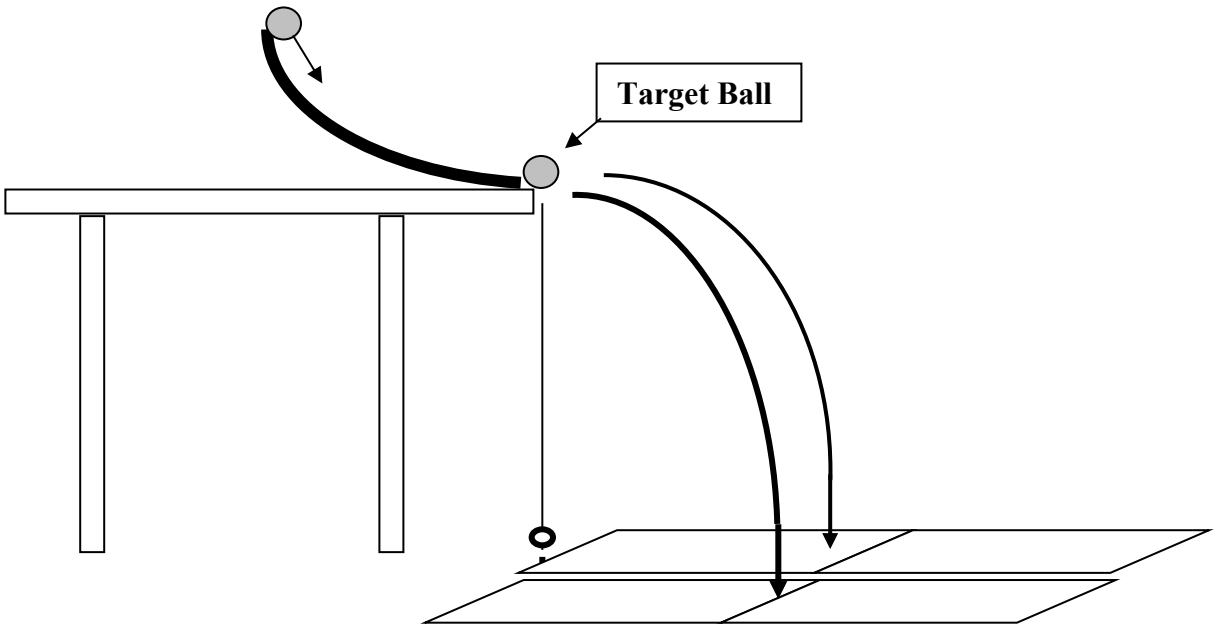
A. Equidistant Collision – Trial #1

1. Now roll the steel ball, starting at the top of the ramp (Starting peg), allowing it to fall onto the paper below. Be certain to roll it from the Staring peg **EACH TIME**!
2. Roll the steel ball **10 times** **WITHOUT** any Target ball on the Target peg. Be certain to catch the ball before it bounces twice! **Draw the smallest circle possible** around the group of dots. Label this spot as the **ORIGINAL MOMENTUM (p) OF THE STEEL BALL**.
3. Now place another **steel ball on the Target peg** & roll the original steel ball so that the collision causes BOTH balls to land at **EQUAL DISTANCES** from the plumb line. You will need to adjust the Target peg horizontally (right/left) to make certain the two balls land on the Target paper equal distances from the plumb line mark. As you adjust the Target peg, be certain that NO Graphite Carbon paper is placed on the Target paper YET.
4. Once your team has determined that the landings are equidistant, you can perform this experiment **10 times** with the graphite carbon paper placed on the spots you found the two balls to land.
5. **Draw a tight circle around the dots** and label the 2 new groups of dots as **Steel Ball #1 and Steel Ball #2**.
6. Mark this paper as **TRIAL #1**.



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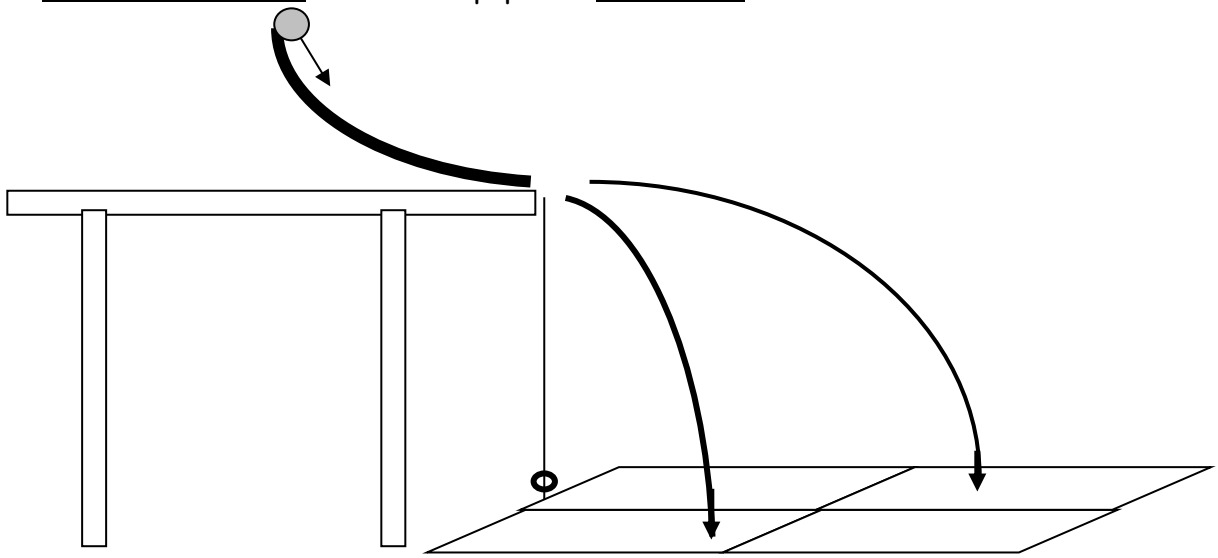
B. Non-Equidistant Collision – Trial #2

1. Repeat the same procedure with a **NEW TARGET PAPER**!
2. Again, roll the original **steel ball** **10 times**. Be certain to catch the ball before it bounces twice! Draw the smallest circle possible around the group of dots. Label this spot as the **ORIGINAL MOMENTUM (p) OF STEEL BALL.**
3. Again place a **steel ball on the target** & adjust the target so that they land at **DIFFERENT Distances** from the plumb line.
4. Do **10 times** & **circle the dots** and label the 2 new groups of dots as **Steel Ball #1 and Steel Ball #2.** Mark this paper as **TRIAL #2**.



C. Inelastic Collision – Trial #3

(Both balls will travel *together* upon collision)

1. Repeat the same procedure with a **NEW PAPER**!
2. Again, roll the original **steel ball** **10 times**. Be certain to catch the ball before it bounces twice! Draw the smallest circle possible around the group of dots. Label this spot as the **ORIGINAL MOMENTUM (p) OF STEEL BALL.**
3. For this trial, use the **WOOD BALL** as the **Target ball**. Be certain to adjust the Target peg so that the steel ball and the wood ball collide at their centers.
4. Before you roll the steel ball, place a small piece of double sided tape on the Wood ball where the collision will occur. This will allow the steel ball and Wood ball to travel together after the collision.
5. Roll the steel ball down the ramp and position the target ball so that the steel STICKS to the Wood ball. If the balls do not "stick" together, reapply another piece of tape to the wood ball and repeat the trial.

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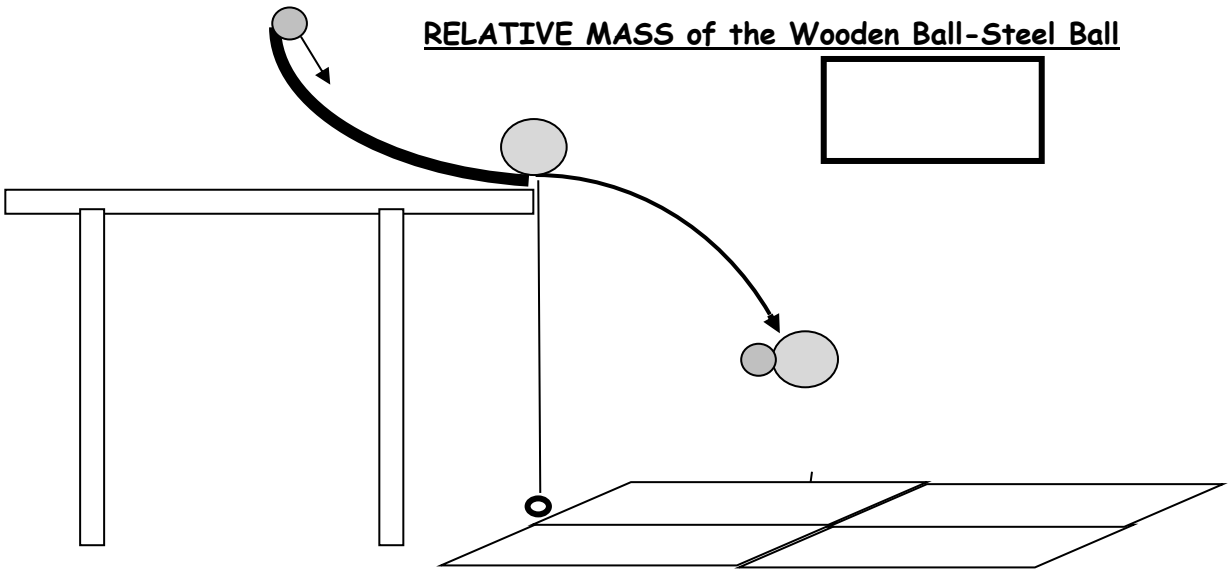
6. **ONLY ONE SUCCESSFUL ATTEMPT** is required.

YOU DON'T NEED CARBON PAPER FOR THE WOOD/STEEL BALL TRIAL… JUST MARK THE SPOT THAT IT LANDS WITH YOUR PENCIL!

- If you have accomplished this successfully once, then mark this paper as **Trial #3**.
- Using **vectors**, show the **RELATIVE MASS** of a wooden-steel ball combination when **compared** with that of a single steel ball.

(***HINT***! The wooden-steel ball vector is most likely much shorter than a single steel ball alone would be **BECAUSE THE MASS INCREASED AND THE VELOCITY DECREASED. (According to the Law of Conservation of Momentum)**

- Find the **RELATIVE MASS** of **the wooden-steel ball combo** using the Trial #3 Vector diagram.
  HINT → Find how many "times" the wooden-steel ball Vector "fits" into a single steel ball Vector!)



Measurements and Calculations

ON THIS LAB, EACH TEAM MUST HAVE...

1. Properly diagramed **Vector Diagrams** (…for Trials #1,2 and 3).

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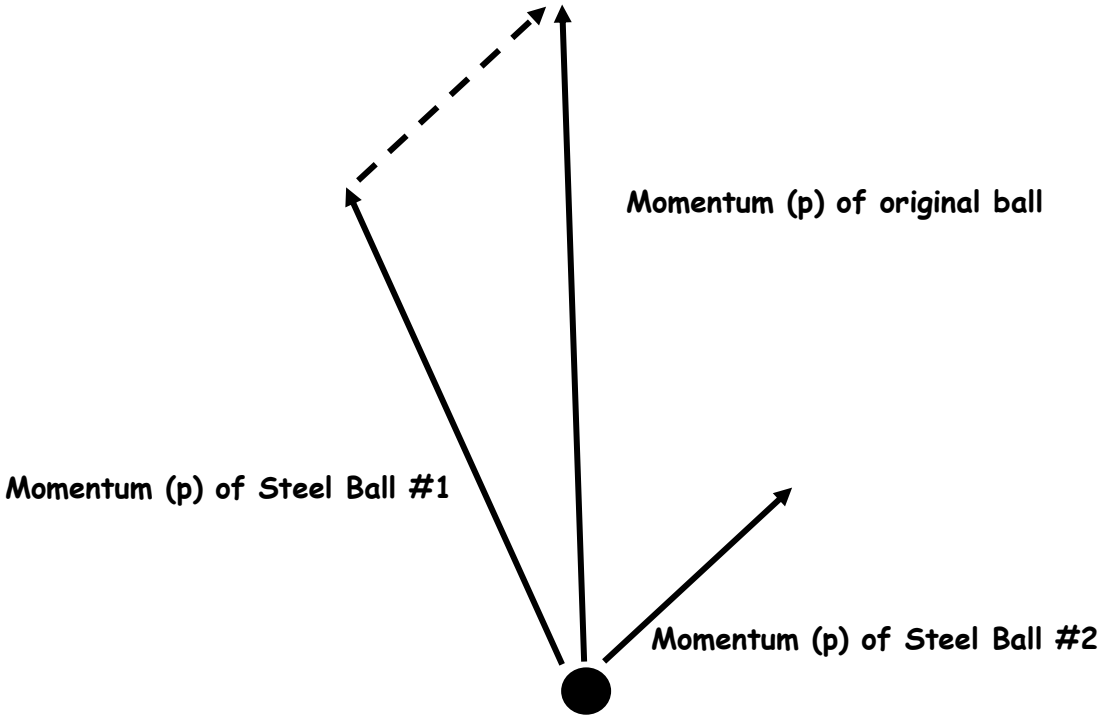
**** You and your partner should have 3 separate trials on 3 separate papers, each with it's own carbon-paper-collision markings! ****

2. Perform ALL drawings with a straightedge and a protractor!
3. You must draw a vector for the original ball and each ball's resulting collision.
4. Using the **Parallelogram Method** (…to solve for Vector Resultants), add the collision vectors together. If you have used correct lab procedure, the two collision vectors *should* be equal to the original p.

SAMPLE DRAWING

[…for trial #2]



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