Ballistic Pendulum
(Inelastic Collision)

Purpose

To determine if momentum and/or kinetic energy is conserved during an inelastic collision. Concepts of 2-D motion will be used to determine the velocity of a projectile prior to the inelastic collision. After the inelastic collision, conservation of energy concepts will be used to determine the velocity of the combined pendulum/ball.

The equipment used for this experiment will be the same equipment that was used in the 2D Motion Activity. However, the launcher apparatus will be reconfigured so that the projectile can be launched into the pendulum as well as launched to the floor. In addition, the photogates will be removed.

Part I. Momentum and Kinetic Energy before Collision

Under no circumstances should you try to lift or move the entire ballistic pendulum apparatus by the pendulum. Contacting the pendulum in any way while trying to move or lift the entire apparatus may cause damage to the pendulum. If you must lift the entire apparatus, lift the apparatus by grasping the base and the very top of the support.

Carefully loosen the thumbscrew at the top of the pendulum and remove the pendulum from its support. Determine the mass of the ball and the combined mass of the pendulum and the ball. Also determine the length (L) between the pivot point and the Center of Mass (CM). See the Data Sheet for a diagram.

Carefully reassemble the pendulum to the support. You must make sure that the pendulum is facing in the correct direction such that the pendulum will be able to receive the ball, and you must make sure that the angle indicator will move as the pendulum swings away from the launcher. Position the entire apparatus near the edge of the table, adjust the apparatus until the launcher is level, and clamp the apparatus firmly to the bench. Swing the pendulum up until the rod of the pendulum engages and remains in a horizontal position; in this position, the launcher can be fired without the ball being caught by the pendulum. Place the ball in the launcher, and cock the launcher with the ramrod until the launcher is engaged in the medium range setting.

Launch the ball by pulling the string, and carefully watch where the ball impacts the floor. Center a piece of blank paper over the impact site and tape it to the floor. *Lay a piece of carbon paper on top of the blank piece of paper, but DO NOT tape the carbon paper down*. During subsequent launches, the carbon paper will mark the blank piece of paper with the exact location of the ball's impact.

Launch the ball five times and determine the average range. It is important that each launch be made from the medium range setting. After you have data from five launches, determine the velocity of the ball before collision and the subsequent momentum and kinetic energy before the collision.

Part II. Momentum and Kinetic Energy after Collision

Release the pendulum from its horizontal position and let it hang freely. Slide the black angle indicator down so that it contacts the pendulum. If the angle indicator does not read exactly zero, the actual angle the pendulum swings can be determined by subtracting the initial angle from the final angle. Load and launch the ball five times into the pendulum. Again, it is extremely important to cock the launcher to the medium range setting for all five launches. Before each launch, make sure that the angle indicator will slide back and record the maximum angle of elevation. Determine the average angle of elevation, and use the diagram on the Data Sheet to determine the average height (h) that the pendulum's Center of Mass ascertains.

The velocity of the pendulum/ball combination must be determined independently from the velocity of the ball. (i.e. neither the concept of conservation of momentum nor the concept of conservation of energy can be applied since this experiment is trying to determine if momentum and/or kinetic energy is conserved during an inelastic collision.)

After the average height is determined, use the height to calculate the velocity of the Pendulum/ball combination just after the collision and the subsequent momentum and kinetic energy just after the collision.

Part III. Comparison

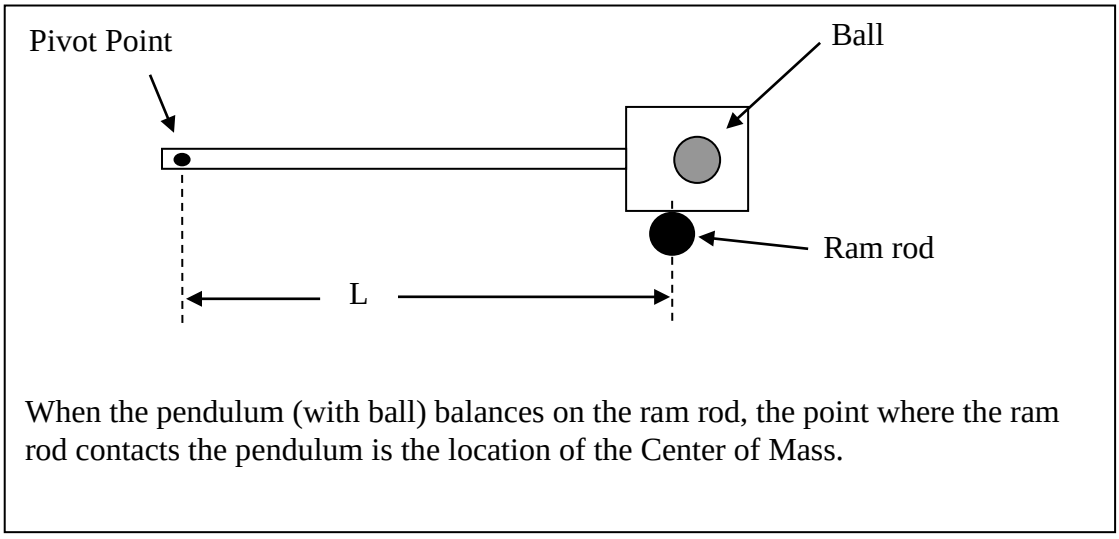
Compare the momentum and kinetic energy before and after the collision by determining the percent difference. Use these comparisons to justify whether the Momentum of the system and the Kinetic Energy of the system was conserved or not for this inelastic collision.

Data and Calculation Summary

Part I. Momentum and Kinetic Energy before Collision

Initial Data

Mass of Ball	Mass of Pendulum and Ball	L – Distance between pivot point and CM



When the pendulum (with ball) balances on the ram rod, the point where the ram rod contacts the pendulum is the location of the Center of Mass.

Launch Data

Height of ball from Floor	H =					
Range	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average
Calculation of velocity before collision						

Momentum and Kinetic Energy before Collision (Show Calculations)

Momentum Before Collision	Kinetic Energy Before Collision

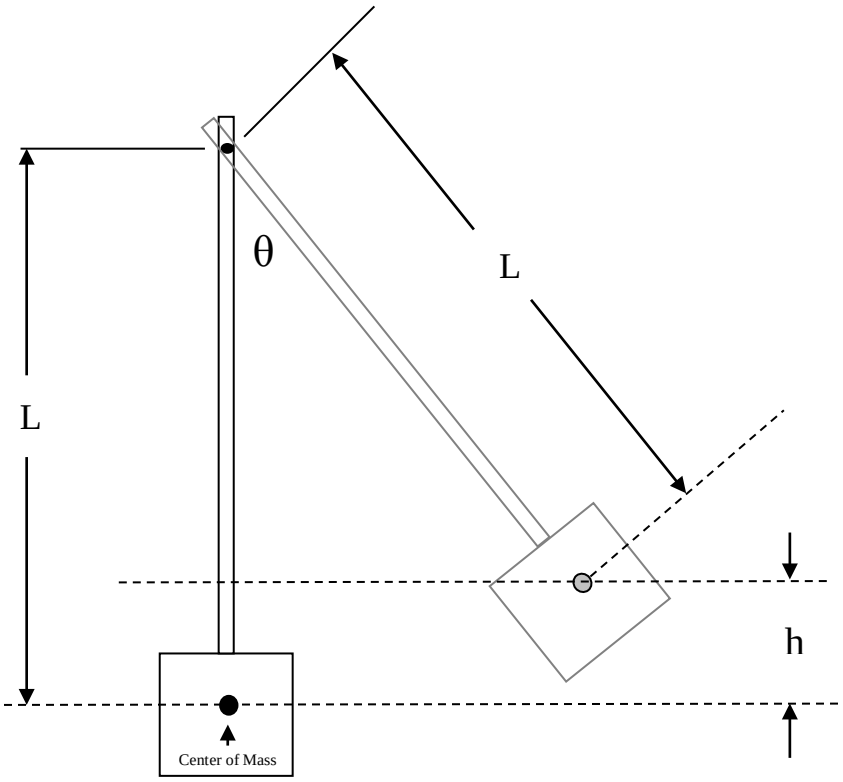
Part II. Momentum and Kinetic Energy after Collision

Post Collision Data

Angular Position	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Average

Calculated Average h

Use the diagram below and the necessary data to calculate the average h. Label the diagram as necessary and show your work.	h =



Calculation of the Pendulum/Ball Velocity just after the Collision (Show Calculation)
Note that the velocity should be determined by using the change in height of the pendulum/ball's center of mass.

Momentum and Kinetic Energy just after the Collision (Show Calculations)

Momentum After Collision	Kinetic Energy After Collision

Part III. Comparison

Percent Difference of Momentum (Show Calculation)	Percent Difference of Kinetic Energy (Show Calculation)

Name: _____ **Banner ID: _____**

Lab Group ID: _____ **Number of Lab Partners: _____**

Ballistic Pendulum Lab Summary

Raw Data

H Launch Height	R Launch Range	m Ball Mass	Θ Average Pendulum Angle	L Distance between pivot point and CM of Pendulum with the ball	M Combined Mass of Pendulum and Ball

Calculated Values

	Velocity	Momentum	Kinetic Energy
Ball (pre-collision)			
Pendulum/Ball (post-collision)			
Percent Difference (Pre/post momentums and kinetic energies)	N/A		

Questions

What type of collision occurred when the ball hits the pendulum? Explain.

Was Momentum Conserved? Explain.

Was Kinetic Energy Conserved? Explain