LAB 5: Collisions

Texas A&M University
College Station, 77843, US

Abstract

The Collisions experiment evaluates the angles created due to the collisions of two pucks. Additionally, it will be determined whether or not the collision is considered elastic, inelastic, or perfectly inelastic. Based on this information, the amount of kinetic energy before and after the collisions will be calculated to determine if kinetic energy was conserved or lost during the reaction. In sum, this experiment will explore the concepts of conservation of momentum, conservation of energy, and the manipulation of the equations associated with these concepts.

Keywords: *momentum, collision angle, kinetic energy, elastic*

Introduction:

The goal of this experiment is to calculate the angles following the collision of two pucks. These values will be found by utilizing the concept of vector dot products. A total of eight trials will be tested, with the pucks being launched toward each other at different initial angles. The velocity and motion of the pucks will be recorded using the tracking camera. This process will occur while the pucks are sliding across the DAQ table. Vector manipulation will be used in determining the separate angles. For this experiment, the mass of the pucks, which are approximately uniform in mass, is 0.028 kg ± 0.0005.

Some important physical concepts that will be explored and used are the law of conservation of energy, conservation of momentum, and the understanding of the differences between elastic, inelastic, and perfectly elastic collisions. Additionally, the kinetic energy and momentum before and after each collision will be calculated. By the end of the experiment, it will be determined whether momentum and kinetic energy were conserved, and whether the collisions exhibited elastic, inelastic, or perfectly inelastic characteristics. This can be found by comparing the kinetic energy before and after the collision.

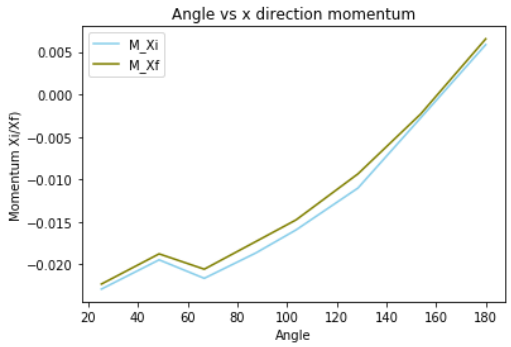
Experimental Procedure:

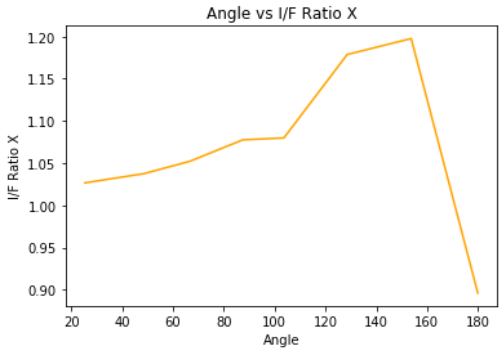
The first step to preparing this experiment was laying down strips of tape on the DAQ table to make different paths for the pucks to travel. Two strips created a 180 angle, a third strip perpendicular to those two making a 90 angle. Six additional strips were stuck to the table surface. Three of the strips made angles between 0and 90 and the other three formed angles between 90 and 180. Two neon stickers were stuck to the pucks as a medium for tracking the pucks. Consequently, the tracking camera was used to record the position and motion of the pucks as they travel and collide.

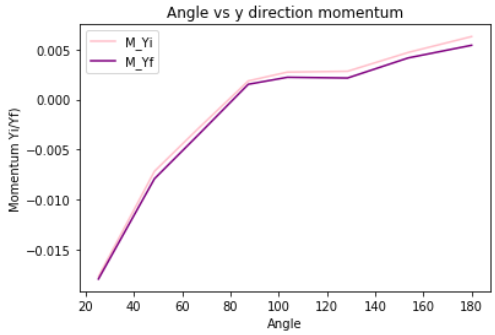
Next, eight trials were run. One puck was launched from the same position for every trial. For the first trial, the other puck was slid down the tape creating the smallest angle between the first puck and itself. After each successive trial, the second puck was launched from the next strip of tape gradually creating a larger angle between itself and the other puck. Thus, by the final launch, the first and second puck was launched with an angle of roughly 180 between them.

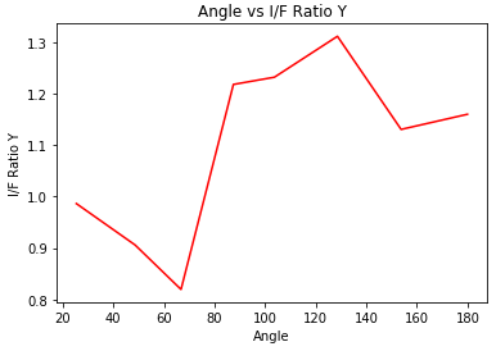
For each trial, the position, velocity, and acceleration of each puck was recorded from the initial launch past the collision. The data for each individual trial was saved to a .CSV file. In addition to the known mass of each puck, these will be analyzed to determine the angle at which each puck was launched. The following kinetic energy equations will be used to solve for the kinetic energy before and after the reaction: $0.5m_iV_{1,i}^2+0.5m_iV_{2,i}^2$ and $0.5m_iV_{1,f}^2+0.5m_iV_{2,f}^2$. The equation for magnitude of the dot product of a vector will be used to determine the angle between the two pucks.

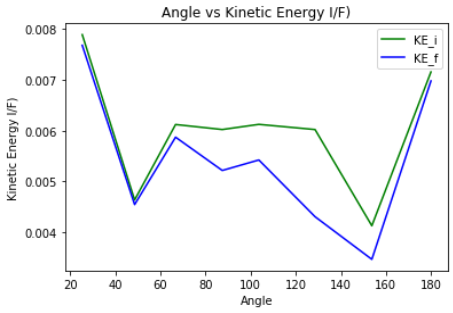
Results:











The graphs plotted to represent the angle, which is the x variable for all graphs. The first 2 sets of graphs represent the momentum before and after in the x-direction. The second 2 sets of graphs represent the momentum before and after in the y-direction. And the last graph represents Kinetic energy before and after the collision.

Calculations:

First, the velocities of both pucks in the x and y directions had to be found both before and after their collision. To accomplish this, I averaged the measured velocities for each instance. For example, as a puck travelled toward the collision, I averaged both the x and y velocities measured pre-collision, for both pucks, and did the same for the velocities that resulted from the collisions. Once all velocities were collected, the collision angles of the puck could be found. To calculate the angles, the inverse cosine was taken of the dot product of the velocity vectors of the pucks before the collision divided by the product of the magnitudes of the velocity of each puck. Once the collision angles were found, the x and y momentums were found by summing the given pick mass multiplied by the velocity in a single direction of both pucks. Then, the x and y momentum ratios were found by simply finding the quotient of the momentum before over the momentum after the collision.

For assignment two, the kinetic energy of the system was calculated both before and after the collision to determine whether the collisions should be considered elastic or inelastic. To do this, the magnitude of the velocity of each puck was found both before and after the collision. The kinetic energy of the system was found by taking the sum of the kinetic energies for each puck, found by multiplying the puck mass by the magnitude of the velocity squared divided by two. Once the kinetic energies were found before and after the collision, the numbers could be compared to decide the elasticity of the collisions.

Conclusions:

In this lab, tracking camera data of the collision of two pucks was used to determine whether momentum and kinetic energy would be conserved throughout the collision. Based on the closeness of the graphs of the x and y momentums before and after the collisions and the fact that the ratio graphs both were fairly close to one for most of the collision angles, it can be concluded that momentum was conserved throughout the collisions studied in this lab. Based on the kinetic energy graph, despite a discrepancy in the before and after graphs with angles near ninety degrees, it can be determined that kinetic energy was conserved in these collisions. The discrepancy in the graphs at around 90 degree collision angle can be explained by the imperfect data provided by the camera, and was also a theme throughout the momentum graphs as well. Thus, it was concluded that the collisions of the pucks studied in this lab would be classified as elastic.