LAB 7: Conservation of Momentum*

Equipment List:
air puck table and two pucks
recording paper
triple-beam balance
ruler
protractor

Purpose: To confirm the law of Conservation of Momentum and determine if a collision is elastic or inelastic. You will also confirm that the velocity of the center of mass is constant for an isolated system.

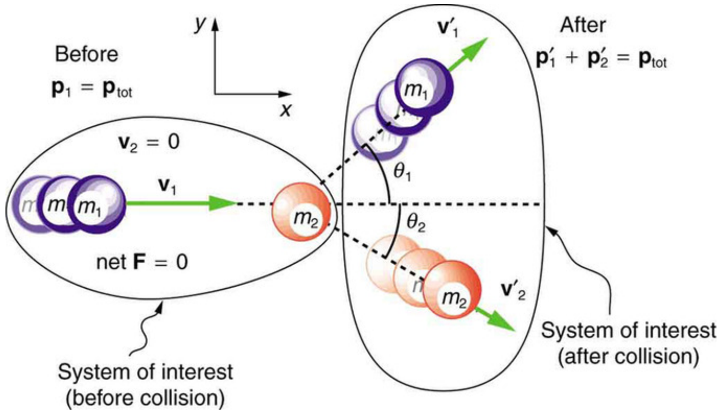

Figure 1: A diagram of a glancing collision.

Theory: In the collision of the pucks on the air table, there is very little friction or air resistance, so the external net forces are negligible. Therefore, momentum should be conserved in this experiment.

Theory Exercise: Choose a coordinate system as in the diagram so that the moving puck travels along the x-axis. From the equation of conservation of momentum:

$$\mathbf{p}_i = \mathbf{p}_f \quad \Rightarrow \quad m_1\mathbf{v}_{1i} + m_2\mathbf{v}_{2i} = m_1\mathbf{v}_{1f} + m_2\mathbf{v}_{2f}$$

find a pair of expressions for the conservation of momentum in the x-direction and in the y-direction, specific to this glancing collision, in terms of the masses m_1, m_2, the speeds of each mass v_{1i}, v_{1f}, v_{2f}, and the angles θ_1 and θ_2.

Write expressions for K_i, the total kinetic energy before the collision, and K_f, the total kinetic energy after the collision.

*Based on the lab by Prof. Luna.

Procedure:

1. As a class, we will measure the mass of each puck with the triple-beam balance.
2. Using the air puck table and two pucks, collect a spark pattern trace (with the assistance of your instructor) that resembles the collision shown in Figure 1.
3. Determine the velocities of the pucks before and after the collisions. Choose the direction of the moving puck before the collision as the x axis. Measure angles using the protractor relative to this x-axis. Lay the ruler along the trajectory of the moving puck before the collision. Measure the distance across as many spark dots as you can, perhaps 5–10, but do not include the first dot. Divide this distance by the number of intervals between the dots and call the result d. From the frequency of the spark generator, determine the time interval between each dot, t. Find the speed using $v_{1i} = \frac{d}{t}$. Repeat this process to find the speeds of the pucks after the collision.
4. Using the equations obtained in the theory section calculate the momentum and kinetic energy before and after the collisions.
5. Calculate the percentage difference of the initial and final momentum. Take the initial momentum to be the "theoretical" or "accepted" value.
6. Calculate the percentage loss of kinetic energy:

$$\text{\%-loss of KE} = \frac{K_i - K_f}{K_i} \times 100\%$$

7. Calculate the velocity of the center of mass, $\mathbf{v}_{\text{CM}}$, before and after the collision.
8. Calculate the percentage difference of the initial and final *speeds* of the center of mass. Take the initial value to be the "theoretical" or "accepted" value.