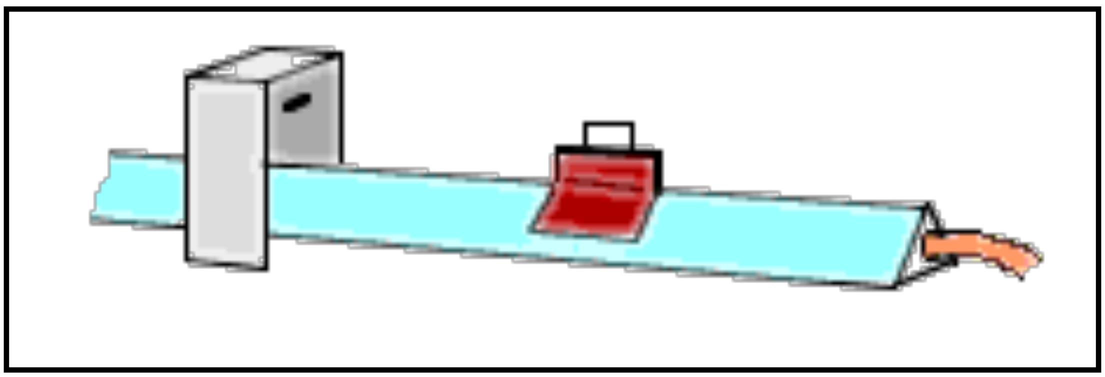
PHY 241
Lab 6

Conservation of Momentum

We will investigate the principle of the conservation of momentum. Strictly speaking, the momentum of a system of objects is conserved only if there are no external forces. Although we cannot completely eliminate friction, we can greatly reduce friction along one direction using the air tracks in the lab. The carts move along the air track riding on a cushion of air. The V-shape bottoms of the carts perfectly match that of the track. Air is forced up through tiny holes in the track surface, which levitates the carts a fraction of a millimeter above the track

IMPORTANT!
- **Treat both the track and carts with great care.**
  Dropping the carts even a few inches onto the table or track can ruin them.
- **Never slide the carts on the track unless the air supply is on.**



Objective

We will investigate conservation of momentum for three different 2-body collisions:
1. Completely inelastic collision between two masses.
2. Elastic collision between two equal masses.
3. Elastic collision between two unequal masses.

In each case it will be necessary to measure the mass of each cart, and the velocity of each cart both before and after the collision.

Procedure

1. The track must be level so that the force of gravity will have no component along the track and hence, has no effect the horizontal momentum of the carts. This is done by placing a cart on the track and adjusting the leveling screw until the cart remains stationary when placed on the track. The track will not be perfectly straight. Consequently, the cart will "fall" into the low spots. It will be necessary to place the cart at three or four locations along the track, adjusting the leveling

screw such that the track is level "on average".

2. Find the mass of each of the three carts using the triple beam balance. Each cart will have a trigger flag and one will have a small plug of soft clay (or something similar) that should be included with the mass. Be careful with the carts when placing them on the balance pan.

3. Place two photogates on the tracks at roughly one third the distance from each end, avoiding places near any low or high spots you have identified on the track. These gates will record the time required for the flag on top of each cart to pass by. Knowing the width of the flag, the velocity with which the cart passed through the photogate can be determined.

4. Turn on the air source and place one of the carts on the track. Determine the width of the the flag by slowly moving the cart into the gate, stopping just as the flag blocks the photo eye and the timer starts. Record the position of the back end of the cart from the track scale. Now continue to move the cart just until the photo eye is unblocked and the timer stops. Record this position. The *difference* in the two positions will be the width of the cart. Repeat for all three carts.

Performing the Experiment

1. **Completely Inelastic Collision:** Two of the carts will have one end with no spring. One of those will have a small plug of soft clay. The clay will provide the mechanism for the two carts to stick together. Place the first cart near one end of the track (outside the photogates). Place the second cart between the photogates. Reset the timers and give the first cart a gentle push. Be sure you are not pushing the cart when it enters the first photogate. The carts will collide and pass through the second photogate. Record the photogate time for each from the timer mechanism. The velocity is calculated by dividing the flag width by the photogate time. Repeat this 5 times.

2. **Elastic Collision for Equal Masses:** Choose two identical carts. Proceed as described above, making sure that the carts will collide with ends having springs. If the masses are truly equal, the first cart should come to rest after the collision. Note the degree to which the first cart comes to rest. Record the time for each cart. Repeat this 5 times.

3. **Elastic Collision for Unequal Masses:** Place the larger cart in the center. It must be the stationary cart. Gently push the smaller cart through the first gate as before. It will collide with the larger cart and rebound in the opposite direction. Allow it to pass through the first photogate again. Record the times on each each timer. Now push the recall button on the first photogate. Record this time and subtract the original reading. The difference will be the time that the rebounding cart blocked the photo eye on the return. Repeat this 5 times.

IMPORTANT NOTE: *The cart must be stopped from rebounding off the end of the track and passing through photogate a third time, as that will add time to the counter. Do so by having one member ready to gently stop the cart after it has cleared the photo gate, just before it hits the end.*

4. **Elastic Collision for Equal Masses II:** If time permits, send both identical carts through the photogates at each end and allow them to collide near the center. Allow the carts to pass through the photogates again. Record the times on each each timer. Now push the recall button on each photogate. Record these time and subtract the original readings. Again, the difference will be the time that the rebounding cart blocked the photo eye on the return.
See the important note above about stopping the carts from passing through the gates a third time.

Report

In each experiment above, calculate the velocity and momentum for each cart before and after the collision. Find the % difference between the initial momentum and the final momentum of the system. Is the % difference small enough for you to conclude that momentum is conserved? Explain any problems or sources of error inherent in this experiment.
NOTE:
For part #4, divide the difference in p_i and p_f by the average of the absolute value of each cart before the collision.