EXPERIMENT: ELASTIC ONE-DIMENSIONAL COLLISIONS

OBJECTIVES

- See previous lab.

APPARATUS

A one-dimensional air track, a photogate timing circuit and an analytical balance will be used.

PROCEDURE

In this experiment we will try to obtain an almost elastic collision of two carts on the air track. The main difference from the previous lab is that the carts will now move separately after the collision. The elastic bumper allows the carts to bounce off of each other with almost no conversion of kinetic energy into other forms of energy.

As before, Cart 2 is initially at rest. Before the collision we have to measure only the velocity of Cart 1, v_1 (Figure 1). However, after the collision we have to measure the velocities of both carts, v_{1f} and v_{2f} (Figure 2). Thus, in all we have to measure three times (t_1, t_{1f}, and t_{2f}), while the photogate system allows us to simultaneously measure only two of them.

We can get out of this situation if after the measurement of the initial time t_1, but before the collision of the two carts, we reset the timer. You will probably have to make several practice trials to learn to quickly remember and reset the contents of the timer before the carts collide. Then, we can again use the contents of the timer display and the memory to find t_{1f} and t_{2f}.

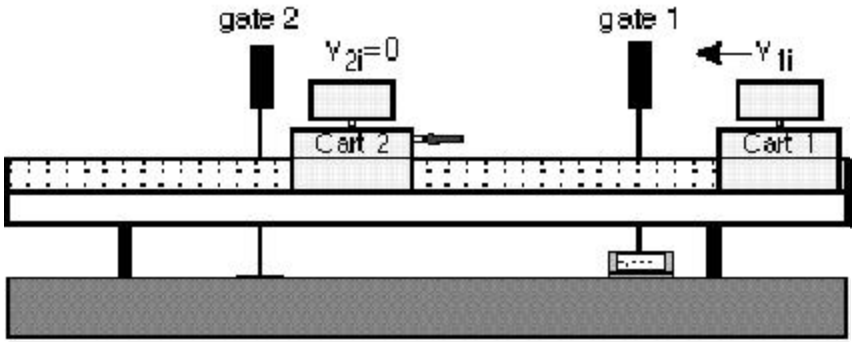

Figure 1: The Initial State of the Carts Before the Collision

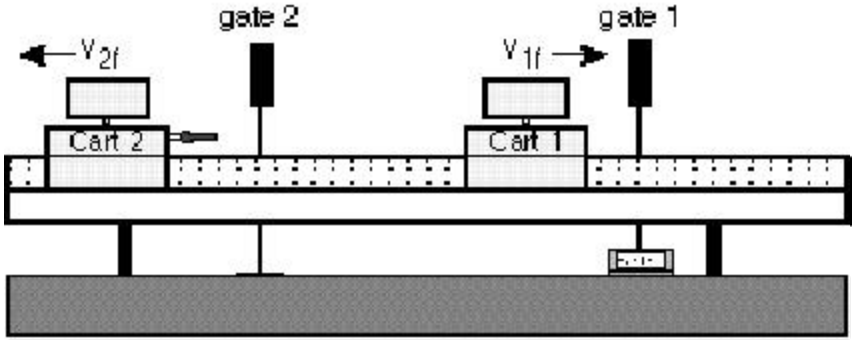

Figure 2: The Final State of the Carts After the Collision

The fins on two carts have the same length. Verify this by measuring these lengths L_1 and L_2. Again the masses of the carts can be varied by adding the metal disks, or weights, to them.
Remember, the experiment will be done with Cart 2 initially at rest. So in the initial state we have

Initial state: Cart 1: has a mass m_1 and initial velocity v_1
Cart 2: has mass m_2 and is at rest, so $v = 0$ cm/s

After the collision (final state): the two carts will be moving independently
the speeds of the carts will be v_{1f} for m_1 and v_{2f} for m_2

You will do 6 trials with the following m_1 and m_2 choices:

Trials 1 & 2: no mass disks on Cart 1, 2 mass disks on Cart 2; measure v_1, v_{1f} and v_{2f}
Trials 3 & 4: 2 mass disks on Cart 1, 2 mass disk on Cart 2; measure v_1, v_{1f} and v_{2f}
Trails 5 & 6: 2 mass disks on Cart 1, no mass disks on Cart 2; measure v_1, v_{1f} and v_{2f}

To measure these speeds you measure the times t_1, t_{1f}, and t_{2f}. Enter the data into the spreadsheet and calculate the momenta and kinetic energies. Pay attention to the signs of the velocities, which depend on the direction of the motion of the carts since velocity is a vector quantity. If the percentage change in momentum or kinetic energy before and after the collision is greater than 5%, repeat the measurement more carefully (collide slower/faster, etc.). Since the spreadsheet is set up it is easy to see whether momentum and/or energy is better conserved with every trial you do.

CHECKLIST

Your lab report should include the following five items:

1) sample calculations of the momentum and the kinetic energy of the system before and after the collision. Sample calculations for the errors in v, P, KE, P_{diff} and KE_{diff}.

2) calculations for percent changes in momentum and kinetic energy through the collision. The change should be less than 5%. Describe what, if anything, you changed to achieve percent changes less than 5%.

3) comments on possible explanations for any change in KE and momentum

4) comments on the experimental uncertainties in the momentum and kinetic energy changes. This is like CHECKLIST #4 in the inelastic lab.

5) comparison of the results of the elastic collision and inelastic collision experiments