INELASTIC COLLISIONS

Purpose:

To analyze the motion of two low friction carts during an inelastic collision and verify that the law of conservation of linear momentum is obeyed.

Equipment:

Computer with Logger Pro software, lab pro, motion detector, horizontal track, two carts, 500 g masses(2), triple beam balance, bubble level

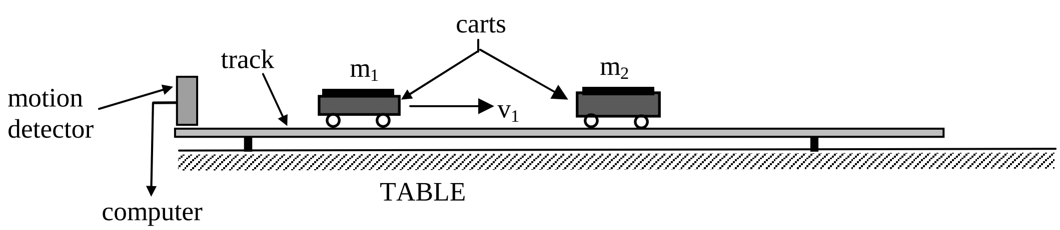
Introduction:

This experiment uses the carts and track as shown in the figure. If we regard the system of the two carts as an isolated system, the momentum of this system will be conserved. If the two carts have a perfectly inelastic collision, that is, stick together after the collision, the law of conservation of momentum says

$$P_i = P_f$$

$$m_1v_1 + m_2v_2 = (m_1 + m_2)V$$

where v_1 and v_2 are the velocities before the collision and V is the velocity of the combined mass after the collision.



Procedure:

1. Set up the apparatus as shown in Figure 1. Use the bubble level to verify that the track is as level as possible. Place each cart on the triple beam balance and make a record of each mass. Connect the lab pro to the computer and the motion detector to the lab pro. On the computer, start the **Logger Pro** software, open the **Mechanics** folder and the **Graphlab** file. You should see a blank position vs time graph.
2. First, check to see that the motion detector is working properly by clicking the **Collect** button to start collecting data. Move the cart nearest the detector back and forth a few times while observing the position vs time graph being drawn by the computer. Does it provide a reasonable graph of the motion of the cart? Remember to be aware of unwanted reflections caused by objects in between the motion detector and the cart. Also, position the carts so that their velcro pads are facing each other. This will insure that they will stick together after the collision.
3. With the second cart (m_2) at rest give the first cart (m_1) a moderate push away from the motion detector and towards m_2. Observe the position vs time graph before and after the collision. You should see two linear curves with two different slopes. These slopes are, of course, representative of the velocity before and after the collision. To avoid the problem of dealing with friction forces (Remember, we are assuming the system is isolated.), we will find the velocity of the carts at the instant before and after the collision. For the velocity before the collision, select a very small range of data points just before the collision. Avoid the rounded portion of the curve which represents the collision itself. Choose **Analyze/Linear Fit**. Record the slope (velocity) of this line. Repeat for a very small range of data points just after the collision. Record this slope (velocity) as well.

4. Repeat for two more collisions. Calculate the momentum of the system the instant before and after the collision for each trial and find the percent difference. Put your results in a data table.
5. Place an extra 500 g on the second cart and repeat steps 3 and 4. Print out one representative graph showing the position vs time for a typical collision.
6. Remove the 500 g from the second cart and place it on the first cart. Repeat steps 3 and 4.
7. Find the average of all of the percent differences found above. This average represents your verification of the law of conservation of linear momentum. How well is the law obeyed based on the results of your experiment?
8. For each of the nine trials above calculate the kinetic energy of the system before and after the collision. Find the percent kinetic energy lost during each collision. Put this information in a separate data table.
9. Do a theoretical calculation for $\Delta K/K$ in a perfectly inelastic collision for the three situations:

    1. a mass, m, colliding with an identical mass, m, initially at rest.
    2. a mass, 2m, colliding with a mass, m, initially at rest.
    3. a mass, m, colliding with a mass, 2m, initially at rest.

10. Compare your experimental numbers calculated in part 8 above with the results of your theoretical calculations in part 9.