LAB 8. COLLISIONS

Introduction

This lab requires two motion sensors, which can connect to a single interface.

Supplies

Rail, two carts, two motion detector setups, extra cart mass, interface, laptop running Logger Pro

Data Collection

Preliminary setup

1. Set up motion detectors with the computer.
2. Position the two motion detectors on the track, facing each other. Decide which direction on the track is positive. (You may need to flip the sign of the readings of one detector.) The default is that motion away from a detector is positive.
3. Level the track.
4. Measure and record the masses of both carts and the auxiliary mass. Record the masses of both carts with each new collision.

Magnetic bumper collisions

Place the two carts on the track, magnetic bumper ends facing each other. If any collision is so violent that the carts actually touch or one of the carts derails, discard the run and repeat under gentler conditions.

Even bump

1. Position one cart near the center of the track and the other near an end.
2. Start data collection with both motion sensors.
3. Give a quick push to the cart near the end of the track toward the other cart. Stop data collection only after the carts travel away from the collision.
4. View the velocity-time graphs of both detectors. Determine the carts' velocities immediately before and immediately after the collision (decide on a consistent way to do that). Assign the signs to properly convey the directions. Record in your data table.
5. Repeat for a second collision. It is not necessary to reproduce the previous velocities.

Light bump

Attach the auxiliary mass to the cart in the center of the track. Repeat the procedure above for two collisions with the lighter cart striking the heavy cart.

Heavy bump

Repeat the above procedure but with the heavy cart striking the lighter cart, for a total of two collisions.

Uneven head-on

Set both carts moving toward each other to collide in the middle.

Even head-on
Remove the auxiliary mass. Set both carts moving toward each other to collide in the middle.

Velcro bumper collisions
Set both carts on the track so that their Velcro bumpers face each other. When the carts collide, the carts should cling together. If they do not, or if either cart derails, repeat the collision under gentler circumstances.

Specific collisions
Carry out the same collisions described above, but using the Velcro bumpers.

Data Processing
1. For each collision, calculate the momentum mv of each cart immediately before and after the collision. Add the (vector) momentum of the two carts together to find the total momentum before and after the collision. (A spreadsheet is helpful here.)
2. For each collision, calculate the kinetic energy $\frac{1}{2} mv^2$ of each cart before and after the collision. Add the kinetic energies of the two carts together to find the total kinetic energy before and after the collision.
3. For each magnetic bumper collision, calculate the difference in velocities of the two carts before and after the collision. (The difference should be zero for the Velcro collisions.)

Results
Make three tables of results. (It is probably easiest to use a spreadsheet.)

1. Momentum of the individual carts and their total before and after (six values per collision).
2. Kinetic energy of the individual carts and their total before and after (six values per collision).
3. Relative velocities for the magnetic bumper collisions before and after (two values per collision).

Interpretation
1. In which collisions is momentum conserved?

2. In which collisions should momentum be conserved? Why?

3. In which collisions is kinetic energy conserved?

4. In which collisions should kinetic energy be conserved? Why?