LAB 9. COLLISIONS

Introduction

This lab requires not one, but two motion sensors. Both can connect to a single interface. You will use the two sensors to record the positions and velocities of two colliding dynamics carts. You will run two types of collisions. When the Velcro bumpers of the carts face each other, the bumpers bind the carts together upon contact. When the magnetic bumpers of the carts face each other, the carts bounce apart without the bumpers touching.

Supplies

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

Data Collection

Preliminary setup

1. Set up the motion detectors with their computers.
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 the other detector, because it faces the opposite direction.)
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. The carts should bounce apart in a collision without touching. 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. Allow it to coast to and collide with the other cart. Stop data collection only after the carts travel away from the collision.
4. View the velocity-time graphs of both carts. Determine and record the carts' velocities immediately before and immediately after the collision. Assign the signs to properly convey the directions.
5. Repeat for a second collision.

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, they 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.
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.)

Lab Report

The report should contain the standard parts. It is probably easiest to present the data and calculations in a spreadsheet.

Theory

What quantities ought to be conserved? What are their formulas? You do **not** need to report or derive formulas for predicted final velocities.

Analysis and Discussion

Make clear tables of results that include:

1. Before and after momentum of the individual carts and their total (six values per collision).
2. Before and after kinetic energy of the individual carts and their total (six values per collision).
3. Before and after relative velocities for the magnetic bumper collisions (two values per collision).

Please answer these questions thoroughly.

1. Was total momentum conserved in any of the collisions? If so, for which collisions? Is this theoretically expected? Explain.

2. Was total kinetic energy conserved in any of the collisions? Which ones? Is this theoretically expected? Explain.

Report and discuss any noteworthy observations.

Conclusion

What quantities are conserved in these collisions? Are your results consistent with accepted conservation laws?