LAB 9. CONSERVATION OF MOMENTUM

Introduction

We only have two setups for this lab, because it requires not one, but two motion sensors. Please maintain proper distance between group members.

Supplies

Rail, two carts, two motion detector setups, extra cart mass

Data Collection

Preliminary setup

1. Set up motion detectors with their computers. Set the detectors to take 40 readings per second.
2. Position the two motion detectors on the track, facing each other. Decide which direction on the track is positive. (You must 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. With each new collision, record the masses of both carts.

Magnetic bumper collisions

1. Place the two carts on the track, magnetic bumper ends facing each other.
2. 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 and record the carts' velocities immediately before and immediately after the collision. Assign the signs to properly convey the directions.
5. Repeat for another collision.

Light bump

1. Attach the auxiliary mass to the cart in the center of the track.
2. 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

1. Set both carts on the track so that their Velcro bumpers face each other.
2. 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.
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 segments. It is probably best to present the data and calculations in a spreadsheet.

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 all of these questions thoroughly.

1. Was total momentum conserved in any of the collisions? Which ones? Is this theoretically expected? Explain.
2. Was total kinetic energy conserved in any of the collisions? Which ones? Is this theoretically expected? Explain.
3. Classify each collision as elastic, inelastic, or totally inelastic. Justify your classifications.
4. Were some collisions closer to elastic than others? Which ones? Explain why this happened.

Conclusion

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