PHYSICS 133 SPRING 2006 EXPERIMENT NO. 5 CONSERVATION OF LINEAR MOMENTUM IN ONE DIMENSION

In this experiment, we study linear momentum conservation in one-dimensional collisions using the air track. In doing this, we observe and test Newton’s third law (action & reaction), the underlying principle that gives us momentum conservation.

NOTE: Perform collisions with the gliders moving **SLOWLY** (no more than 0.5m/s). If there is an audible "clank" (caused by a glider coming into contact with the air track) you will have introduced an external force, momentum will not be conserved, and the equipment might be damaged.

A. Equipment

1 air track, 1 glider with photogate, additional weighted gliders with Velcro, 1 light sensor, 1 interface box, 1 computer with timing program, rubber bands.

B. Method

By allowing two gliders to collide under varying conditions, we test the validity of several ideas: (1) The center of mass of a system initially at rest remains at rest when no external force acts on it. (2) Each action has an equal and opposite reaction (Newton's Third Law). (3) Linear momentum is conserved when external forces are negligible. By measuring the velocity of the photogate glider before and after totally inelastic collisions, the momentum of the two-glider system is calculated. After verifying conservation of momentum, the energy loss in collisions will be studied.

C. Procedure

I. Center of Mass and Action & Reaction.

Level the air track as before. Place two ***non-photogate*** gliders of equal mass on the air track with the Velcro strips facing each other and connect them with a rubber band using the screws on top of the gliders. Separate the gliders by a distance ***slightly*** greater than the relaxed length of the rubber band (so that the gliders will not collide too hard when they are released). Locate and mark (with masking tape) the center of mass of the two-glider system. Now release the gliders simultaneously. (This may take some practice. ***Be sure the gliders do not collide too hard!***) Repeat with gliders of unequal mass.

Q1. What is the momentum of the system before the gliders are released?

Q2. How far has each glider moved? How much has the center of mass moved? Is it at the point of collision?

Q3. What is the momentum of the system after the collision?

Q4. Compare the momentum of each glider while they are moving.

Q5. Do the relative masses of the gliders affect your answer to questions 1-4?

Q6. On the basis of what you have observed, what can you say about the forces acting between the gliders?

II. Inelastic Collisions.

Remove the rubber band and collide the photogate glider with a stationary non-photogate (target) glider so that they stick together after the collision. Use the computer timing program to record the motion before and after the collision. Plot data in your lab book for the first run. Fit the data with straight lines and obtain the best values of velocities just before and just after the collision. Repeat several times with the different target gliders. Obtain velocity values from the computer. Calculate the momentum before and after the collisions, using the measured velocities and the masses of the gliders.

Q7. Is linear momentum conserved?

Q8. Is energy conserved in the collision?

III. Elastic Collisions.

Move the target glider to the other side of the photogate glider, so that the metal loop-springs on the ends of the gliders may collide. Launch the photogate glider at the target glider as before, and record its velocity before and after collision. Assuming that momentum is conserved, calculate the velocity of the target glider after the collision.

Q9. Is energy conserved in the collision?

Q10. Is the collision completely elastic?

Repeat for different velocities and different mass gliders as time permits.