LAB A11: *CENTER OF MASS MOTION BEFORE AND AFTER A COLLISION* 11/12/02

GOAL: To investigate the motion of the center of mass of a system that has no net external forces on it.

READING: Walker 9(7)

PROCEDURE: **PRODUCING A COMPLETELY INELASTIC COLLISION ON THE AIR TABLE**
Record all data below directly onto spark sheet;
Prepare the sheet for an in-class poster-style presentation

Produce a completely **inelastic** collision of two pucks of **equal mass** that have been surrounded with opposite types of Velcro.

1) The table should have already been leveled - although you're welcome to check.

2) Your pucks should be adjusted to have the same mass to within 1 gram. If not, tape the necessary amount of mass to the less massive one.

3) On top of the table place a black carbon sheet (that will produce the dark spark marks) and on top of that place a sheet of white (actually recycled newsprint) paper. The carbon paper must be black-side up. The white paper should be flush against two of the table edges and should not move (relative to the table) during your collision.

Most of the tables have foot pedals that must be continuously depressed to produce sparks. Make sure that no hands are on or near the table when sparking occurs. You will not see the spark marks until you turn the paper over, of course. You may not even hear the sparker.

4) A spark rate of 20 Hz is suggested. Record all actual data about the apparatus on your spark paper. (puck masses & numbers, air table number, spark rate, etc.)

5) Look at the example spark paper that has been prepared so that you can see the results of a successful experiment. Then practice your collision a few times, using the following guidelines:

a) start the pucks from the two different corners of the table; the pucks should collide around the middle of the table and continue moving towards the opposite wall of the table
b) start the sparks as soon as possible AFTER your hands leave the pucks
c) you MUST have at least seven sparks that are in a straight line (for each puck) before the collision occurs.
d) stop the sparks <u>before</u> **either** puck hits a wall.
e) make sure that the Velcro cuffs do not cause friction by dragging on the table; also be sure that the air hoses leading to the pucks do not get tangled or twisted and thus slow down the pucks
f) the pucks should hit one another at a glancing angle such that they twirl around once or twice before reaching the opposite wall
g) label your spark sheet **as soon as you finish** with the initial and final positions of each puck; remember that the paper gets flipped over; writing your names on the paper is also an excellent idea.
h) count and label (with numbers) the sparks for each puck; make sure that there are **<u>exactly</u>** the same number of spark positions for each puck. If not, do the collision over.
i) as a final check, what should the separation of two matching spark points be after the collision?

RESULTS: DETERMINING THE POSITION AND VELOCITY OF THE CENTER OF MASS (all on the spark sheet)

Once you have a spark paper that you are satisfied with, bring the paper with you to class on the day that the lab analysis will be done. All of the measurements and calculations will be done directly on the spark paper (not in your lab book).

1) Both partners should work first on determining the center-of-mass position for each of the spark times. If you have more than 20-25 sparks per puck, you need not find the center of mass position for every spark time - instead you could use only odd- or even-numbered sparks. You want to have at 10 - 15 CM positions spaced at regular intervals.

Explain, clearly on your paper, using words and an equation, how you will locate the center-of-mass (CM) position, given the two spark positions of the equal-mass pucks. Mark the CM position on the paper with a tiny " · " for each of the spark times you determined the position.

2) a) Determine the average CM speed before and after the collision. Before you start your calculations, decide what parts of the spark paths are "before" and "after". In general, you should use all of the sparks available before the collision and all the sparks available after the collision, unless there is some good reason not to do so. On your spark paper, show (with a bracket) which sparks were actually used to determine the CM speed.

b) Did the CM speed "after" differ appreciably from that "before"? Be quantitative in your comparison.

3) On your spark paper, use your CM positions to draw lines to show the direction of the CM velocity before and after the collision. Your lines should go through as many of the "before" or "after" sparks as possible. Compare the direction of motion for the CM after the collision to that before by measuring and recording the angle the "after" velocity vector makes with the "before" velocity vector. Be sure to label this angle on your spark paper.

ANALYSIS: BEHAVIOR OF THE CENTER OF MASS (all on the spark sheet)

1) Should the CM velocity have changed? Why or why not?

2) Is there a discrepancy between your answers to Results questions 2/3 and Analysis question 1? Be sure to account for it.

CONCLUSION

On your spark sheet ,neatly and clearly write a summary, like an abstract, so others can read it and understand what you did, how you did it, and what you determined simply by seeing this one sheet.