EXPERIMENT 7:

CONSERVATION OF LINEAR MOMENTUM

Objective:

To compare the sum of the momentum vectors before and after a two-dimensional collision between metal balls of unequal mass. To demonstrate the principle of conservation of linear momentum.

Procedure:

The instructor will demonstrate recording a collision with 60-Hz spark timers.

1. Work with another student, but collect your own collision data.

2. Practice making a 'good' collision with the power off.

3. ***For your safety, carefully follow your instructor's directions before turning the power on.***

4. With the spark timer off, pull the balls 25-40 cm from their equilibrium position, release them, and observe the collision. Practice with the spark timer off to find a release position that produces a deflection between 30 and 90 degrees. Then, **AVOIDING CONTACT WITH THE HIGH VOLTAGE**, record a collision for each student in the group. Vary the release point to obtain different speeds and scattering angles.

As in the *Free Fall* analysis experiment, your data will be tracks of spots registering the positions of the balls at equally spaced time intervals. But this time the motion is in two dimensions; *each velocity has direction as well as speed.*

Analysis:

Data Collection

1. Circle the spark spots so they don't get lost in the scratches and marks that are going to appear on your data sheet as you work. Draw a straight line through each track, averaging any oscillations produced in the collision. Show the direction of motion with an arrow. Let the subscript "s" represent the smaller ball and "b" represent the bigger ball, and let a prime mark (') indicate values after the collision, and label each track with the notation v_s, v_b, v_s', and v_b', so that you define the initial and final tracks of each ball.

2. Draw an x-axis across your data sheet so that it contacts each of the four tracks. If necessary, extend the tracks so that they intersect the x-axis. Use a protractor to measure the direction of travel of each track. This angle is between the positive x-axis and the line of the

track. Angles measured "above" the x-axis are positive, angles measured "below" the x-axis are negative. Be careful, you must know what direction the ball was moving along the track so that you can measure the proper angle. Record these directions in the table provided on the next page.

3. Determine the speed of the balls on each track by measuring the distance traveled in a small time interval just before and just after the collision: $v=\Delta x/\Delta t$. A time interval of $\Delta t = 6/60$ s is convenient. Note that the distance, Δx, between 7 spots corresponds to a 6/60 s time interval. Record your speeds in m/s.

4. Compute your values for the magnitude of the momentum vectors and add these to your table. The mass of the large ball is 1350±5 g and the mass of the small ball is 725±5 g.

Vector Diagrams

5. Using the values in your table, construct two full page momentum vector diagrams. On the diagram, state your scaling factor (Let 0.1 kg·m/s = 1 cm, for example) and keep this scale consistent in both diagrams. The first diagram will contain both initial vectors and their vector sum $(m_b\vec{v}_b + m_s\vec{v}_s)$ and the second vector diagram will contain the final vectors and their vector sum $(m_b\vec{v}_b' + m_s\vec{v}_s')$. Do not compute the vector sum analytically. Find the vector sum by either of the two graphical methods, the tip-to-tail or the parallelogram method.

6. Compare the initial and final vector sums in your diagram. Did you achieve the goal stated in the objective?

Energy Computation

7. Mechanical energy is not required to be conserved in collisions. Compute the initial and final energy of the system. What percentage of the initial energy was lost in the collision?

Table of Data and Results

Big Mass = 1.350 kg Small Mass = 0.725 kg	θ(degrees)	V(m/s)	mV(kg·m/s)
Big ball (initial)			
Small ball (initial)			
Big ball (final)			
Small ball (final)			

Report

In addition to the standard elements of a well written lab report described in the introduction to this manual, your report must include:

1. The data sheet containing the spark dots.
2. The data and results table on this page, or your own version of it.
3. Two full page vector diagrams with the vectors labeled and the scale specified.
4. A conclusion, addressing the two questions asked in the analysis section under 6 and 7.