Name:_____

HONORS PHYSICS
Ashby

Conservation of Momentum Lab

Introduction

The momentum of an object of mass m moving with velocity v is defined to be: $p = mv$. Momentum is a vector quantity because it is the product of a scalar (m) with a vector (v). It can be shown for a system of particles that the total momentum of the system is constant if there are no external forces acting on the system. The forces exerted between the particles of the system are called "internal forces" and they cannot change the momentum of the system.

A collision between two objects is an example of a case in which momentum is conserved because the forces the two objects exert on each other are internal to the system. If $p_{1,i}$ and $p_{2,i}$ stand for the initial momenta of particles 1 and 2 and $p_{1,f}$ and $p_{2,f}$ stand for their final momenta after the collision then:

$$p_{1,i} + p_{2,i} = p_{1,f} + p_{2,f}$$

In the most general case, this equation implies that each of the components of the momentum is conserved. This equation is strictly valid only if there are no external forces on the system. Friction, though, is an external force. Thus, we usually consider frictionless systems when studying basic conservation of momentum situations.

In this experiment, you will use conservation of momentum to determine the speed of a Nerf dart just before it hits a toy car.

Materials

Meter stick
Stopwatch
Nerf Dart Gun
Matchbox
Tape

Lab Safety

Goggles should be worn for the duration of this lab, including clean up.

Procedure

1. Lay the meter stick on the table as shown in the demonstration.
2. Place the matchbox car at the zero end of the meter stick.
3. Aim the nerf gun at the tail end of the matchbox car and fire!
4. Make sure the nerf dart does not stick to the end of the car.
5. Record the time the car is in motion and the distance traveled by the car. Make sure the car moves in a straight line and stays on the table. If not, the trial does not count. (Hint: using a

smaller time and distance interval will give better results)
6. Repeat for three trials and record your data in the data table.
7. Using the balance, mass of the car and dart. Convert the gram amount to kilograms and record.

Data

Mass of dart: _____ kg

Mass of car: _____ kg

Data Table 1

Trial	Distance (m)	Time (sec)	Average Velocity (m/sec)
1			
2			
3			

Calculations
1. Calculate the average velocity of the toy car after being hit by the dart for all three trials. Show your work for one calculation.
2. Assume the velocity of the dart after the collision is zero. Consider the velocity of the car before the collision. Then calculate the velocity of the dart just before the collision for all three trials.
3. Calculate the average velocity of the dart before the collision from the tree trials.

Conclusion Questions
1. List two assumptions made during the course of the experiment? How does each assumption affect the final result in calculation 3.
2. According to the law of conservation of momentum, what is the relationship between the momentum of the dart before impact and momentum of the car after impact?
3. Other than the assumptions made during the lab, describe some other specific sources of error that could be made during the experiment.