Name Leah Period ______ Date Due ______________

Physics I - Mini Lab: Tailgated by a Dart

Purpose: To estimate the speed of an object by applying conservation of momentum to an inelastic collision.

Equipment:

Velcro hook and loop fasteners
Toy dart gun with rubber-tipped darts
Meter stick
Toy car
Stopwatch
Balance

Pre-Lab Discussion Questions:

What is an elastic collision? Give an example.

2 or more objects come together and bounce apart. No kinetic energy is lost. Ex: atoms, Newton's cradle

What is an inelastic collision? Give an example.

2 or more objects come together & bounce apart. Some KE is lost. Ex: People bump into each other "Fender Bender" crash

What does "Conservation of Momentum" mean for a collision?

Total momentum before the collision has to equal total momentum after the collision

Procedure:

Step 1: Fasten one type of Velcro tape to the back end of a toy car. Fasten the opposite type of Velcro to the rubber tip of a dart. When the car is hit, it must be free to coast in a straight line on a level table or the floor until it comes to a stop. Practice shooting the dart onto the back end of the car. The dart should stick to the car and cause it to coast.

1. What is the relationship between the momentum of the dart before the impact and the combined momenta of the dart and the car immediately after the impact? Use words and an equation in your answer.

$\Sigma p_i = \Sigma p_{after}$

The total momentum is constant

$p_{dart} + (p_{car}) = p_{dart+car}$ (but this is zero)

Step 2: Measure the distance and time that the car coasts after it is hit by the dart, until it comes to a stop. Record your data in the data table. Repeat for two more trials.

Step 3: Calculate the average speed of the car after impact for Trial 1 here. Show your equation and your work.

$$\text{Speed} = \frac{\text{distance}}{\text{time}}$$

Calculate the average speed for trials 2 and 3 and record these speeds in the data table on the back of the page.

For this lab, Calculations can stay in cm & g

Trial	Coasting Distance (cm)	Coasting Time (s)	Average speed of car after impact (cm/s)	Speed of car at impact (cm/s)	Initial speed of dart (cm/s)
1					
2					
3					
	measure	measure	$S = d/t$	2 (average)	Use momentum conservation

2. Was the speed of the car constant as it coasted? Explain.

   No – it stopped eventually

3. What force slowed the car down?

   Friction

4. If this retarding ("slowing down") force is assumed to be nearly constant, how does the speed of the car immediately after impact compare with the average speed? (Hint! How do you find the AVERAGE of two numbers?)

   $V_{fastest} = 2(V_{average})$

   Initial velocity of the car is twice the average speed

5. Enter values for the speed of the car at impact into the data table.

   (double all the average speeds)

6. You have several values for speed (or velocity). What other piece(s) of information do you need to calculate momenta for the car and the dart? Get those pieces of information and record them here. (Hint: you need a scale!)

   mass of car, dart (ok to leave in grams for both)

7. Write an equation that shows the momenta before and after the collision. This is the conservation equation for the experiment.

   INITIAL: $m_{dart} V_{dart} + m_{car} V_{car}$ = FINAL: $(m_{dart} + m_{car})(V_{final})$

8. Using the conservation equation, calculate the initial speed of the dart for each trial. Show one sample calculation here.

   ← This is what we want

9. Find an average value for the initial speed of the dart. Show your calculations here.

   (average the 3 values from the table)

10. Convert the initial speed of the dart to miles/hour.
    1 mile = 5280 feet 1 foot = 0.3 meters 1 hour = 3600 seconds

    Your answer → $\frac{\square \text{ cm}}{1 \text{ s}} \cdot \frac{1 \text{ m}}{100 \text{ cm}} \cdot \frac{1 \text{ ft}}{0.3 \text{ m}} \cdot \frac{1 \text{ mile}}{5280 \text{ ft}} \cdot \frac{3600 \text{ s}}{1 \text{ hour}} = \square \frac{\text{miles}}{\text{hour}}$

11. Is the momentum of the tailgated car constant the whole time it is moving? Explain.

    No. The velocity changes so the momentum has to change