Name ____ Date ___________

Supplemental Activity: Conservation of Momentum

<u>Lab Overview and Pre-Lab Questions</u>

We are going to conduct an experiment to show that momentum is conserved. A Hot-Wheels car is going to collide and stick (with the help of Velcro) to another Hot-Wheels car. We are going to calculate the momentum of both cars before the collision and compare this to the total momentum of both cars after the collision.

Before we do any calculations we need to review some important terms, concepts and formulas.

1. Fill in the blank: The momentum before the collision will be _________ (more, less or the same?) as the momentum after the collision.
2. What formula will we use to calculate momentum?
3. An experiment similar to ours is done with toy train cars. Use the data given to perform the calculations requested. Do a good job of showing your work.

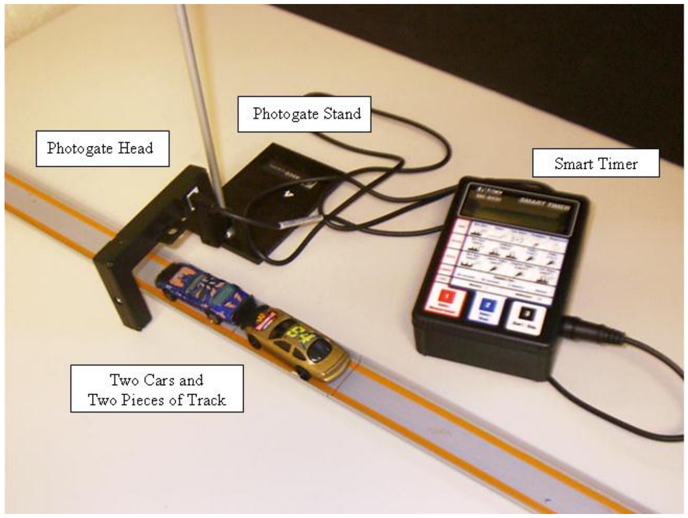
   The first train car has a mass of 0.520 kg and it was traveling 4.15 m/s. The second car has a mass of 0.693 kg and it was at rest. Calculate the total momentum of both train cars before the collision.

   After the collision both cars were moving with a speed of 1.79 m/s. Calculate the total momentum of both train cars after the collision.

   Was momentum conserved in this experiment? How do you know?

Objective: Show that the total momentum of two cars before a collision is equal to the momentum of two cars after a collision.

Equipment and Setup: Measure and record the mass of both cars. Record in grams and convert to kilograms. Setup your equipment. Use the diagram below as a guideline.



Part 1: Momentum Before the Collision

1. You want to know the momentum of the first Hot-Wheels car before it collides with the second car. To calculate momentum, you must know speed. The Smart Timer will measure time and calculate speed for you. There should be a "flag" on top of your car. When the car passes through the photogate, the two white lines on the flag will trigger the Smart Timer on and off. The first thing you need to do is make sure the beam is hitting in the middle of the flag. The easiest way to do this is to put the timer in "test" mode.

HOW TO PUT THE SMART TIMER IN TEST MODE: Press the red button, "Select Measurement". Push this button until you see the word "Test". Push the blue button, "Select Mode" until you see: "Test: Gates". Now the red lights on top of the photogate will turn on and off whenever the beam is interrupted.

2. Now put the Smart Timer in the mode to measure velocity. Press the red button named "Select Measurement". Push this button until you see the word "speed". Push the blue button, "Select Mode" until you see: "Speed: One Gate". The timer is now ready.
3. To measure the speed of the first car before the collision, the first car must go through the photogate without colliding with the second car. Do not put the second car on the track at this time.
4. When you are ready to collect data, click on "Start" (Black Button).
5. You should see an asterisk (*) on the second line of the display.
6. Release the car from some point on the hill. ALWAYS release the car from the same place on the hill each time.
7. When the car goes through the photogate, a value will appear in the display.
8. Record this value in the data table.
9. Send the car down the ramp a total of eight times.
10. Calculate the mean velocity.

Part 2: Momentum After the Collision

11. Position the second car on the track. The second car must be placed such that the timer starts timing immediately after the collision takes place. Put both cars on the track with the “flag” blocking the photogate. Use the light on top of the photogate to help you. Move the cars back and forth until the “flag” is as close to the beam as possible without touching the beam. Without moving the first car, separate the cars and position the first car on the ramp. When you are ready, push "Start" and release the car on the ramp.

This car is too close the photogate. The “flag” of the second car should trigger the photogate immediately after the collision.

12. Record the speed in your data table.
13. Repeat the steps above until you have all eight values in your data table.
14. Calculate the mean velocity.
15. Calculate the momentum before and after the collision.
16. Calculate a percent difference.

$$\%difference = \left| \frac{Momentum_{before} - Momentum_{after}}{Momentum_{before}} \right|$$

Data

Mass of Car A = __________ g = ____________kg

Mass of Car B = __________ g = ____________kg

Speed of Car Before Collision

Trial	1	2	3	4	5	6	7	8	Mean
Speed (cm/s)									

Speed of Car After Collision

Trial	1	2	3	4	5	6	7	8	Mean
Speed (cm/s)									

Total Momentum of Both Cars Before the Collision	Total Momentum of Both Cars After the Collision	% Difference

Conclusion: Was momentum conserved in this experiment? (Answer this question by writing at least two complete sentences that justify your answer.)

Questions

1. Why was it important that the first car be released from the same point on the hill each time?
2. If you repeated this experiment but replaced the second car with a car that is more massive, would the speed of both cars after the collision be more, less or the same?
3. If the Hot-Wheels cars had collided but did not stick together, would momentum still be conserved?