Crash, Boom, Bang!

Please read the entire lab write-up prior to starting so that you know what is expected of you.

Purpose:
In this activity you will investigate an aspect of motion called momentum. An object's momentum is a vector that is defined as the product of its mass and velocity. A system's momentum is the vector sum of the momenta of its parts. It is your goal to identify, experimentally, a relationship between a system's momentum before and after a particular interaction (for example, a system made up of two objects colliding). You will need to collect data and use it as evidence to support your claims about the relationship of the momentum before and after such an interaction.

Set-up:
For this activity you will need your Pasco equipment. You will need two motion detectors, two metals carts and a red or blue plastic plunger cart as well. Configure your track and motion sensors as shown below:

Fig. 1 Equipment setup

Attach the Spark interface to the computer and create a new Capstone display. Discuss what type of graphs would be most helpful for collecting the data you need in order to address the overall goal (stated in the purpose) and format your display appropriately. Remember that the motion sensors do not collect accurate data until the cart is 15cm away, and that they need to be set to the cart setting and aligned properly to do so. Finally, make certain your track is level.

Experiment:

Part A

As part of this experiment you will investigate three types of interactions. Using the two metal carts, investigate what happens when the two carts collide and stick together. Do this using the ends of the carts having non-repelling magnets. Ensure that the Velcro tabs actually hold the two carts together, and make sure that the carts do not "jump" the track.

- For this section, collect data for at least four different mass combinations.
- Organize your data in an easy to read data table in Excel.
- Print your best set of graphs for this part (make sure the interaction is identified)

Part B

For your second interaction again use the metal carts, however this time do not allow the carts to stick together. Instead make sure that the ends of the carts containing the repulsive magnets carts face one another. Ensure that the carts do not hit each other or "jump" the track.

- As in part A, collect data for at least four different mass combinations.
- Organize your data in an easy to read data table with a new title to reflect the new interaction.
- Print your best set of graphs for this part (make sure the interaction is identified)

Part C

For this third interaction you will use one metal cart and one plastic cart. This time instead of having a collision we will have an explosion! Arrange the carts so the plunger of the plastic cart is between the two carts. Be careful about setting the plunger with too much tension, as the recoiling cart may cause damage to the motion detectors.

For this explosion set the carts in motion so that they stay in contact. While they are freely moving down the track release the plunger with a gentle tap to the trigger on top of the plastic cart. Do your best to not influence the motion of the carts when you release the plunger. Be sure to record data during this entire interaction.

- As with parts A & B, collect data for at least four different mass combinations.
- Organize your data in an easy to read data table with a new title to reflect the new interaction.
- Print your best set of graphs for this part (make sure the interaction is identified)

Discussion:

How does the momentum of each system (carts during each interaction) before the interaction compare to the momentum of the system after the interaction? Please provide evidence for your claims. An example or two illustrating your point may prove useful.

For each of the interaction types, how do the changes in the momentum of cart one compare to the changes in momentum of cart two? Again, provide evidence to support your claim.

Error Analysis:

Determine the ratio of the system momentum before the interaction to the system momentum after the interaction. Do this for each mass combination for each interaction type. Determine the average and standard deviation of your ratios for each interaction type. Explain your results and any significant deviation from what you expect.