Momentum Lab

The purpose of this lab is to demonstrate the conservation of momentum in a collision between two carts using Tracker software and to determine the average force between the carts in the collision.

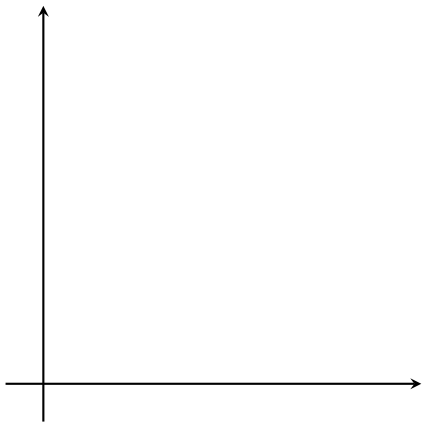
Equipment: 2 Motion carts (261 g each), meter stick, cell phone, tracker software, calibrated masses (250 g each).

Procedure:

1. Place one cart in the middle of the lab bench. This will be cart 2 and will have an intitial velocity $v_2 = 0$.
2. Place the meterstick parallel to the length of cart 2, near, but not touching the cart.
3. Place the other cart near the edge of the table directly behind cart 2. This will be cart 1. It should be lined up so that when you push it, it will collide with the 2nd cart. The two pieces of velcro should be facing each other.
4. Hold your phone above the carts. Try to get it as high as possible to get as wide a field of view as you can. You should center it on cart 2.
5. Start the video recording on your phone.
6. Push cart 1 (not too hard) and release it. When it collides, the velcro should stick and the two carts should move together. You may need to practice this a few times so that the velocity after the collision is not too slow.
7. Stop the video.
8. Using a scale (or from information from the teacher) determine the masses of both carts and record them below.

   Mass of cart 1: _____ kg **Mass of cart 2:** _____ kg

9. Import the video into Tracker software. Use the meter stick as a calibration stick. Create track for Cart 1 before the collision and continue this after the collision.
10. **Sketch the position-time graph below (numbers not required)** and label the axes. Use a best fit line on the graph before the collision (you can select the points for the line) to determine the speed of cart 1 (v_1) before the collision. Select the points after the collision and use the best fit line to determine the speed of the two carts (v') after the collision. Record them below.



$v_1 =$_____ $\frac{m}{s}$

$v' =$ _____ $\frac{m}{s}$

11. On a separate piece of paper, determine the total momentum of the cart before the collision and the momentum of the carts after the collision. Is momentum conserved? Calculate the percent difference between the momentum before and after the collision.
12. Calculate the kinetic energy immediately before the collision and after the collision. Is kinetic energy conserved? Why or why not?
13. From the graph or the video, *estimate* the time of the collision. Remember each frame of your video is approximately 1/30 s (The video rate is 29.7 frames per second on most cameras). Using this estimate of time, and the momentum-impulse theorem, calculate the average force between the two carts at impact.
14. What are some sources of error in this lab? Would you say that you have experimental evidence that momentum is conserved within experimental error? Why or why not?
15. Write a conclusion for this lab.