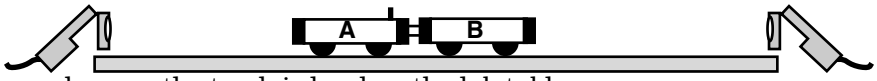
Lab 7-1: **Momentum and Recoil**

Purpose: To determine if momentum is conserved in an "explosion" by measuring the velocities of two carts immediately after a spring is released and they quickly push apart.

Materials: 1 track 1 cart with plunger 1 cart with no plunger
2 500 gram bars 2 motion detectors

Procedure:



1. As always, make sure the track is level on the lab table.
2. Start up Logger Pro and open the file "18 Momentum Energy Coll." The motion detector plugged into "Dig 1" is Position 1 (the red line) and the motion detector plugged into "Dig 2" is Position 2 (the blue line).
3. Call cart A the one with the plunger in it and push in the plunger so that it locks in place. (Push it in and lift it up a little so that the notch in the plunger hooks on the cart. Ask your teacher for help if needed. This is surprisingly difficult.)
4. Place both empty carts on the track. Start recording data by clicking on "Collect". Using a meter stick, tap the little knob on the cart to release the spring plunger, pushing the carts apart. Record the velocities for both carts after the spring is released. This is probably easiest to do by using the "Examine" button and just finding the biggest velocities from the velocity vs. time time graphs. Include any negative signs!
5. Place a 500 gram black bar mass in cart B and repeat.
6. Place the second 500 gram black bar oin cart B and repeat.

Data and Results:

	Mass (kg)	Initial Velocity (m/s)	Final Velocity (m/s)	Initial Momentum (kg•m/s)	Final Momentum (kg•m/s)
Cart A	0.5	0			
Cart B	0.5	0			
Totals	---	---	---		

Cart A	0.5	0			
Cart B	1.0	0			
Totals	---	---	---		

Cart A	0.5	0			
Cart B	1.5	0			
Totals	---	---	---		

Conclusions:

1. In terms of Newton's Third Law, why do the two carts go in opposite directions?

2. For each trial calculate the momentum of each cart before and after the explosion and record in the table above. Include any negative signs. What is the equation for finding momentum?

3. For each trial, calculate the total momentum before and after the explosion by adding up the momentums of each cart. Record your results in the table above.

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4. In all three trials, what was the total momentum of the carts before the explosion? Why does this make sense?

5. In all three trials, the total momentum of the carts after the explosion should also have been zero. Did your results show that? How can the total momentum be zero if the carts were moving?

6. When we say that something is conserved in physics, we mean that a quantity does not change during an interaction or over time. In this lab, we are curious about whether momentum was conserved before and after the explosion.
   a. Was the momentum of cart A conserved?
   b. Was the momentum of cart B conserved?
   c. Was the total momentum of cart A plus cart B conserved?

7. In the second and third trials, the masses of the carts were not the same.
   a. Which cart experienced a greater change in velocity?
   b. Which cart experienced a greater force during the explosion?
   c. Which cart experienced a greater change in momentum?

Follow-up Questions:

1. Imagine you do the experiment again, but this time the masses of the carts are 2 kg and 1 kg. If the 1 kg cart has a speed of 1 m/s after the "explosion," how fast is the other cart going?

2. This time the masses of the carts are 3 kg and 2 kg. If the 2 kg cart has a speed of 1.5 m/s after the "explosion," how fast is the other cart going?

3. This time the speeds of the carts after the "explosion" are 5 m/s and 2.5 m/s. If the cart going 5 m/s has a mass of 2 kg, what is the mass of the other cart?

4. This time the speeds of the carts after the "explosion" are 4 m/s and 1 m/s. If the cart going 1 m/s has a mass of 2 kg, what is the mass of the other cart?

5. This time the speeds of the carts after the "explosion" are 1.75 m/s and 1.25 m/s. If the cart going 1.75 m/s has a mass of 2 kg, what is the mass of the other cart?

6. A 1.5 kg gun can fire a 0.005 kg bullet with a speed of 500 m/s. What is the "recoil velocity" of the gun?

7. Why would a super-light gun that has a mass of only 0.010 kg, yet could a fire a 0.005 kg bullet with a speed of 500 m/s be really dangerous for the person firing the gun?