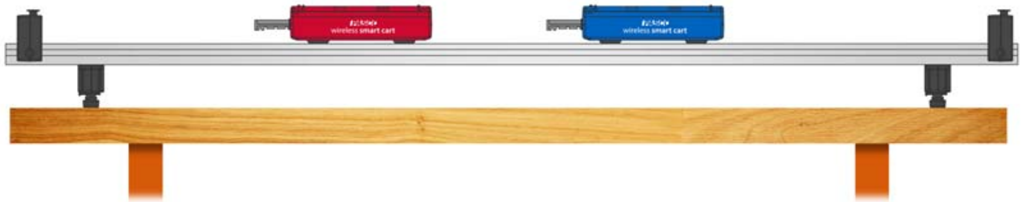
Investigation 11A: Conservation of momentum

Essential question: How does momentum change for objects in an isolated system?

The law of conservation of momentum is a powerful generalization of Newton's third law. For an isolated system, the total momentum of all the objects inside is constant. In this investigation, you will explore the conservation of momentum for two carts that are subject to no outside net force. The only catch is that the carts have a compressed spring inserted between them! Is momentum conserved for this system?



Part 1: Conservation of momentum for spring-loaded carts

1. Open the experiment file **11A_ConservationOfMomentum**, and then power-on the Smart Carts and connect them wirelessly to your software.
2. Set a red cart and a blue cart on a level track, as shown.
3. Press the plunger on the blue cart until it loads at its third position. Set both carts in the middle of the track with the plunger on the blue car touching the red cart.
4. Begin collecting data and then tap on the plunger release trigger to launch the carts.
5. Use your software to find the velocity of each cart after the launch.
6. Run the experiment for different combinations of masses for the two carts. Use your data table to record the mass and velocity for each combination.

Table: Tabulate the velocities and calculate the momentum of each cart for masses 250 g (empty cart), 500 g, and 750 g. Use the results in this table to answer the questions below.

m_{red} (g)	v_{red} (m/s)	p_{red} (kg m/s)		m_{blue} (g)	v_{blue} (m/s)	p_{blue} (kg m/s)
250				250		
500				250		
750				250		
250				500		
500				500		
750				500		
250				750		
500				750		
750				750		

Questions

a. Describe the velocities when the masses of the two carts are equal.

b. Describe the velocities when the red cart has more mass than the blue cart.

c. Describe the velocities when the blue cart has more mass than the red cart.

d. Evaluate the data in your table. What quantity can you construct or calculate that is equal and opposite for the two carts after they are released? How is this the most logical conclusion to draw from your data?

e. If the two carts together are considered a closed system, what is the net force on the system? What is the change in the system's momentum after being released? Use appropriate equations to explain how these two questions are related to each other.

f. What similarities are there in the velocities and momenta when the masses of both carts are equal?

g. What is the difference in *velocity* when one mass is twice that of the other? When one mass is three times the other?

h. What is the difference in *momentum* when the masses are equal? When one cart has twice the mass of the other? When one cart has three times the mass of the other?