Name _____ Class _____ Date _____

Skills Practice Lab

DATASHEET FOR IN-TEXT LAB

Conservation of Momentum

The product of the mass of a moving object and its velocity is called its *momentum*. Studying momentum helps physicists understand the relationship between the motion of two interacting objects.

According to the impulse-momentum theorem, the change in an object's momentum is equal to the product of the force acting on the object and the time interval during which the force acts. Newton's third law states that every action is accompanied by an equal and opposite reaction. Thus, when a spring-loaded cart pushes off against another cart, the force on the first cart is accompanied by an equal and opposite force on the second cart. Both of these forces act for exactly the same time interval, so the change in momentum of the first cart is equal and opposite to the change in momentum of the second cart, in the absence of other forces.

In this experiment you will study the momentum of two carts with unequal masses. The carts will be placed together and will move apart when a compressed spring between them is released. You will find the mass and velocity of each cart in order to compare the momentum before and after the carts move apart.

OBJECTIVES

Measure the mass and velocity of two carts.

Calculate the momentum of each cart.

Verify the law of conservation of momentum.

MATERIALS LIST

- two carts, one with a spring mechanism
- balance
- metric ruler
- support stand with clamp
- set of masses
- tape
- recording timer
- paper tape
- stopwatch

SAFETY

- Tie back long hair, secure loose clothing, and remove loose jewelry to prevent their getting caught in moving or rotating parts.

Procedure

PREPARATION

1. Read the entire lab procedure for the experiment. Plan the steps you will take.

2. Record your data in the data table below.

Trial	m_1 (kg)	m_2 (kg)	Cart 1 Distance (m)	Cart 2 Distance (m)	Cart 1 Time Interval (s)	Cart 2 Time Interval (s)
1						
2						
3						

3. Choose a location where both carts will be able to move at least 1.0 m without any obstacles.

CONSERVATION OF MOMENTUM

4. Set up the apparatus as shown in **Figure 1.** ***Do not plug in the timer until your teacher approves your setup. Do not close the switch.***

5. If you have not used the recording timer before, ask your teacher for instructions. Calibrate the recording timer with the stopwatch, or use the previously determined value for the timer's period.

6. Record the value for the timer's period on a line near the data table.

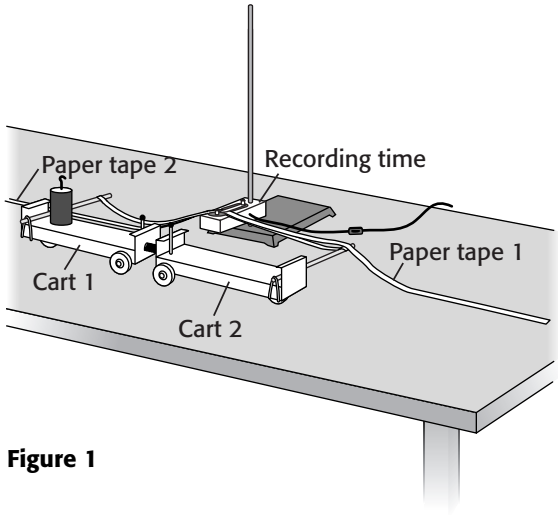

Figure 1

7. Measure the mass of one cart, and record it in the data table. Add a 1.0 kg mass to the second cart, and record the mass of the cart plus the 1.0 kg mass.

8. Fasten a timing tape to one end of each cart. Because both tapes pass through the same timer, place two carbon paper disks back to back between the paper tapes.

9. Compress the spring and position the carts. When your teacher approves your setup, plug the recording timer into the wall outlet. Start the timer and release the spring simultaneously.

10. Catch the carts before they reach the edge of the table and then stop the timer. ***Do not let the carts fall off the table.*** Remove the tapes. Label each tape so that it corresponds to the cart to which it was attached.

11. On each tape, find a portion where the distance between dots is fairly constant. Use the metric ruler to measure three distances between successive dots.

12. Find the average of these three values and record the average as the distance for that cart in your data table. Record the period of the timer as the time interval in your data table.

13. Using different masses, repeat the experiment two more times for trial 2 and trial 3.

14. Clean up your work area. Put equipment away safely so that it is ready to be used again.

Analysis

1. Organizing Data For each trial, find the velocities $\mathbf{v_1}$ and $\mathbf{v_2}$. Because the carts are moving in opposite directions, assign one of the carts a negative velocity to indicate direction.

2. Organizing Data For each trial, calculate the momentum of each cart by multiplying its mass by its velocity.

3. Organizing Data For each trial, find the total momentum of the two carts.

4. Applying Ideas For each trial, what is the total momentum of the two carts before they start moving?

Conclusions

5. **Drawing Conclusions** In this situation, conservation of velocity would mean that the total velocity for both carts is the same after the spring mechanism is released as it was before the release. Is velocity conserved in this experiment? Support your answer with data from the experiment.

6. **Drawing Conclusions** Is momentum conserved in this experiment? Support your answer with data from the experiment.

7. **Evaluating Methods** What source of experimental error might have affected your results?

8. **Evaluating Methods** How would using two carts with identical masses affect your answer to items 5 and 6?