

# Activity: Momentum

## Objective

Determine the change in momentum of a cart during a collision and explore how the change in momentum differs between an elastic and inelastic collision.

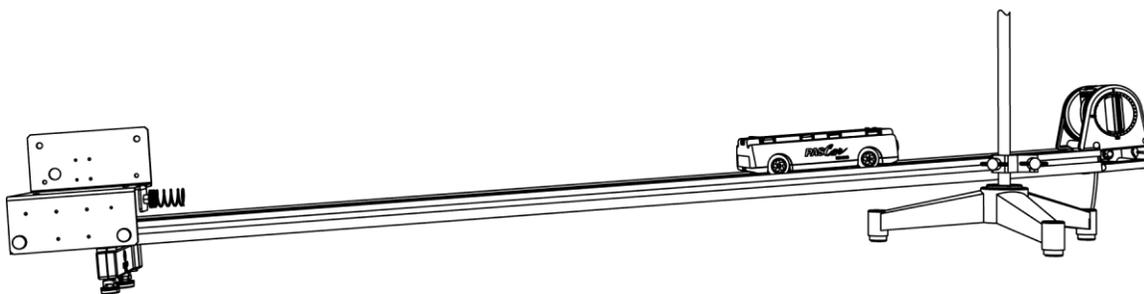
## Materials and Equipment

- Data collection system
- Motion sensor
- Dynamics track
- Dynamics cart
- Pivot clamp
- Force accessory bracket with light spring bumper, force sensor clay bumper cup, and clay
- Large base and support rod
- Balance, 2,000-g capacity (1 per class)

**NOTE:** Record all work, including tables, data, diagrams, and answers, into your notebook.

## Procedure

1. Measure and record the mass of the cart in your notebook.
2. Use the pivot clamp to mount the track to the rod stand at a shallow angle ( $\sim 5^\circ$ ).
3. Mount the motion sensor to the top of the track. Mount the force accessory bracket to the bottom of the track so the tab on the bracket points downward and faces up the track.
4. Attach the light spring bumper to the tab of the force accessory bracket.



5. Start a new experiment on the data collection system  $\diamond^{(1.2)}$  and then connect the motion sensor to the data collection system.  $\diamond^{(2.1)}$  Make sure the switch on the top of the motion sensor is set to the cart position.
6. Create a graph of Velocity versus Time  $\diamond^{(7.1.1)}$ . Then set the sampling rate to 40 samples per second.  $\diamond^{(5.1)}$
7. Mark a point on the track approximately 15 cm from the motion sensor. This is the point to place the front end of the cart for each run.
8. Hold the cart in place on the track at your mark, start recording data, and then release the cart.  $\diamond^{(6.2)}$
9. Stop recording data after the collision.  $\diamond^{(6.2)}$
10. Repeat the same steps to record a total of 3 runs of data using the spring bumper.
11. After you have recorded 3 runs of data using the spring bumper, take a small piece of clay (about the same size as the spring bumper) and form it into a cone. Attach it to the bumper cup as shown in the picture to the right.
12. Remove the spring bumper from the force accessory bracket and replace it with the clay bumper.
13. Record 3 more runs of data using the clay bumper  $\diamond^{(6.2)}$ , forming the clay back into a cone shape before each run.



14. Copy Tables 1 and 2 into your notebook and then use the tools on your data collection system to determine the velocity of the cart just before (initial velocity) and just after (final velocity) each collision. ♦ (9.1)

Table 1: Collision characteristics using a spring bumper (elastic collision)

Spring Bumper	Mass of the Cart (g)	Velocity (m/s)		Momentum (kg·m/s)		Change in Momentum (kg·m/s)
		Initial	Final	Initial	Final	
Run 1						
Run 2		RECORD YOUR ANSWERS IN YOUR NOTEBOOK.				
Run 3						
Average						

Table 2: Collision characteristics using a clay bumper (inelastic collision)

Clay Bumper	Mass of the Cart (g)	Velocity (m/s)		Momentum (kg·m/s)		Change in Momentum (kg·m/s)
		Initial	Final	Initial	Final	
Run 4						
Run 5		RECORD YOUR ANSWERS IN YOUR NOTEBOOK.				
Run 6						
Average						

15. Momentum  $p$  is defined as the product of mass and velocity. Calculate and record in Tables 1 and 2 the momentum just before and just after each collision.
16. Change in momentum is defined as the final momentum minus the initial momentum. Calculate and record the change of momentum for each run in Tables 1 and 2. Record the average change in momentum for each type of bumper in Tables 1 and 2.

### Questions

1. Is there a significant difference in the change of momentum from run to run with the same bumper? Use your data to explain your answer.
2. For an elastic collision, how does the momentum before the collision compare to the momentum after the collision? For an inelastic collision, how does the momentum before the collision compare to the momentum after the collision?
3. How does the average change in momentum for an elastic collision with the spring compare to the average change of momentum for an inelastic collision with the clay?
4. How would using a cart with twice the mass affect the change in momentum?
5. Complete the questions in the Challenge: Collisions handout for this activity.