

# Activity: Peak Force

## Objective

Test and identify materials and structures that minimize the peak force in a collision.

## Materials and Equipment

- Data collection system
- Force sensor
- Dynamics cart
- Dynamics track with feet
- Pivot clamp
- Force accessory bracket with both spring bumpers and the magnetic bumper
- Large base and support rod
- Materials to test
- Tape or Velcro® fasteners, several

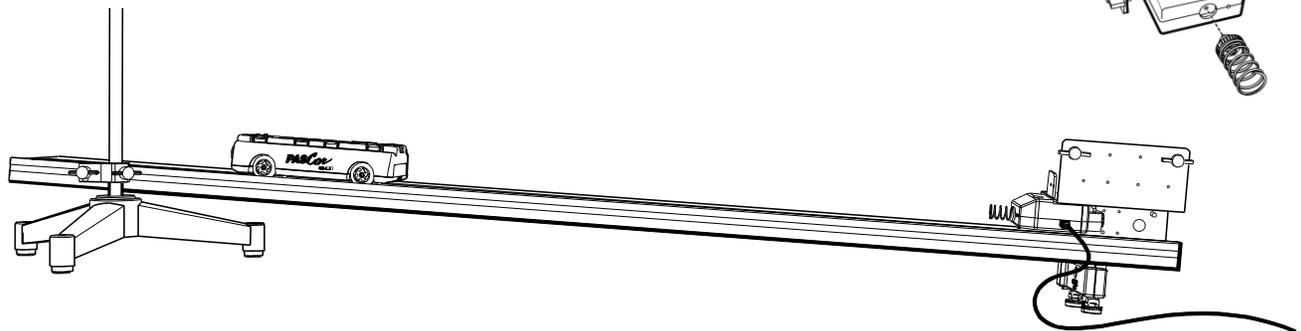
## Safety

Wear eye protection during this lab. Small bits of bumper material could fly off randomly during each collision.

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

## Procedure – Measuring Peak Force Using the Spring Bumpers

- 1. Attach the heavy spring bumper to the front of the force sensor. Then mount the sensor to the force accessory bracket, as in the picture to the right.
- 2. Assemble the accessory bracket with the force sensor and the other pieces of your equipment as in the picture below. Make sure that the angle on the track is very shallow (about 5°)



- 3. Connect the force sensor to your data collection system and start a new experiment. ♦(2.1)
- 4. Create a graph of Force, push positive, versus Time ♦(7.1.1), and then set the sample rate to 500 samples per second. ♦(5.1)
- 5. Hold the cart on the track so that the front of the cart is 60 cm away from the spring bumper. Press the Zero button on the top of the force sensor, start recording data, and release the cart. Stop recording data after the cart collides with the bumper. ♦(6.2)

*NOTE: Be sure to release the cart from the same position for every run. Also, the collision force should be no greater than 50 N. Adjust the track angle to reduce the force, if necessary.*

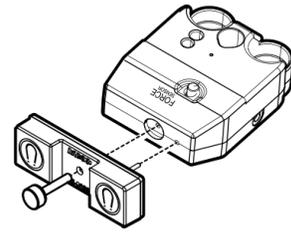
- 6. Switch the heavy spring bumper to the light spring bumper. Record another run of data. ♦(6.2)
- 7. Use the statistics tools on your data collection system to determine the impulse and peak force associated with each bumper collision. ♦(9.4) Record all four values into your notebook.

*NOTE: Your impulse measurements should show two significant digits. To add or remove significant digits in your impulse measurements, use the Data Properties screen to increase or decrease the number of digits to the right of the decimal for your force measurements. ♦(5.4)*

- 8. How do the two impulse values compare? How do the two peak force values compare? How is it possible to have similar impulse values, but different peak force values in identical collision?

### Procedure – Measuring Peak Force Using a Test Bumper

- 9. Switch the spring bumper to the magnetic bumper. The magnetic bumper attaches to the force sensor as in the picture to the right.
- 10. Use the materials provided by your teacher to construct a test bumper that will minimize the peak force on impact and mount to the front of the cart. This test bumper can be of any design, but consider the results when using the different springs, your initial design ideas, and the concepts learned in previous activities, as well as the project's design constraints.
- 11. Once you have constructed your test cart bumper, mount it to the front of the cart using tape or Velcro fasteners. Make sure the bumper is not so large that it interferes with the motion of the cart moving down the track.
- 12. Test the impact absorbing power of your test bumper by repeating the same data collection procedure as in the previous section.
- 13. Use the statistics tools on your data collection system to determine the peak force associated with the bumper collision. ♦<sup>(9.4)</sup> In your notebook, describe the construction of your test bumper (you can sketch a drawing of it to help explain) and indicate the peak force from the collision.
- 14. Make any alterations or overhauls to your test bumper to achieve a minimum peak force. Record a run of Force versus Time data for each different test bumper. Explain in your notebook any changes you made to your test bumper that helped lower the peak force, and indicate the lowest peak force achieved.
- 15. Sketch or attach a copy of your Force versus Time graph in your notebook.



### Questions

1. What is a material not provided by your teacher that you believe would have worked better in your test bumper to minimize the peak force in the collision? Why would it have worked better?
2. Complete the questions in the Challenge: Collisions handout for this activity.