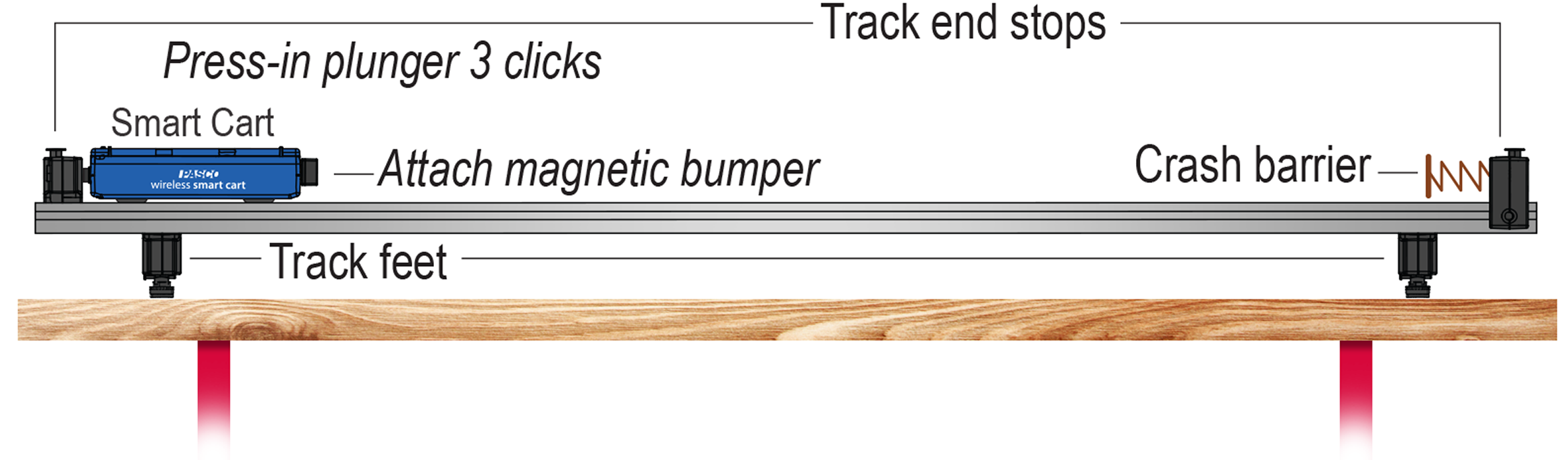
# **Crash barrier**

**Design project: Design a crash barrier**

Design challenge

Construct a crash barrier designed to minimize the impact force experienced by a cart in a collision.

Design criteria and constraints

Your crash barrier must:

* reduce the impact force to less than 10.0 N;
* have mass less than 50 g;
* have length less than 12 cm;
* and, have a flat front.

Test equipment

Smart Cart with bumper, dynamics track with feet and end stops.

Part 1: Observe the effect of changing variables.

Set up your test equipment like the picture. Use the **DC\_CrashBarrier** experiment file to record data.

* Test the cushioning ability of different barrier materials. Write a testable hypothesis on the effect of each parameter. Record your observations.
* Test the effect of different configurations of materials. Write a testable hypothesis on the effect of each parameter. Record your observations.

Part 2: Design the prototype crash barrier

Describe your design, with words and sketches.

Part 3: Construct the prototype crash barrier

Part 4: Evaluate the prototype crash barrier

Test your crash barrier and describe its performance (strengths and weaknesses).

Part 5: Revise and re-evaluate

Revise your design and then conduct a final performance evaluation. Describe its strengths and weaknesses.

Part 6: Share your findings.

Prepare a brief presentation to share with your class.

Applying new knowledge

1. Which of the following methods would be sure to reduce the force on a cart during its collision with a barrier?
2. Increase the impulse on the cart.
3. Increase the length of time the collision lasts.
4. Increase the mass of the materials in the barrier.
5. Give the cart an initial positive momentum (upward).
6. Explain your answer to question 1 above.
7. A hockey puck that has a mass of 170 g travels with a speed of 30 m/s.
   1. What is the momentum of the puck?
   2. What impulse must be imparted to the puck by a player who wishes to change the puck's direction by 180° while keeping the puck moving at the same speed?
8. Write a multiple-choice question that requires the reader to understand the tradeoff between force and time duration when applying an impulse.

Grading Rubric

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| --- | --- | --- | --- | --- |
| **Criterion** | **Criterion Not Met**  **(0)** | **Needs Improvement**  **(1 pt)** | **Satisfactory**  **(2 pts)** | **Excellent**  **(3 pts)** |
| **Crash Barrier Design** | Did not test any materials and configurations; or, barrier was clearly ***not*** designed based on supporting data. | Tested various barrier materials, or tested different configurations, but did not test both. | Tested materials and configurations, but it was not clear how the test results informed the design of the barrier. | Tested materials and configurations, and data were clearly used to inform and/or support the barrier design. |
| **Crash Barrier Construction** | Crash barrier was ***longer than 12 cm***, and had ***mass greater than 50 g***. | Crash barrier was ***longer than 12 cm***, but had ***mass less than 50 g***. | Crash barrier was ***shorter than 12 cm***, but had ***mass greater than 50 g***. | Crash barrier was ***shorter than 12 cm***, and had ***mass less than 50 g***. |
| **Crash Barrier Performance** | Maximum impact force was ***greater than 40 N***. | Maximum impact force was ***between 25 N-40 N***. | Maximum impact force was ***between 10 N-25 N***. | Maximum impact force was ***less than 10 N***. |
| **Report**  **Elements** | Did not submit a written report. | Report was submitted but was missing one or more of its critical components: test phase data and observations; a prototype design sketch; or, design revisions. | Report was submitted with all critical components, but the components were incomplete: test phase observations and data were minimal; design sketch was incomplete or not detailed; design revisions were minimal or presented without reasoning. | Documented all materials, data, and observations from the test phase.  Included a complete design sketch with concise descriptions of the barrier components.  Clearly documented strengths and weaknesses of the prototype, and indicated all revisions to its design with reasoning. |
| **Class Presentation** | Did not present a report to the class. | Presentation did not include any critical information regarding design choices and revisions. | Presentation included information regarding design choices and revisions, but did not elaborate on how testing results informed those choices. | Presentation was thorough and concise, and included participation from all group members. The information presented clearly reflected ideas and revisions based on testing. |