# 6.2: Activities

## Things You Will Need

Nothing! All the data has been meticulously collected for you.

## Elastic Collisions

As was stated in the Background Material, the forces exerted between the carts have been engineering so that they act over a long enough period of time that we can measure them as they change. For the first two collisions we will examine, this is achieved by placing strong repulsing magnets on the fronts of the two carts. As the carts get closer together, this repulsive force grows, and the carts "gradually" (the whole collision is over in under 0.2 seconds) push on each other with increasing magnitude, until they finally push each other apart. The repulsive magnetic force gets so strong when the magnets get close that they never actually touch each other (at least not at the speed that we provide to the incoming cart). The gif below shows an example of one of these collisions, with the laptop recording the two force-vs-time graphs at the top of the screen and the two velocity-vs-time graphs at the bottom, as the collision unfolds.

**Figure 6.2.1 – Elastic Collisions**

The graphs of the data for two elastic collisions is given below. The graphing software provides tools for more easily pulling numerical values from the graphs. First, the graph can be greatly enlarged from what you see on the laptop screen above, so that finer details can be discerned. Second, a pinpoint utility provides the ordered pair coordinates of any point on the graph. And finally, by selecting a section of the graph one can measure the area under the curve. All of these have been used in the graphs of our data for your convenience.

- **Equal Masses:** $m_A = m_B = 1.307kg$

Answer all the questions below, and include explanations or calculations based on the data to backup your answers in each case. Without access to the equipment, it is not possible to get a good sense of the uncertainties we are dealing with, so with this handicap of "performing" the experiment online, we'll arbitrarily use 10% as the percentage uncertainty within which our results must lie to declare victory.

1. Consider the impulses delivered to the carts in the collision.
   a. Is Newton's third law, expressed in terms of impulse, confirmed for this collision?
   b. Is the impulse-momentum theorem confirmed?
2. Examine the data in terms of momentum conservation.
   a. Determine whether momentum is conserved using the before and after pinpoint values in the graphs.
   b. Does the momentum of the system appear to remain constant *during* the collision? Should it be? Explain.
3. Examine the data in terms of kinetic energy conservation.
   a. Determine whether kinetic energy is conserved using the before and after pinpoint values in the graphs.
   b. Does the kinetic energy of the system appear to remain constant *during* the collision? Should it be? Explain.

- **Unequal Masses:** $m_A = 1.307kg, \;\; m_B = 0.838kg$

4. 5. 6. Answer questions 1-3 again for this case of a collision of unequal masses.

## Inelastic Collision

For our inelastic collision, we will be using a "perfectly-inelastic collision," where the two carts stick together and move off together at one speed. A bottle brush and tube are used, to once again ensure that the force exerted between the carts changes slowly enough to observe its details. The gif below shows an example of one of these collisions.

**Figure 6.2.2 – Inelastic Collisions**

The only collision of this kind for which we have data features a heavier incoming cart than target cart. The data for this collision is given below.

**Unequal Masses:** $\boldsymbol{m_A = 1.335 kg, \;\; m_B = 0.847 kg}$

Answer all the questions below, and include explanations or calculations based on the data to backup your answers in each case.

7. Consider the impulses delivered to the carts in the collision.
   a. Is Newton's third law, expressed in terms of impulse, confirmed for this collision?
   b. Is the impulse-momentum theorem confirmed?
   c. In this run there is a small but undeniable dip in the force-vs.-time curve for both carts, just after the main "bump." Interpret what this apparent anomaly is telling us is happening physically.
8. Examine the data in terms of momentum conservation.
   a. Determine whether momentum is conserved using the before and after pinpoint values in the graphs.
   b. Does the momentum of the system appear to remain constant *during* the collision? Should it be? Explain.
9. Examine the data in terms of kinetic energy conservation.
   a. Find the kinetic energy lost using the before and after pinpoint values in the graphs.
   b. Confirm that this matches what is supposed to be lost for such a collision.

## Lab Report

Download, print, and complete this document, then upload your lab report to Canvas. [*If you don't have a printer, then two other options are to edit the pdf directly on a computer, or create a facsimile of the lab report format by hand.*]