

Experiment 5

Elastic Collisions

5.1 Objectives

- Measure the momentum and kinetic energy of two objects before and after a one-dimensional collision.
- Try to account for any change in KE in the nearly elastic collision.
- Compare and contrast the results obtained from the inelastic collision experiment with the results obtained from this experiment.

5.2 Introduction

Now that we are acquainted with inelastic collisions, it is time to investigate elastic collisions. This time around, we will observe the conservation of both momentum *and* kinetic energy. Energy can tell us a great deal about how a system works, and if it is conserved, we can understand the process much better than if we cannot. Though we are not in the ideal and impossible conditions of a perfectly frictionless system and in vacuum, we will be able to see these conservation laws with very good precision.

5.3 Key Concepts

As always, you can find a summary on-line at Hyperphysics.¹ Look for keywords: elastic collision.

5.4 Theory

Please refer to the inelastic collision lab to refresh your knowledge of the theory for collisions.

5.5 In today's lab

In today's lab, we will observe the effects on changing the mass in elastic collisions between two carts. After collecting our data, we will then compare the results of elastic collisions with those of inelastic collisions and try to understand where energy loss can occur.

5.6 Equipment

- Air Track
- Air Supply
- Two carts (one with bumper and one with blade, see Fig. 5.1)
- Photogate Circuit
- 4 50g masses

¹<http://hyperphysics.phy-astr.gsu.edu/hbase/hph.html>

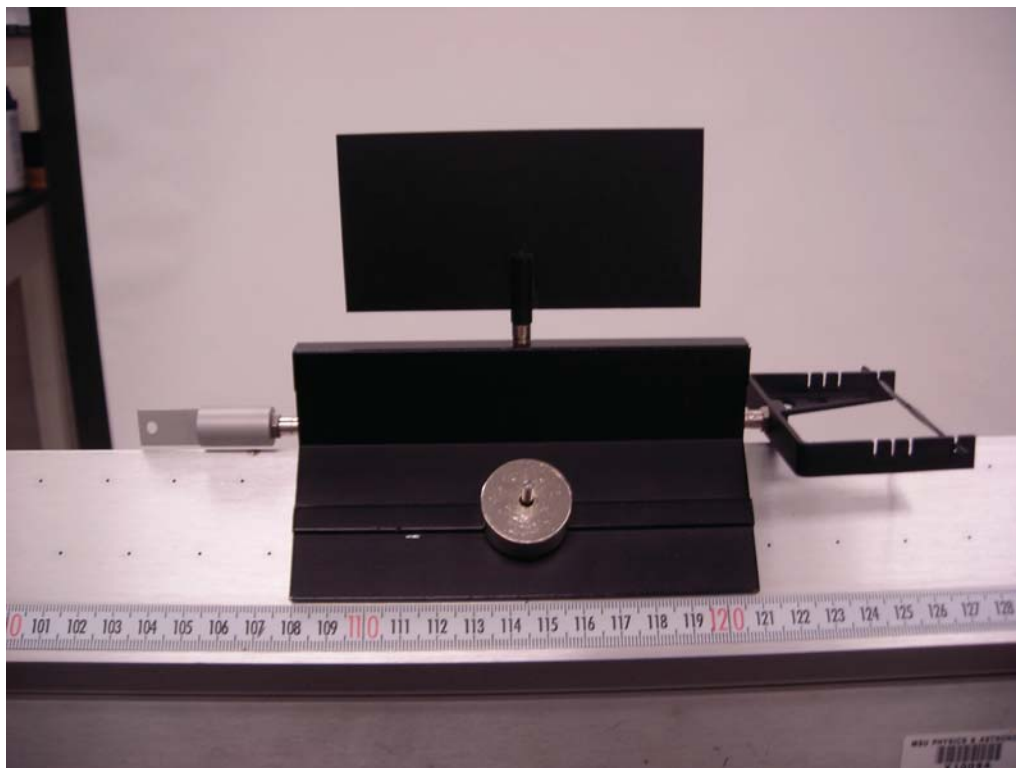


Figure 5.1: Cart with bumper.

5.7 Procedure

1. Start by making sure that the air track is level. Your instructor will demonstrate how at the beginning of class.
2. Set up the photogates such that there is sufficient room to reset the timer before the collision, for the collision to happen in between the photogates, and enough room on the remainder of the track for the carts to move freely.
3. Set the photogates to **GATE** mode.
4. We will define Cart 1 as the cart with the *bumper* and Cart 2 as the cart with the *bumper blade*. We will always push Cart 1 for each trial and will always start with Cart 2 stationary ($v_{2i} = 0\text{cm/s}$) in the

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- middle. Before placing the carts on the track, measure their mass *without* the extra masses. Record the empty cart masses data on the given results sheet.
5. Measure the lengths of the fins on both carts and record them on your worksheet and in excel. Be sure to put a reasonable uncertainty for the fin length in excel as well.
 6. Input the uncertainty for the times measured by the photogate into excel (0.0005 s).
 7. Put 2 masses on Cart 2 so they are evenly distributed (1 on each side) and no masses on Cart 1.
 8. Place Cart 2 in between the photogates and have one partner hold the cart steady until the collision occurs.
 9. Place Cart 1 “outside” of the photogates.
 10. Making sure that your photogates are reset, give a brief but firm shove to Cart 1 such that it collides with Cart 2. Allow the two carts to leave the middle completely before stopping them. **Do not let the carts drift back through the photogates until you finish recording the times.** Be sure to have one partner memorize the first time that appears on the photogate (t_i) and reset the photogate **before either cart passes through the photogates following the collision.** It may take multiple tries to get this method correct, so feel free to practice a few times.
 11. Record t_i and in Excel. Also record the other times off of the photogate in Excel. **If you reset the timer at the correct moment, the time you read on the photogate prior to flipping the READ switch will be either t_{1f} or t_{2f} depending on which cart left the middle first. The *other* time will be calculated the same way as before using t_{mem} .**
 12. Once again, note that the velocities for each cart are calculated in the same way as before (i.e. L/t).
 13. Make sure that the absolute value of the percent difference between initial and final momentum is less than 5% *and* the absolute value of

the percent difference between initial and final kinetic energy is **less than** 10% (the spreadsheet does these calculations for you). If they are not, rerun the trial until they are. Make sure that the fin on top of Cart 1 is completely through the photogate before the collision occurs and that the carts remain outside of the photogates until you have your times recorded. If the trial is acceptable, record the times on your worksheet. Always keep your best trials recorded on the worksheet just in case you run out of time and need to use those.

14. Repeat this trial one more time and record the results.

15. Repeat steps 8–14 for the cases when you have:

- 2 mass disks on Cart 1 and 2 mass disks on Cart 2
- 2 mass disks on Cart 1 and no mass disks on Cart 2

For trials 3 and 4, you can use 1000s for t_{1f} as in an ideal case, Cart 1 will transfer all of its momentum to Cart 2 and will stop moving after the collision.

16. Be sure to include hand calculations for the light blue boxes in excel.

5.8 Checklist

1. Excel Sheets
2. Questions
3. Hand Calculations

