Experiment 7. Inelastic Collisions

Nature works in mysterious ways!
Total kinetic energy may change but momentum is always conserved.

Objective:

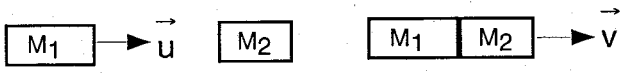
To study inelastic collisions and to verify that in an inelastic collision, momentum is conserved and that kinetic energy is not conserved.

Apparatus:

An air track, gliders, a glider with a flag, photogates, a meter stick, photogate, CHAMP interface and a personal computer.

Theory:

Let a glider of mass M_1, moving with an initial velocity $\vec{u}$, strike and stick to another glider of mass M_2, initially at rest. Further, let the combination move with a velocity $\vec{v}$ after the collision. If the resultant of the external forces acting on the two gliders is zero, then their total momentum will be conserved.



Before Collision After Collision

Thus

initial momentum of the gliders $\vec{P}_i$ = final momentum of the gliders $\vec{P}_f$.

Or $$M_1\vec{u} = (M_1+M_2)\vec{v} \qquad (1)$$

The initial kinetic energy E_i and final kinetic energy, E_f are given by

$$K_i = \frac{1}{2} M_1u^2 \; ; \; K_f = \frac{1}{2}(M_1 + M_2)v^2.$$

Thus $$\frac{K_f}{K_i} = \frac{(M_1 + M_2)v^2}{M_1u^2} = \left(\frac{M_1 + M_2}{M_1}\right)\left(\frac{v}{u}\right)^2$$

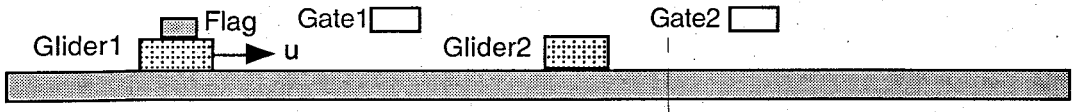
Now by Eq:(1), $$\frac{v}{u} = \frac{M_1}{M_1 + M_2}.$$

Thus $$\frac{K_f}{K_i} = \left(\frac{M_1 + M_2}{M_1}\right)\left(\frac{v}{u}\right)^2 = \left(\frac{M_1 + M_2}{M_1}\right)\left(\frac{M_1}{M_1 + M_2}\right)^2 = \frac{M_1}{M_1 + M_2}.$$

Procedure:

1. Measure the length of the flag twice.
2. Place the two photogates at suitable positions. Place gate 1 at a convenient position near the left end of the air track and gate 2 at a

suitable distance from the other end of the air track. Remember that the first glider is given an initial velocity u which is measured by gate 1 when it passes through it. Then glider 1 collides and sticks to glider 2. The final velocity of the combination is measured when it passes through gate 2. Make sure that the gliders do not bounce back to gate 2. After each run, lift the gliders off the track.



3. Select two gliders having nearly equal masses. Attach the flag to glider 1 and find their masses.
4. Turn on the CHAMP and then the computer.
   (Always make sure that CHAMP interface is connected and turned on before switching on the computer. Also the computer should be switched off before turning off the CHAMP.)
   At the prompt
   C:TPACK>
   enter TP
   You will see 'TIMEPACK' on the screen among other things.
   Press any key and you will see
   You will see 'HIT ENTER TO ACCEPT', etc. on the screen.
   Press the enter key.
   You will see 'PLEASE ENTER PASSWORD'.
   Enter PASS as the password.
5. You will see the menu containing:

A: Single gate timer	H: Frequency Timer
B: Double gate timer	- - - - -
C: Time between gates	- - - - -
D: Pendulum timer	- - - - -
E: Motion timer	L: Data Analysis
F: Collision timer	M: Test photogates
- - - - -	N: Exit Timepack

Select "M" to test the photogate. Press any key to return to the main menu.

6. To measure times, select "F: Collision timer"
7. Turn on the air flow.
   Make sure that the air track is level. Place a glider on the air track. If the track is horizontal, the glider will not move appreciably.
   Place glider 1 on the left of gate 1 and give it a gentle push keeping glider 2 between the two gates. Repeat the process three times.
8. Now select two gliders such that $M_1 > M_2$. Attach the flag to glider 1 and find their masses. Repeat step 7.
9. Finally select two gliders such that $M_1 < M_2$. Attach the flag to glider 1 and find their masses. Repeat step 7.
10. Now press any key to terminate data collection.
    You will see the menu containing:

A: Display Data Table	E: Edit Timing Data
B: Print Data Table	- - - - -
C: Analyze Timing Data	H: Repeat Experiment
D: Graph Timing Data	I: Return To Main Menu

11. Enter C to select "C: Analyze Timing Data"
    Enter length of flag in m (meter).
    A table containing velocity #1 velocity #2 will be displayed.
    Copy velocities in the appropriate tables and complete the calculations.
    Use mks units in this experiment.

York College of The City University of New York

Physics I Name:

Experiment No. 7: Pre-Lab Questionnaire

1. What is the theoretical value of p_f/p_i? If M_1 = 0.56 kg and M_2 = 0.82 kg, what will be the theoretical value of K_f/K_i?

2. Glider A of mass M_1 = 0.56 kg, moving with a velocity of 2.1 m/s, strikes and sticks to glider B of mass M_2 = 0.82 kg. After the collision, the two move with a velocity of 0.85 m/s. (a) Find the experimental value of p_f/p_i. (b) Find the experimental value of K_f/K_i.

Experiment No. 7

Name: Marks:

Partner: Remarks:

Section:

Date Submitted:

Title:

Objective:

Theory/Formulas:

Data Sheet

Length of the flag: Reading 1 = ; Reading 2 =

Average length of the flag, L =

A. M_1 nearly equal to M_2:

Mass of glider 1, M_1 = ; Mass of glider 2, M_2 =

No	$u = v_1$	$v = v_2$	p_i	p_f	p_f/p_i	K_i	K_f	K_f/K_i

Average p_f/p_i (experimental) =

p_f/p_i (theoretical) =

Average K_f/K_i (experimental) =

K_f/K_i (theoretical) =

Comments:

B. $M_1 > M_2$

Mass of glider 1, M_1 = ; Mass of glider 2, M_2 =

No	$u = v_1$	$v = v_2$	p_i	p_f	p_f/p_i	K_i	K_f	K_f/K_i

Average p_f/p_i (experimental) =

p_f/p_i (theoretical) =

Average K_f/K_i (experimental) =

K_f/K_i (theoretical) =

Comments:

C. $M_1 < M_2$

Mass of glider 1, M_1 = ; Mass of glider 2, M_2 =

No	$u = v_1$	$v = v_2$	p_i	p_f	p_f/p_i	K_i	K_f	K_f/K_i

Average p_f/p_i (experimental) =

p_f/p_i (theoretical) =

Average K_f/K_i (experimental) =

K_f/K_i (theoretical) =

Comments:

Experiment No. 7: Questions

1. Is momentum conserved in inelastic collisions?

2. If an external force is acting on the system, will the final momentum be equal to the initial momentum? If the air track is not horizontal, will momentum will be conserved? Explain.

3. How will you check that the air track is level?

4. How is friction between the glider and air track minimized?