Collisions on Air Track | Teacher's Notes

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|---|---|
| **Main Topic** | Forces |
| **Subtopic** | Newton's Laws |
| **Learning Level** | High |
| **Technology Level** | Mid |
| **Activity Type** | Student |

Description: Investigate elastic and inelastic collisions on an air track. Evaluate conservation of momentum and energy.

| | |
|---|---|
| Required Equipment | Air track, 2 gliders, elastic collision apparatus, inelastic collision apparatus, 2 photogates, ruler or meterstick, balance |
| Optional Equipment | |

## Educational Objectives

- Evaluate conservation of momentum and conservation of energy for linear collisions on an air track.

## Concept Overview

Students will observe elastic and inelastic collisions on an air track, measuring the gliders' speeds before and after impact. They will calculate momentum and kinetic energy before and after impact, and conclude that momentum is conserved in both types of collisions, while energy is conserved only in elastic collisions.

## Lab Tips

Simple photogates are needed for this lab. They need to display the time they are blocked up to <u>two times per trial</u>.

The lab includes 4 separate trials (3 elastic, 1 inelastic). It will almost certainly take more than one class period to complete.

Caution students to be sure the photogates are measuring the quantities desired. There is a lot of motion in this experiment, and it is easy to accidentally record a *final* velocity when you want an *initial*, and vice versa.

"Motion on Level Air Track," in which students use photogates to calculate the speed of a glider, should be completed prior to this lab.

Collisions on Air Track Name: ____________________

Class: ______________________

**Goal:**

Evaluate conservation of momentum and conservation of energy for linear collisions on an air track.

**Materials:**

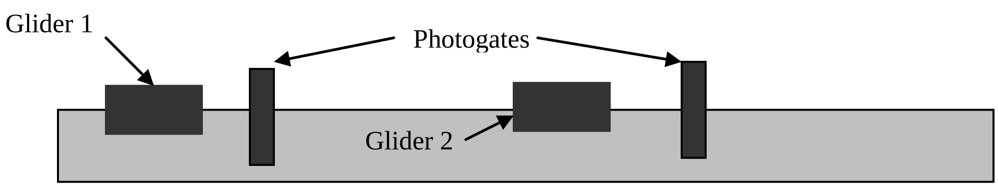
Air track, 2 gliders, elastic collision apparatus, inelastic collision apparatus, 2 photogates, ruler or meterstick, balance

**Procedure:**

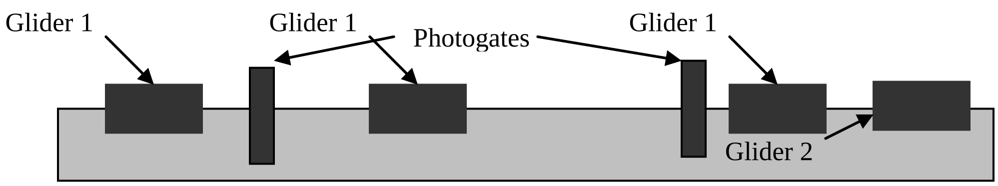
**Elastic Collisions**

1. Affix the elastic collision apparatus to each glider.
2. Turn on the air blower. Place a glider in the center of the track. If the glider starts to slide on its own, adjust the track's feet until it is perfectly level and the glider does not move when put down.
3. Record the length (of the part that blocks the photogate) and mass of each glider in the table (next page) for Trial 1.
4. Arrange two photogates carefully along the track to accommodate different possible conditions after the collision. Plan ahead to make sure the gliders can completely pass through the gates in each situation. Glider 2 will always go forward. Glider 1 may remain between the photogates after colliding, or it may bounce backward (going through the first gate again), or it may continue forward (following Glider 2 through the second gate).

**Before Collision**:




**After Collision:**




5. Set the photogates to measure the speed of the gliders. Each photogate should be ready to record up to two different speeds for each trial.
6. Place Glider 2 between the photogates, so that it stays stationary. Push Glider 1 toward it, and record the velocities before and after the collision in the table (next page).
7. Repeat the experiment, adding mass as described in the table. Be sure to record any backwards motion as a negative velocity.

# Collisions on Air Track

Name: ____________________
Class: ______________________

| TRIAL 1 – MASS APPROXIMATELY EQUAL | | |
|---|---|---|
| | Glider 1 | Glider 2 |
| Mass (kg) | | |
| Length (m) | | |
| Initial velocity (m/s) | | 0 |
| Final velocity (m/s) | | |
| Initial momentum | | 0 |
| Final momentum | | |
| System initial momentum | | |
| System final momentum | | |
| Initial kinetic energy | | 0 |
| Final kinetic energy | | |
| System initial kinetic energy | | |
| System final kinetic energy | | |

8. Is momentum conserved for this elastic collision? Explain.

9. Is kinetic energy conserved for this elastic collision? Explain.

Collisions on Air Track Name: ___________________
Class: ______________________

| TRIAL 2 – GLIDER 1 MASS GREATER THAN GLIDER 2 MASS | | |
|---|---|---|
| | Glider 1 | Glider 2 |
| Mass (kg) | | |
| Length (m) | | |
| Initial velocity (m/s) | | 0 |
| Final velocity (m/s) | | |
| Initial momentum | | 0 |
| Final momentum | | |
| System initial momentum | | |
| System final momentum | | |
| Initial kinetic energy | | 0 |
| Final kinetic energy | | |
| System initial kinetic energy | | |
| System final kinetic energy | | |

10. Is momentum conserved for this elastic collision? Explain.

11. Is kinetic energy conserved for this elastic collision? Explain.

Collisions on Air Track        Name: ____________________
Class: ______________________

| TRIAL 3 – GLIDER 1 MASS LESS THAN GLIDER 2 MASS | | |
|---|---|---|
| | Glider 1 | Glider 2 |
| Mass (kg) | | |
| Length (m) | | |
| Initial velocity (m/s) | | 0 |
| Final velocity (m/s) | | |
| Initial momentum | | 0 |
| Final momentum | | |
| System initial momentum | | |
| System final momentum | | |
| Initial kinetic energy | | 0 |
| Final kinetic energy | | |
| System initial kinetic energy | | |
| System final kinetic energy | | |

12. Is momentum conserved for this elastic collision?  Explain.

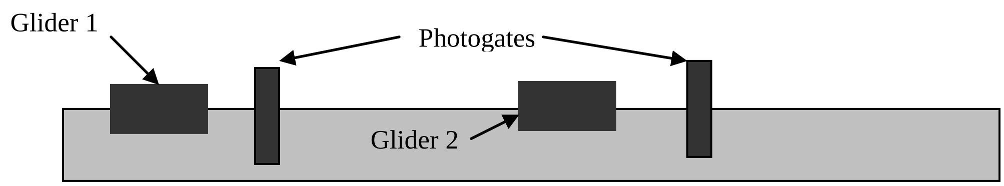
13. Is kinetic energy conserved for this elastic collision?  Explain.

Collisions on Air Track Name: ____________________
Class: _____________________

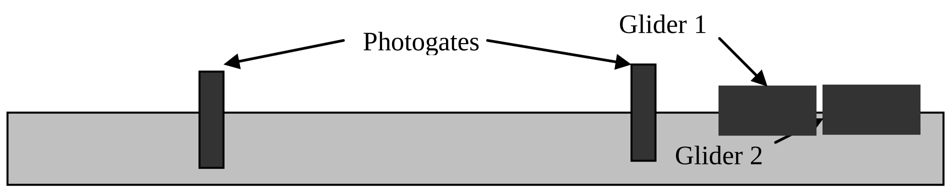
## Inelastic Collisions

14. Affix the inelastic collision apparatus to each glider.
15. Level the track again if necessary.
16. Record the length (of the part that blocks the photogate) and mass of each glider in the table (next page) for Trial 4.
17. Arrange two photogates carefully along the track. This time, the gliders will stick together and both travel forward through the second gate.

**Before Collision**:




**After Collision:**




18. Set the photogates to measure the speed of the gliders. Each photogate should be ready to record up to two different speeds for each trial.
19. Place Glider 2 between the photogates, so that it stays stationary. Push Glider 1 toward it, and record the velocities before and after the collision in the table (next page).

Collisions on Air Track Name: ____________________
Class: _____________________

| TRIAL 4 – INELASTIC COLLISION | | |
|---|---|---|
| | Glider 1 | Glider 2 |
| Mass (kg) | | |
| Length (m) | | |
| Initial velocity (m/s) | | 0 |
| Final velocity (m/s) | | |
| Initial momentum | | 0 |
| Final momentum | | |
| System initial momentum | | |
| System final momentum | | |
| Initial kinetic energy | | 0 |
| Final kinetic energy | | |
| System initial kinetic energy | | |
| System final kinetic energy | | |

20. Is momentum conserved for this inelastic collision? Explain.

21. Is kinetic energy conserved for this inelastic collision? Explain.