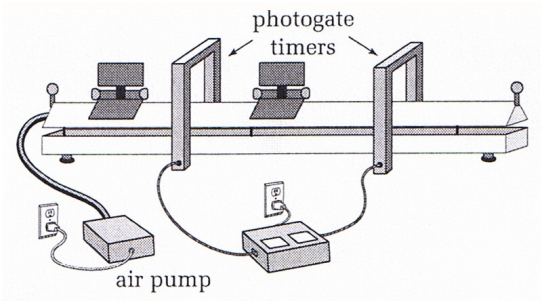
Problem

Are there characteristics that allow you to predict whether a collision will be elastic?

Background

- An air track similar to the diagram was set up and levelled.
- Two gliders (A and B), with velocity flags attached, were then placed on the track as shown.
- Glider A was set in motion while glider B remained stationary (i.e. the before velocity for glider B is always zero).
- The time for each velocity flag to go through the photogate timer was recorded.
- The experiment was repeated for (a) various masses of A and B and (b) elastic and inelastic collisions.



Notes

① The before and after velocities for each glider will be given to you.
② Since all of the motion was be in one dimension only, positive and negative signs will be needed to indicate direction. Motion to the right was assumed to be positive.
③ Carry your answers through to ensure as much accuracy as possible is ensured.
④ The momentum and kinetic energy values should be expressed to 2 decimal places and the % difference values should be expressed to 1 decimal place.

Calculations & Questions

1. Get your velocity data from the teacher and record it in the charts on the next page. Use the collision observation data given below to help analyse the data. Also be sure to indicate which velocity data you were given.

Collision Observations (In each case, glider A moves to the right and collides with glider B which is at rest)

Trial 1 Glider A & Glider B Relatively Same Mass
A stops and B moves to the right (B seems to have relatively the same speed as A had initially).

Trial 2 Glider A Heavier Than Glider B
A and B both move to the right (B moves more quickly than A).

Trial 3 Glider A Lighter Than Glider B
A rebounds to the left (negative displacement = negative velocity) and B moves to the right.

Trial 4 Glider A & Glider B Relatively Same Mass
A sticks to B and both move to the right as a coupled pair.

Trial 5 Glider A Heavier Than Glider B
A sticks to B and both move to the right as a coupled pair (speed is faster than trial 4).

Trial 6 Glider A Lighter Than Glider B
A sticks to B and both move to the right as a coupled pair (speed is slower than trial 4).

2. For each trial, calculate the initial and final momentum of both gliders (i.e. before and after the collision). Be sure to include positive and negative signs.
3. For each trial calculate the total momentum of both gliders before and after the collision. (Note: when the two gliders collide and stick together, they have the same velocity.)
4. For each trial calculate the % difference between the total momentum before and after the collision.
5. For each trial calculate the initial and final kinetic energy of both gliders (i.e. before and after the collision). Recall: since energy is a scalar quantity, your kinetic energy values should all be positive .
6. For each trial calculate the total kinetic energy of both gliders before and after the collision.
7. For each trial calculate the % difference between the total kinetic energy before and after the collision.

Questions

8. Examine the collisions. Which collisions were elastic and which were inelastic? Describe and explain the trend that allowed you to predict whether a collision would be elastic or inelastic.
9. Consider a situation in which you are the driver of a car stopped at a red light and you see a car of similar mass approaching rapidly from behind. Use the results of this experiment to discuss possible strategies for reducing the impact of the impending collision. For example, should you take your foot off the brake? Should you accelerate forward?
10. Suppose you are riding a skateboard along a narrow path and realize that you are about to have a head-on collision with another skateboarder of similar mass approaching from the opposite end of the path. Use the results of this experiment to describe your best strategy for minimizing injuries from the collision. Assume that jumping off the skateboard is not an option.

VELOCITY DATA: _____

TRIAL	GLIDER A			GLIDER B		
	mass m (kg)	before velocity v_A (m/s)	after velocity v_A' (m/s)	mass m (kg)	before velocity v_B (m/s)	after velocity v_B' (m/s)
1	0.50			0.50	0.00	
2	1.00			0.50	0.00	
3	0.50			1.00	0.00	
4	0.50			0.50	0.00	
5	1.00			0.50	0.00	
6	0.50			1.00	0.00	

TRIAL	Momentum (kg·m/s)						
	A		B		Total		% Diff
	Before	After	Before	After	Before	After	
1			0.00				
2			0.00				
3			0.00				
4			0.00				
5			0.00				
6			0.00				
	2 decimal places						1 dec.pl.

TRIAL	Kinetic Energy (J)						
	A		B		Total		% Diff
	Before	After	Before	After	Before	After	
1			0.00				
2			0.00				
3			0.00				
4			0.00				
5			0.00				
6			0.00				
	2 decimal places						1 dec.pl.

* The BEFORE momentum and BEFORE kinetic energy for B are zero because the BEFORE velocity for B is 0

MARKING SCHEME
(REFERENCE ONLY - DO NOT SUBMIT)

ENERGY & MOMENTUM: ANALYZING COLLISIONS

STUDENT: _____

CORRECT VALUES	Momentum % Diff.		Kinetic Energy % Diff.	
	1,2,3	4,5,6	1,2,3	4,5,6
A moving glider and stationary glider of equal mass.				
A moving glider heavier than a stationary glider.				
A moving glider lighter than a stationary glider.				

STUDENT ANSWERS				
A moving glider and stationary glider of equal mass.				
A moving glider heavier than a stationary glider.				
A moving glider lighter than a stationary glider.				

% ERROR BETWEEN CORRECT VALUES & STUDENT ANSWERS				
A moving glider and stationary glider of equal mass.				
A moving glider heavier than a stationary glider.				
A moving glider lighter than a stationary glider.				

STUDENT MARK

% Error — TOTAL ÷ 2 = /30

- ☞ based on % error between yours and accepted (<1 % = 5, 1-2 % = 4, 2-5 % = 3, 5-10 % = 2, > 10 % = 1)
- ☞ glider calculations = 2 decimal places (-1 for each omission)
- ☞ % difference values = 1 decimal place (-1 for each omission)

Sample calculations = /10

- ☞ pick a trial & show all your work (watch your accuracy)

Answers to questions = /15

- ☞ #8 (/5), #9 (/5), #10 (/5)

TOTAL = /55