

SAN DIEGO MESA COLLEGE

Name: _____

PHYSICS 195 LAB REPORT

Date: _____ Time: _____

TITLE: Conservation of Linear Momentum

Partners: _____

Objective:

To demonstrate conservation of linear momentum for elastic and inelastic collisions.

Theory:

Consider the situation in which a mass m_1 moving with velocity v_i , collides with a stationary mass m_2 , and the two then move as a single mass $m_1 + m_2$, with velocity v_f afterwards. The conservation of momentum theorem states $(P_i = P_f)_{system}$ for collisions in which only internal forces act upon the participants.

The momentum before and after this collision are given by:

The initial momentum in the system: $P_i = m_1 v_i$

The final momentum in the system: $P_f = (m_1 + m_2) v_f$

Equipment:

- | | |
|---------------------|--------------------|
| Air Track | Blower with hose |
| 2 Photogates | 2 Gliders |
| “needle” attachment | “wax” attachment |
| “flag” attachment | 50g Masses |
| 12” Ruler | White Bubble Level |

Diagram:

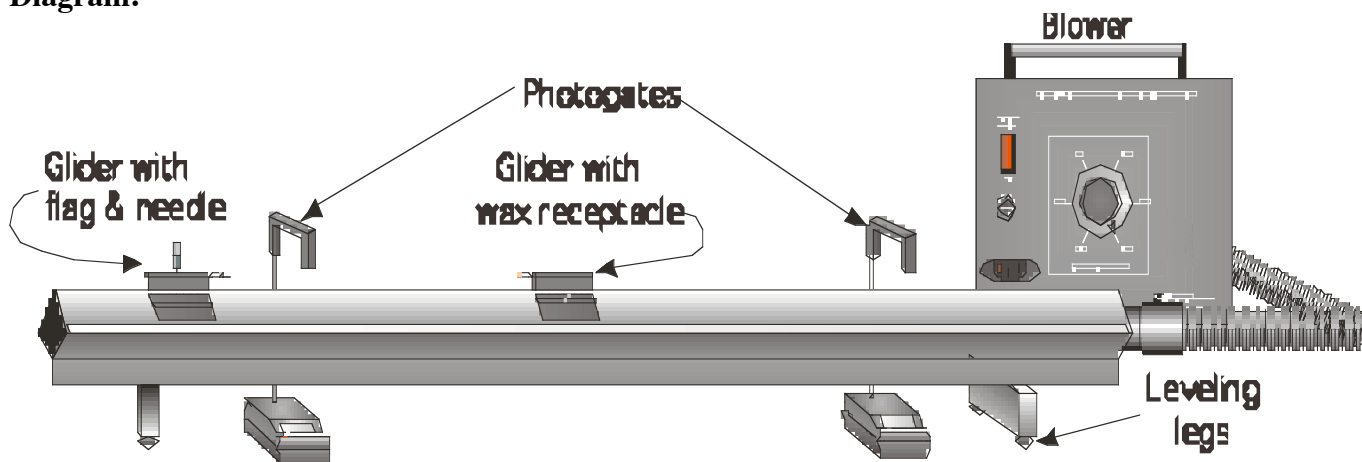
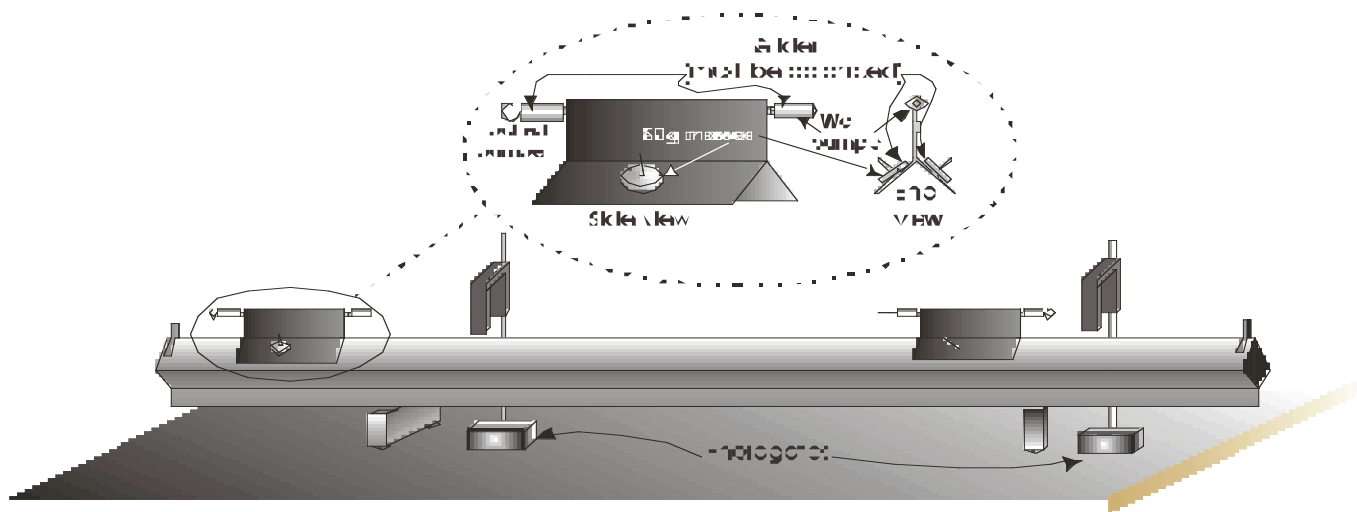


Fig. 1

Part I: Perfectly Inelastic Collisions**Diagram:****Procedure:**

Refer to the diagram to set up the air-track and level it.

Photogate Calibration: Position the two photogates next to each other on the middle of the track and pass the glider through them several times. Since the air-track is closely representing a frictionless surface, and the photogates are right next to each other, the time displayed on each photogate should be the same. When the batteries are low, the photogate can display an incorrect time so if the times differ by more than a few milliseconds, please notify your instructor.

Now position two photogates along the track about 40 cm apart. Insert the “needle” attachment in one glider and the “wax” attachment in the other. Keep each glider balanced by inserting another attachment on the opposite side of each glider as shown in the figure.

Insert the large “flag” attachment on the top of the moving glider. Measure and record the length of the flag, L , in the data section. For the first collision, make sure that $m_1 = m_2$ by adding pieces of clay to either glider until the equal-mass condition is met. Record the mass of the moving glider as m_1 and the mass of the other glider as m_2 . Place the moving glider near one end of the track, before the first photogate. Place the other glider just before the second photogate. Give the moving glider m_1 a small push. Make sure that m_2 is at rest when the collision occurs. You may find that faster *or* slower collision speeds will produce better results, so adjust the speed of m_1 accordingly.

After the gliders collide, become stuck together, and pass through the second photogate, stop them before they rebound. Make sure that the collision occurs *after* the first glider has *completely* passed through the first gate. Record the times from the two photogates, and call them t_1 and t_2 respectively. **After each collision, use your finger to smooth and fill in any holes in the wax surface.** Repeat the procedure with different choices of m_1 and m_2 ($m_1 \neq m_2$) by placing additional 50 g masses on the sides of the gliders. Always add two masses to a glider, one on either side for balance.

Data: Part I: Perfectly Inelastic Collisions

Length of glider flag, L = _____

Case	m ₁	m ₂	t ₁	t ₂	v _i	v _f	P _i	P _f	% difference
	kg	kg	s	s	m/s	m/s	kg-m/s	kg-m/s	
1 m ₁ = m ₂									
2									
3									
4									
5									

Show a sample calculation with units for one complete case. $\% \text{ Difference} = \frac{2(|p_f - p_o|)}{p_o + p_f} * 100\%$

Test for Kinetic Energy Conservation for Inelastic Collisions:

Case	K _o (Joules)	K _f (Joules)	% difference	Is Kinetic Energy Conserved?
1				
2				
3				
4				
5				

Show a sample of each calculation with units.

Part II: Perfectly Elastic Collisions**Procedure:**

Both gliders need to have a flag on the top. To perform an elastic collision, attach a rubber band bumper to each of the gliders. Keep each glider balanced by inserting another attachment on the opposite side of each glider as was done in part I.

Measure and record the length of each flag, L_1 and L_2 . Make sure that $m_1 = m_2$ by adding pieces of clay to either glider until the equal-mass condition is met. Place the moving glider near one end of the track, before the first photogate. Place the other glider somewhere between the two photogates. Make sure that m_2 is at rest when the collision occurs. Give the moving glider m_1 a push.

Note that you are not measuring the final speed of m_1 , you are assuming it comes to rest after the collision. Thus, any final momentum that m_1 has **is not accounted for**, and may be a source of error when you calculate momentum conservation. Therefore, you should experiment with collision speeds until you are able to have m_1 at rest or nearly at rest following the collision. After the gliders collide, record the times from the two photogates, and call them t_1 and t_2 respectively. Repeat this procedure for various values of v_i .

Data: Part II: Perfectly Elastic Collisions

Length of glider flags: $L_1 =$ _____ $L_2 =$ _____

Case	m_1	m_2	t_1	t_2	v_i	v_f	P_i	P_f	% difference
	kg	kg	s	s	m/s	m/s	kg-m/s	kg-m/s	
1									
2									
3									
4									
5									
	↓	↓							

Show a sample of each calculation with units.

Test for Kinetic Energy Conservation for Elastic Collisions:

Case	K_o (Joules)	K_f (Joules)	% difference	Is Kinetic Energy Conserved?
1				
2				
3				
4				
5				

Show a sample of each calculation with units.

Conclusion and Summary of Results:

Write a brief conclusion, including a brief discussion of the physics involved in this experiment, including possible sources of error, and indicate whether your results give support or validate the purpose of the lab exercise.

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