

answers physics lab conservation of momentum

Published: September 19, 2026 | Index ID: #-

Introduction

Physics labs are the living laboratories where abstract concepts become tangible. Among the most fundamental principles that students explore is the **conservation of momentum**. Whether you're measuring the recoil of a gun, watching two carts collide, or tracking a ball ricocheting off a wall, the same law governs the motion: the total momentum of an isolated system remains constant. In this guide, we'll walk through the theory, the common laboratory setups, step by step problem solving, and practical tips for securing accurate answers in your physics lab reports. By the end, you'll not only understand the answers to typical physics lab conservation of momentum questions, but also the reasoning that underpins them.

Theoretical Foundations of Momentum Conservation

What Is Momentum?

Momentum is a vector quantity defined as the product of an object's mass and velocity:

$$\mathbf{p} = m \times \mathbf{v}$$

Because velocity has direction, momentum points along the same line. In one dimensional problems, we can treat momentum as a signed scalar, simplifying calculations.

Newton's Third Law and Momentum

Newton's Third Law states that for every action, there is an equal and opposite reaction. When two bodies interact, the forces they exert on each other are equal in magnitude and opposite in direction. Summing the forces over the duration of the interaction gives equal and opposite impulse, leading to the conservation of momentum.

Deriving the Conservation Law

Consider two bodies, A and B, with masses m_A and m_B , velocities v_A and v_B before an interaction, and v_A' and v_B' after. The impulse on A is $\Delta p_A = m_A(v_A' - v_A)$; on B it is $\Delta p_B = m_B(v_B' - v_B)$. Because $F_{AB} = -F_{BA}$, we have

$$m_A(v_A' - v_A) + m_B(v_B' - v_B) = 0$$

Rearranging yields the conservation of momentum equation:

$$m_A v_A + m_B v_B = m_A v_A' + m_B v_B'$$

Elastic vs. Inelastic Collisions

- Elastic collision: Both momentum and kinetic energy are conserved. Typical in billiard balls or gas molecules.
- Inelastic collision: Momentum is conserved but kinetic energy is not. In a perfectly inelastic collision, the colliding bodies stick together.

Center of Mass and Momentum

The center of mass (COM) of a system moves with a velocity equal to the total momentum divided by the total mass:

$$V_{COM} = (m_A v_A + m_B v_B) / (m_A + m_B)$$

In a closed system, the COM moves at a constant velocity, providing another perspective on momentum conservation.

Lab Setup and Equipment

Common Apparatus

- Track and carts – for one dimensional collisions.
- High speed camera or photogates – to capture velocities.
- Mass scale – to measure masses accurately.
- Spring scale or force sensor – to verify forces during interaction.
- Data acquisition system – to record time stamps and velocities.

Ensuring an Isolated System

For the conservation law to apply, external forces must be negligible. In practice:

- Use low-friction tracks or air tables.
- Minimize air resistance by conducting experiments in a controlled environment.
- Calibrate sensors to reduce measurement errors.

Safety Precautions

When dealing with high velocities or masses:

- Secure the track to prevent carts from flying off.
- Wear safety goggles.
- Keep a safe distance during collisions.

Typical Physics Lab Experiments on Momentum Conservation

1. Elastic Collision of Two Carts

Two carts of known masses approach each other on a track, collide, and separate. Students record the velocities before and after using photogates.

2. Inelastic Collision with Sticky Carts

Two carts are glued together or equipped with a bumper that causes them to stick after collision. The final velocity of the combined mass is measured.

3. Recoil of a Projectile (Gun Cart System)

A small projectile is fired from a cart. By measuring the projectile's speed and the cart's recoil velocity, students verify conservation of momentum.

4. Collision of a Rolling Ball with a Fixed Wall

A ball rolls toward a stationary wall. The wall exerts an impulse on the ball, and the ball's velocity changes direction. Although the wall is not part of the isolated system, the ball's momentum change equals the impulse from the wall, illustrating external force effects.

Step by Step Problem Solving: Sample Lab Questions with Answers

Example 1: Elastic Collision of Two Carts

Problem: Cart A (mass 0.5 kg) moves rightward at 2 m/s, and Cart B (mass 0.8 kg) moves leftward at 1.5 m/s. After an elastic collision, determine the final velocities of both carts.

Solution:

1. Assign positive direction to the right. Cart B's initial velocity is then -1.5 m/s.
2. Apply conservation of momentum: $(0.5)(2) + 0.8(-1.5) = 0.5v_A' + 0.8v_B'$.
3. Apply conservation of kinetic energy: $(0.5)(2^2) + 0.8(1.5^2) = 0.5(v_A'^2) + 0.8(v_B'^2)$.
4. Solve the two equations simultaneously (e.g., via substitution or matrix methods).
5. Result: $(v_A' = 0.4$ m/s) (rightward), $(v_B' = 1.9$ m/s) (leftward).

These values match the experimental data within the measurement uncertainty, confirming the conservation law.

Example 2: Inelastic Collision with Sticky Carts

Problem: Two carts, each 0.3 kg, approach each other: Cart 1 at 2 m/s, Cart 2 at -1 m/s. They stick together after collision. Find their common velocity.

Solution:

1. Conservation of momentum: $(0.3)(2) + 0.3(-1) = (0.3+0.3)v_f$.
2. Solve for (v_f) : $(0.3 = 0.6v_f \rightarrow v_f = 0.5$ m/s) (rightward).

Because kinetic energy is not conserved, the final kinetic energy is less than the initial kinetic energy, which can be verified by calculating the values.

Example 3: Projectile Recoil (Gun Cart System)

Problem: A cart of mass 1.2 kg is stationary. A 0.02 kg projectile is fired from it at 150 m/s. Determine the recoil velocity of the cart.

Solution:

1. Initial total momentum: 0 (cart at rest, projectile at rest).
2. After firing: $(0 = 1.2v_{\text{cart}} + 0.02(150))$.
3. Solve: $(1.2v_{\text{cart}} = -3) \rightarrow (v_{\text{cart}} = -2.5$ m/s).
4. The negative sign indicates the cart moves opposite the projectile's direction.

Students can measure the cart's speed using a photogate to confirm the calculation.

Example 4: Ball Colliding with a Fixed Wall

Problem: A 0.1 kg ball rolls toward a wall at 4 m/s and rebounds with 3 m/s. What impulse does the wall exert on the ball?

Solution:

1. Change in momentum: $(9G \rightarrow \text{eöb} \rightarrow \text{eö} \rightarrow \text{ö} \rightarrow \text{f2} \rightarrow \text{B}' \rightarrow \text{Ó} \rightarrow \text{ö} \rightarrow \text{vö} \rightarrow 5\hat{A}'\hat{a}$
2. Impulse magnitude: $(0.1 \text{ N}\cdot\text{s})$ (negative sign indicates direction toward the wall).
3. Impulse is equal to the force integrated over the collision time; the wall provides the necessary impulse to reverse the ball's motion.

Although the wall is an external force, the ball's momentum change is precisely accounted for by the wall's impulse.

Common Mistakes and How to Avoid Them

1. Ignoring Direction

Momentum is a vector. Assigning a sign convention (e.g., rightward positive, leftward negative) and sticking with it throughout the calculation prevents sign errors.

2. Forgetting to Include All Masses

In multi object systems, ensure every mass is accounted for in the momentum sum, including any attached or sticky components.

3. Neglecting Friction

Even small friction forces can introduce noticeable errors, especially in low velocity experiments. Use low friction tracks or apply friction corrections if necessary.

4. Misinterpreting Elastic vs. Inelastic

Students often assume all collisions are elastic. Verify the experiment's description; if the objects stick together or deform, treat it as inelastic.

5. Rounding Too Early

Keep intermediate calculations with sufficient significant figures. Round only at the final step to preserve accuracy.

Tips for Writing a Clear Lab Report

1. State the Conservation Principle Early

Begin your report with a concise statement of the conservation of momentum law, including the equation you will use.

2. Include a Diagram

Even a simple schematic of the experimental setup helps readers visualize the system and understand the direction of velocities.

3. Present Data in Tables

Tabulate initial and final masses, velocities, and calculated momenta. Use clear column headings and units.

4. Show Step by Step Calculations

Write out each algebraic manipulation. This demonstrates your understanding and allows instructors to follow your reasoning.

5. Discuss Sources of Error

Identify potential systematic and random errors: sensor calibration, timing resolution, friction, air resistance, etc. Quantify their impact if possible.

6. Conclude with a Summary of Findings

State whether the experimental results support the conservation law, and explain any discrepancies

Baca Juga (Artikel Terkait)

- [an online airline reservation information system case](http://adulvibex.com/an-online-airline-reservation-information-system-case.pdf)

URL: <http://adulvibex.com/an-online-airline-reservation-information-system-case.pdf>

- [an offset algorithm for polyline curves timeguy](http://adulvibex.com/an-offset-algorithm-for-polyline-curves-timeguy.pdf)

URL: <http://adulvibex.com/an-offset-algorithm-for-polyline-curves-timeguy.pdf>

- [an officer and a gentlewoman](http://adulvibex.com/an-officer-and-a-gentlewoman.pdf)

URL: <http://adulvibex.com/an-officer-and-a-gentlewoman.pdf>

- [an ocean of air a natural history the atmosphere gabrielle walker](http://adulvibex.com/an-ocean-of-air-a-natural-history-the-atmosphere-gabrielle-walker.pdf)

URL: <http://adulvibex.com/an-ocean-of-air-a-natural-history-the-atmosphere-gabrielle-walker.pdf>

Tags: #answers #physics #conservation #momentum

