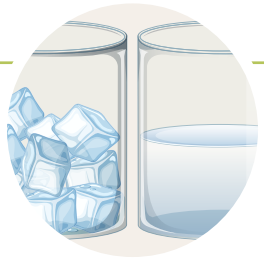
Law of Conservation of Mass

A Carolina Essentials™ Investigation



Overview

This inquiry investigation of the law of conservation of mass includes a brief review of physical and chemical changes and examples of conservation of mass for both processes. Use the investigation as a discovery-inquiry activity to introduce conservation of mass or as a confirmatory investigation.

Chemistry, Physical Science
Grades: 9–12

Phenomenon

How do we know mass is conserved? Your teacher will provide a simple demonstration.

Teacher preparation: Pre-cut a 6–8-in square of aluminum foil. Set a digital balance under a document camera so students can see the balance and its read-out. Weigh the foil flat, folded, and balled up. Discuss results and what conservation means from a physical science perspective.

Mass of aluminum foil flat: _____

Mass of aluminum foil folded: _____

Mass of aluminum foil balled up: _____

Did changing the shape of the foil affect the mass? Was mass conserved?

Essential Question

How can the law of conservation of mass be demonstrated for physical and chemical changes?

TIME REQUIREMENTS

PREP	ACTIVITY
20–30 min	30 min

Teacher Prep: 20–30 min
Student Activity: 30 min

SAFETY REQUIREMENTS

MATERIALS (PER GROUP)

Ice chips

Calcium chloride, $CaCl_2$, 0.1 M, 1.5 mL

Sodium carbonate, Na_2CO_3, 0.1 M, 1.5 mL

1 25-mL test tube, vial, or centrifuge tube with cap

2 test tubes, 5 to 10 mL

1 100-mL beaker or plastic cup

2 10-mL graduated cylinders

1 digital balance

HELPFUL LINKS

Carolina's Solution Preparation Manual

REFERENCE KITS

Carolina ChemKits®: Law of Conservation of Mass Kit

Continued on the next page.

Investigation Objective

1. Explain the law of conservation of mass for physical and chemical changes.
2. Demonstrate the law of conservation of mass mathematically.
3. Recognize the difference between physical and chemical changes.

Next Generation Science Standards* (NGSS)

HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model based on evidence to illustrate the relationships between systems or components of a system.	**PS1.A: Structure and Properties of Matter** • The law of conservation of mass models how reactants are broken down and reformed to make products so total mass remains constant.	**Energy and Matter: Flows, Cycles, and Conservation** • The law of conservation of mass tracks the movement of atoms within a system.

Safety Procedures and Precautions

Wear gloves and goggles and practice safe laboratory procedures.

Teacher Preparation and Disposal

Collect the calcium carbonate, the precipitate, from all groups and dispose of in the manner prescribed by local, state, and federal guidelines. Do not flush it down the sink.

Student Procedure

Procedure A: Ice Water

1. Place the beaker or cup on the balance, demonstrate how to zero or tare balances, record the mass in grams, and then zero or tare the beaker.
2. Remove the cap from the test tube. Fill the test tube half full of chipped ice. Replace the cap.
3. Weigh the capped test tube in the beaker or cup on the balance. Record the mass in table A.
4. Place the test tube on your lab table and continue to make observations until the ice has melted.
5. Reweigh the capped tube in the beaker or cup after the ice has melted. Record the mass in table A.
6. To determine the change in mass, take the mass of the water with tube and substract the mass of the ice with tube.
7. Record the change in mass in table A.

Teacher Preparation and Tips

If ice cubes are the only type of ice available, wrap cubes in a towel and break them into pieces with a hammer so they will fit into the tube.

Prepare enough volume of each solution for the total number of lab groups. Add an additional 10 to 20% more volume in case students make mistakes.

See Carolina's Solution Preparation Manual for instructions on preparing molar solutions.

Demonstrate how to zero or tare balances.

Review and discuss with students what physical and chemical changes are and what type of evidence they may observe.

Keep ice in a well-insulated cooler to minimize melting.

*Emphasize that caps must be on the tubes securely. **No leaks.***

*Remind students that the mass of the beaker or cup should **not** be included in the recorded mass.*

Continued on the next page.

Student Procedure *(continued)*

Procedure B: $CaCl_2$ and Na_2CO_3

1. Place the beaker or cup on the balance and zero or tare the balance.
2. Using a **clean** graduated cylinder, measure 1.5 mL of calcium chloride solution ($CaCl_2$).
3. Pour the calcium chloride into a test tube.
4. Wipe off the outside of the tube with a paper towel to remove any excess. Place the tube in the beaker or cup on the balance.
5. Using a **clean** graduated cylinder, measure 1.5 mL of sodium carbonate solution (Na_2CO_3).
6. Pour the sodium carbonate into the test tube.
7. Wipe off the tube with a paper towel to remove any excess. Place the tube in the beaker or cup on the balance.
8. Record the mass of both tubes with solutions in table B.
9. Pour the calcium chloride into the test tube that contains sodium carbonate and record your observations in table B.
10. After combining the calcium chloride and sodium carbonate, reweigh both test tubes in the beaker or cup. Record the mass in table B.
11. To determine the change in mass, take the final mass of the test tubes and subtract the beginning mass of the test tubes. Record the change of mass in table B.

Data and Observations

See the student worksheet. Answers will vary but should be close.

Teacher Preparation and Tips *(continued)*

Have all solutions prepared, labeled, and in a central location.

Instruct students that M is molarity, which is a unit of concentration. Demonstrate how to pour liquids.

This is a good time to introduce the vocabulary and concepts of reactants and products.

Emphasize to students that the graduated cylinder must be clean or a reaction will take place in the cylinder.

If students spill a solution, wipe it up immediately with a paper towel and dispose of the paper towel in the trash.

If students spill a solution, they will need to start over.

Continued on the next page.

Analysis and Discussion

1. Use the data to explain whether mass was conserved in procedures A and B.

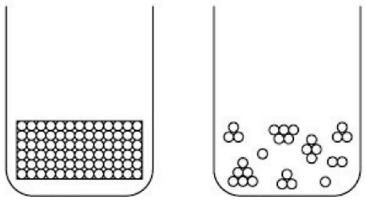
   Mass should be conserved in both procedures. The initial mass was the same as the final mass.

2. Translate your explanation above into a mathematical statement.

   mass before = mass after
   $mass_{(i)} = mass_{(f)}$
   $mass_{(reactants)} = mass_{(products)}$

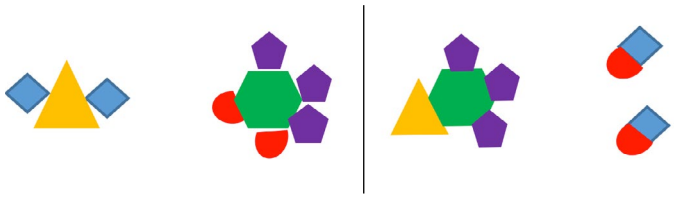
3. Create a particle diagram for each process.

A.



(a) solid (b) liquid

B.



Reactants Product

4. Identify the processes above as a chemical change or physical change, and state the observations used to make the identification.

   A. Physical: Water did not change its identity, only its state of matter.

   B. Chemical: Two new products and a precipitate were formed.

TEACHER NOTES