Lab: Investigating Mass Change

FOR THE TEACHER

**Summary**
In this lab, students perform seven different investigations in order to develop an understanding of conservation of mass.

**Grade Level**
High School

**Objectives**
By the end of this lab, students should be able to
- Explain the difference between the system and surroundings
- Explain the difference between a “closed system” and an “open system”
- Define mass as the amount of “stuff” in a substance and that the particles of the substance give the substance mass
- Explain that mass is conserved in a closed system and that if the universe is considered the system that mass is conserved during any process
- Make and defend a claim given data in a histogram
- Provide reasonable sources of error for data that do not follow a trend observed during an investigation

**Chemistry Topics**
This lab supports students’ understanding of
- Conservation of mass
- Matter
- Observations
- Systems vs. Surroundings
- Error Analysis
- Particulate Nature of Matter

**Time**
**Teacher Preparation:** 30 minutes
**Lesson:** Three 50 minute periods for lab and discussion

**Materials**
- Balances (0.1 g or 0.01 g precision)
- Test Tubes
- Beakers
- Crucible tongs
- Container with lid
- Bunsen Burner or Lighter (to ignite steel wool)
- Watch glass
- Balloon
- Erlenmeyer flask
- Steel Wool
- Ice
- Sugar or salt (to dissolve in water)
- Baking Soda and Vinegar (to produce a gas)
- 0.1 M sodium carbonate and 0.1 M calcium chloride (to form precipitate)

**Safety**
- Always wear safety goggles and lab aprons when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- When steel wool is ignited it should be done over a watch glass or flame resistant container that can then be massed. It can melt weigh boats. Small pieces may fly off a short distance.
- The precipitate reaction used here is safe and nontoxic. Avoid the use of toxic ions or ions that require special disposal such as lead (II), silver, or mercury.

**Teacher Notes**
- This lab is designed to be done as one of the first activities of the year in a first year course.
- Students will perform seven different investigations. You may choose to have them complete all of them at once or place them in to groups as you see appropriate for post-lab discussion.
- Creating a central area for material distribution aids in facilitation so each lab group does not need all of the materials. Students do not all have to be doing the same experiment at the same time.
- The use of centigram (0.01 g) balances is recommended for an introduction to error, precision, and significant figures as students may observe a 0.01 g change when no change in mass actually occurred. Students always complain about the last digit “ticking back and forth” and not settling on one value. If you do not wish to introduce this at this time, the use of decigram (0.1 g) balances is appropriate.
- You may choose to give students the detailed procedure below or demonstrate the goals of each investigation and develop a procedure as a class during pre-lab discussion. The latter is recommended so that students have an understanding of what is going to happen and don’t get lost in procedure.
- Because this is an introductory lab before students have accepted the particulate nature of matter, this is not an appropriate time to discuss physical vs. chemical changes.

**Melting Ice**
- Use small pieces of ice and have students work on other investigations while their ice melts as it could take some time.
- This investigation produces the most consistent results as no transferring of material is required between mass measurements.
- Get the students to notice that liquid water takes up less space than solid water, this is a good example to come back to when density is discussed in future lessons.

**Forming a Precipitate**
- Use two small test tubes and support them on a balance by placing them in a small beaker.
- Students will usually predict the mass will increase because “solids weigh more than liquids”
- Some students will suggest subtracting the mass of the empty containers so they are only recording the mass of the reagents while others will recognize this is not necessary if all materials are massed before and after. Either method is appropriate, use this as an opportunity to discuss proper techniques of massing by difference with them and the
importance of massing all containers before and after the reaction.

**Dissolving Salt or Sugar**
- The best technique is to use a container with a lid, place the substance in the lid for massing before and then massing the substance, container, and lid afterwards.
- Students usually record a small mass loss during the investigation due to improper transfer when pouring the substance into water.
- Some students conclude this mass loss is because the substance dissolved “disappeared.” If so, provide the proper explanation as an alternative and see if they accept it. If not, this may be an appropriate time to boil the solution as a demonstration to show the solute remains.

**Pulling apart Steel Wool**
- Students usually record a loss of mass in this investigation due to small pieces of steel wool not falling on the watch glass. When you observe this ask them why the mass decreased, they are usually quick to offer the proper explanation.

**Burning Steel Wool**
- The best technique is to hold steel wool with crucible tongs over a watch glass and having a second student hold the flame of a lighter or Bunsen burner to the steel wool.
- Students are usually very intrigued by the bright glow and sparks produced, but make sure to coach them not to be distracted and remain aware of safety precautions.
- The piece of steel wool should be heated for 5-10 minutes. Doing so ensures a significant mass increase >0.1 g
- Students usually predict the mass will go down.
- The mass will increase due to the oxidation of the iron in the steel wool. Many students may suggest that particles of fire attach to the steel wool.

**Baking Soda and Vinegar (no lid)**
- Do trial runs to know how much you should use for the beaker/container you’re working with so there are not spills. Update the student handout to indicate the required amount.
- Any reaction that produces a nontoxic gas may be used, but this produces consistent results and occurs quickly with visible gas production. The use of antacid tablets is another cheap alternative, but they should be crushed to a powder to increase the rate of reaction.

**Baking Soda and Vinegar (with lid or balloon)**
- This should be done as a demonstration to avoid unwanted explosions and student difficulty getting a balloon over the mouth of a flask. This [demo and video](#) from the AACT library may be helpful to reference.
- When paired with the first investigation, this variation highlights
  - The difference between an open and closed system
  - The fact that gases are matter, they are made of particles, and they have mass. A prevailing misconception among students is that “gasses weigh less than liquids or solids” or that they have no mass at all
  - You can also tie this back to the Burning Steel Wool Investigation if students are struggling with where the added mass came from.
Investigating Mass Change

Purpose
You will perform a number of investigations in order to determine if and how the mass changes when matter is changed.

Procedure

Part 1: Melting Ice
Do you think the mass of the ice will increase, decrease, or stay the same when it is melted?

1. Put a piece of ice in a container and find the total mass using the balance. Remember to zero the balance first. Record it below.
2. Put it aside and let it melt. Try to warm it up with your hands to speed up the process.
3. Go on to the next parts while you wait for it to melt. When it is melted, find the mass and calculate the change in mass. Record both values below.
4. Also, report your change in mass to the class using the google doc.

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Part 2: Making a Precipitate
Do you think the mass of the entire system increases, decreases, or stays the same when the solid is formed from two liquids?

1. Fill a test tube about ¼ of the way with sodium carbonate. Fill another test tube about ¼ of the way with calcium chloride.
2. Find the total mass of both test tubes with the help of a beaker (place both test tubes in a beaker to hold them on the scale.)
3. Carefully add the contents of one test tube to another.
4. Place both test tubes back in the beaker and find the total mass again. Record values below.
5. Report your change in mass to the class using the google doc.

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Part 3: Dissolving Sugar
Do you think the mass of the entire system increases, decreases, or stays the same when sugar is dissolved in water?

1. Fill your vial about ½ full of water. Add a small scoop of sugar to the cap.
2. Find the mass of the vial + water and the cap with sugar. Record it below.
3. Pour the sugar into the water, screw the cap on, and shake to dissolve the sugar.
4. Once the sugar is dissolved. Find the mass of the container and its contents. Record it below.
5. Report your change in mass to the class using the google doc.

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**Part 4: Tearing Steel Wool**

Do you think the mass of the steel wool will increase, decrease, or stay the same when it is pulled apart?

1. Obtain a piece of steel wool, place in a weight boat, and record the mass below.
2. Carefully pull the steel wool apart so that it occupies a volume about twice as large as before.
3. Record the mass again.
4. Report your change in mass to the class using the google doc.

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**Part 5: Burning Steel Wool**

Do you think the mass of the steel wool will increase, decrease, or stay the same when it is burned?

1. Obtain a piece of steel wool, place it on a watch glass, and record its mass.
2. Hold the steel wool with crucible tongs over the watch glass.
3. Holding the Bunsen burner on its side, ignite the steel wool. Make sure anything that falls during the burning process lands on the watch glass. Make sure all of the steel wool is burned.
4. Place the steel wool on the watch glass and record its mass.
5. Report your change in mass to the class using the google doc.

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**Part 6: Baking Soda and Vinegar**

Do you think the mass will increase, decrease, or stay the same when these items are combined?

1. Fill a vial about ¼ full of vinegar. Find the mass of the vial and baking soda.
2. Add baking soda (amount specified by the teacher) to the vinegar, observe what happens.
3. Take the mass once it has completely dissolved.
4. Report your change in mass to the class using the google doc.

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**Part 7: Demonstration - Baking Soda and Vinegar (with balloon lid)**

Do you think the mass of baking soda and vinegar will increase, decrease, or stay the same when it is combined and covered with a lid?

1. Fill a small flask (125 ml) about ¼ full of vinegar. Find the mass of the flask, baking soda (amount indicated by teacher), and empty balloon.
2. Put the baking soda in a balloon, place the balloon over the flask and allow the baking soda to fall in.
3. Find the mass once the baking soda has completely dissolved.
4. Report your change in mass to the class using the google doc.

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**Cleanup and disposal**

All liquids can be poured down the sink with running water. All solids can be thrown in the trash. Rinse all glassware and leave on a paper towel to dry.

**Analysis**

1. Review the class data on the Google Doc.
2. Were the results of each experiment what you expected, or did any surprise you?
3. Try to formulate explanations for each change in mass you observed.
4. Next class we will have a “board meeting.” Each group will be assigned one particular experiment and will prepare a white board explaining their observations to and present to the class.

Use the space below to make notes on any of the experiments in preparation for, or during the board meeting.