

Three Balances: Lost, Kept, Gained. Where Did the Grams Go?

Investigation question: When the same reaction runs in an open cup and in a sealed bag, and a damp steel pad sits in air for several days, why does the cup lose mass, the sealed bag keep its mass and the pad gain mass, if matter can never be created or destroyed?

Evidence-based mystery

Groups of 4

2 sessions

Setup 10 · Activity 70 · Cleanup 10 min

MS-PS1-5 · assesses

MS-PS1-2 · supports

Name _____

Group _____

Date _____

Your role today

- ☐ **Balance reader:** Zeroes the balance, places and removes items the same way every time, and reads each value aloud twice before it is recorded.
- ☐ **Mixer:** Measures the vinegar and baking soda, pours and seals, and handles the steel-wool pad with gloves. Wears goggles the whole time, like everyone.
- ☐ **Recorder:** Writes the group's prediction before each measurement, records every reading, and computes the change in mass.
- ☐ **Boundary checker:** Before each station, says out loud what the system is and what can cross its boundary, and makes sure the group's prediction matches that boundary.

Safety

- Goggles on for the whole wet part of the lab. Vinegar stings eyes; rinse with water for several minutes if it gets in.
- Use only the pre-measured half teaspoon of baking soda per bag and only gallon-size bags. Students never seal this reaction in a rigid bottle or jar; the gas pressure can pop a lid or burst a thin container. If a bag balloons tightly, open one corner away from faces.
- Handle steel wool with gloves; the fine fibers can splinter into skin. Do not rub eyes after touching it. Keep steel wool away from any flame or heat source and away from batteries; fine steel wool can ignite from a battery short.
- No burning of steel wool by students. If you choose to show the burning phenomenon, do it yourself behind a shield on a heat-proof tray with goggles, with the room's fire plan in mind, or use a video.
- Wipe spills at once; vinegar on a floor is a slip hazard. Wash hands at the end of both sessions.

Procedure

1. Session 1, station C first (so it can rust all week): put on gloves. Mass the dry test pad and record it. Mass the dry control pad and record it. Both pads must be completely dry.

2. Dip only the test pad in vinegar for about one minute, squeeze it out gently over the sink, rinse it under the tap for ten seconds, squeeze again and set it on dish T. Mist it with water until damp but not dripping. Leave the control pad dry on dish C in the dry spot. Write the boundary and prediction for station C before leaving it: can anything enter or leave the pad over the week?
3. Station A (open cup): place an empty cup on the balance, pour in 30 mL of vinegar, and set one paper square with half a teaspoon of baking soda beside the cup on the same balance. Write the boundary and prediction, then record the total mass as 'before'.
4. Tip the baking soda into the vinegar (drop the paper square beside the cup so it stays on the balance). Watch the fizzing. When bubbling has stopped and the reading has been steady for 30 seconds, record the 'after' mass. Compute the change.
5. Station B (sealed bag): place the empty gallon bag on the balance with a cup inside it. Pour 30 mL of vinegar into the cup inside the bag. Tip the second half teaspoon of baking soda into a bottom corner of the bag, outside the cup, without letting it touch the vinegar. Squeeze most of the air out and seal the bag completely. Write the boundary and prediction, then record 'before'.
6. Keeping the bag sealed, tilt it so the vinegar pours over the baking soda. Let it fizz; the bag will puff up. When it has settled for 30 seconds, place it on the balance, check that the bag is still puffed and that the reading holds steady for one minute, and record 'after sealed'. Compute the change.
7. Now open one corner of the bag away from faces, gently press the gas out, seal it again, and record 'after opened'. Compute the change from 'before'.
8. Make the atom drawing of the bag on the recording sheet: the same atoms before and after, regrouped, inside a boundary nothing crossed.
9. Between sessions: once a day, a volunteer mists the test pads so they stay damp. The control pads are never wetted.
10. Session 2 (three to five school days later): move the test pads to the dry spot one full day before this session so they are completely dry when massed. Mass the dry test pad and the control pad again. Record both and compute the change for each.
11. Pool the class data on the board: average change at station A, at station B (sealed and opened), and for the test and control pads. Answer the analysis questions individually, then compare within the group.

Record your observations

Lab 1 recording sheet: Three balances

Rule of the lab — Before every measurement, your Boundary checker says what the system is and what can cross its boundary, and your Recorder writes the group's prediction (up, down or same, and why). Then you measure. Predictions are never erased.

Boundaries and predictions

Station	What is the system? (everything on the balance)	Can matter enter or leave? What kind?	Prediction: reading goes up, down or stays the same	Reason for the prediction
A: open cup				
B: sealed bag				
B: bag after opening				
C: damp test pad in air				
C: dry control pad				

Mass data, stations A and B (session 1)

Station	Mass before (g)	Mass after (g)	Change (after minus before, g)	What you saw
A: open cup				
B: bag, still sealed				
B: bag after opening and resealing				

Mass data, station C (session 1 and session 2)

Pad	Dry mass, day 1 (g)	Dry mass, session 2 (g)	Change (g)	Color and texture on session 2
Test pad (kept damp)				
Control pad (kept dry)				

-  Draw the sealed bag at station B twice: before the vinegar reaches the baking soda, and after the fizzing stops. Use simple circles for atoms (label the kinds you use) and show the bag as the boundary. Your two drawings must contain the same atoms. Write one sentence under them explaining why the total mass inside the bag cannot change.



1. Which of your three predictions was wrong, if any? Copy the prediction and write what the balance actually showed.

2. At station B the bag puffed up, the sealed reading dropped less than the open cup's and held steady, and opening the bag made it drop further. What was in the puffed-up part of the bag, and why did the reading fall again only when the bag was opened?

Analysis questions

3. Station A lost mass and station B did not, yet the same reaction ran in both. Use the words 'system' and 'boundary' to explain the difference.

4. Compare the change at station A with the change at station B after you opened the bag. Should they be about the same? Explain what the opened bag and the open cup have in common.

5. The damp test pad gained mass while the dry control pad did not. Where did the extra mass come from? Name the atoms and where they were before.

6. Why did the lab include a dry control pad at all? What result on the control pad would have made you distrust the test pad's gain?

7. Write one rule that explains all three results (down, same, up) and show how it applies to each station.

8. Suppose a group's sealed bag read 0.6 g lower after the reaction. Give two possible explanations and one way to tell them apart.

9. A classmate says, 'The cup reading dropped by 1.1 g, so the reaction must have made 1.1 g of gas.' Was the mass of gas the reaction made less than 1.1 g, exactly 1.1 g, or 1.1 g or more? Explain.
