

White Powder In, White Powder Out: Did Heating Make a New Substance?

Learning target: I can use before-and-after measurements of mass, solubility and behavior, together with control samples, to argue whether heating turned a substance into a different one, and say which evidence is strongest.

Claim, evidence, reasoning

About 40 min

Individual

MS-PS1-2 · assesses

writing

data analysis

Name _____

Date _____

Period _____

Directions

Read the scenario, the observations and both tables. Answer the warm-up questions first; they will organize your evidence. Then write your Claim, Evidence and Reasoning in the boxes. A strong response uses specific numbers, says which sample each number comes from, explains what the two control samples rule out, and names the evidence that would convince a skeptic most. Finish with the two follow-up questions.

You will need: This worksheet, Pencil, Scrap paper for the evidence grid, Calculator (optional)

The scenario

Ms. Tran's class is testing a claim from a cookbook: 'Baking soda baked in a dry pan for twenty minutes becomes a different, stronger powder.' Elena, the student running the test, weighs 10.0 g of baking soda into a dry metal pan and heats it on a hot plate set to about 150 °C for twenty minutes (the teacher handles the hot plate). To be fair, she sets up two more samples. Sample 2 is 10.0 g of baking soda in an identical pan that is **not** heated. Sample 3 is 10.0 g of table salt heated exactly like Sample 1. Afterward, every powder is cooled and tested at 20 °C.

Elena's observations during the twenty minutes — Sample 1 (baking soda, heated): a faint hiss for the first few minutes; a cold glass plate held above the pan fogged with tiny droplets during minutes 1 to 6, then stayed clear; gas led through a tube into limewater turned it cloudy; the powder stayed white and gave off no smell. Sample 2 (baking soda, not heated): nothing seen. Sample 3 (table salt, heated): no hiss, the cold plate stayed clear, the limewater stayed clear, the powder stayed white.

Table 1. Tests on each sample before and after the twenty minutes (teaching dataset)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Sample	Mass before (g)	Mass after (g)	Solubility before (g per 100 mL)	Solubility after (g per 100 mL)	Fizzes with vinegar: before / after	Odor: before / after	Heated a second time
1: baking soda, heated	10.0	6.3	9.5	21.8	yes / yes	none / none	no fog on the plate, no mass lost
2: baking soda, not heated	10.0	10.0	9.5	9.6	yes / yes	none / none	not tested
3: table salt, heated	10.0	10.0	36	36	no / no	none / none	no fog on the plate, no mass lost

Simulated data for teaching. All solubility tests at 20 °C in 100 mL of water; repeat tests on the same powder agree within 1 g per 100 mL.

Table 2. Reference values for three white powders kept in the stockroom (real values, rounded)

Powder	Density (g/cm³)	What it does when heated	Solubility at 20 °C (g per 100 mL)
Baking soda (sodium bicarbonate)	2.20	breaks down above about 80 °C instead of melting; gives off water vapor and carbon dioxide	9.6
Washing soda (sodium carbonate)	2.54	melts at 851 °C	about 21.5
Table salt (sodium chloride)	2.17	melts at 801 °C	36

Table 2 is not part of Elena's data. Use it only for q4.

Warm-up: organize the evidence

1. List the three clues Elena noticed for Sample 1 during heating (one from the plate, one from the limewater, one from the balance). For each, say what it **suggests** happened, and why none of them by itself proves a new powder was made.
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2. Why did Elena include Sample 2 and Sample 3? State what each control sample rules out as an explanation for Sample 1's results.

3. Calculate (a) the mass Sample 1 lost and that loss as a percentage of the starting mass, and (b) how many times larger Sample 1's 'after' solubility is than its 'before' solubility. Show your work.

Your argument

CLAIM

Claim: State whether heating turned the baking soda in Sample 1 into a different substance, and whether the control samples changed.

EVIDENCE

Evidence: Give at least three specific pieces of evidence from the observations and Table 1, with numbers and sample labels. Include at least one measured property compared before and after, and say what Samples 2 and 3 showed.

REASONING

Reasoning: Explain why a change in a characteristic property measured at the same temperature identifies a different substance, why the control samples make the evidence stronger, and which single piece of evidence you would show a skeptic first and why. Also explain why the powder still fizzing with vinegar does not weaken your claim.

Follow-up

4. Elena wonders what the new powder is. Compare Sample 1's 'after' results with Table 2. Which stockroom powder matches best, and which property in Table 2 that Elena has **not** measured could she test next to check? Say what result would support the match.

5. A classmate argues: 'Sample 1 is white, has no smell and still fizzes with vinegar, exactly like baking soda, so nothing really changed.' Respond using the idea that a product differs from its reactant in **some** characteristic properties, not necessarily all.

Evidence grid before writing

On scrap paper, draw a grid with the three samples across the top and these rows down the side: mass, solubility, fizz, odor, plate, limewater, second heating. Fill each cell with the number or word from the tables. Circle every cell where 'after' differs from 'before'. The circled cells in Sample 1's column are your evidence; the uncircled cells in Samples 2 and 3 are what your controls show. Sentence frame: 'Before heating, Sample 1 dissolved ____; after, it dissolved ____ at the same temperature, so ____.'

Where did 3.7 grams go?

The fogged plate and the cloudy limewater show that water vapor and carbon dioxide left the pan.

Design a way to catch and weigh what escaped, using a sealed container with a balloon or a bag, so that you could test whether the mass that left the pan equals the mass that the gases gained. Draw the setup, list what you would weigh before and after, and predict the numbers if the total mass is conserved. Then write two sentences on why this test belongs to the next lesson (tracking atoms) rather than to the question answered here (did a new substance form?).