

Mystery Powders: Reactions as Fingerprints

Investigation question: Can the way a white powder behaves with water, vinegar and a baking soda solution identify it, and how many tests does it take to be sure?

Evidence-based mystery

Groups of 4

1 session

Setup 8 · Activity 35 · Cleanup 7 min

MS-PS1-2 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Tester:** Measures the level quarter-teaspoon of powder, adds the 10 mL of liquid, and stirs for the same 20 seconds every time.
- ☐ **Observer:** Reads the thermometer before and 60 seconds after mixing, watches for fizz and cloudiness, and calls out observations in plain words.
- ☐ **Recorder:** Writes every observation in the fingerprint table as it is called out, including 'no change', and makes sure no cell is left blank.
- ☐ **Safety and materials captain:** Checks goggles are on before any pouring, labels every cup before it is used, keeps the tray tidy, and runs the cleanup checklist.

Safety

- Splash goggles on from the first pour to the last rinse. Vinegar and calcium chloride solutions sting eyes.
- Nothing is tasted or smelled up close; waft gently if you must check for a smell. Keep hands away from your face and wash them at the end.
- Calcium chloride is a skin and eye irritant and its solution gets warm. Use only the level quarter-teaspoon, never touch the solution, and tell the teacher if a cup feels hot.
- Unknown Z fizzes in water; keep every cup uncovered and never seal anything that is fizzing.
- Wipe spills at once; wet powders are slippery. All solutions go down the sink with running water; solids and cups go in the trash.

Procedure

1. Put on goggles. Label nine cups for the knowns: K1, K2 and K3 each with 'water', 'vinegar' and 'soda solution'. Label nine more for X, Y and Z the same way.
2. Read the temperature of the water, the vinegar and the soda solution before any mixing and record each as the starting temperature for that liquid.
3. Water test on the knowns: put a level quarter-teaspoon of K1 in its water cup, add 10 mL water, stir 20 seconds. Record whether it dissolves (all, some, none) and the temperature after 60 seconds. Repeat for K2 and K3 with clean spoons.
4. Vinegar test on the knowns: a level quarter-teaspoon of each known in its vinegar cup, 10 mL vinegar, stir 20 seconds. Record fizz (none, slight, strong), whether it dissolves, and the temperature after 60

seconds.

5. Soda-solution test on the knowns: a level quarter-teaspoon of each known in its soda-solution cup, 10 mL baking soda solution, stir 20 seconds. Record whether the liquid turns cloudy, any bubbles, and the temperature after 60 seconds.
6. Look at the fingerprint table. For each cell, mark R if you think a chemical reaction happened (a new substance formed) and P if the powder only dissolved. Discuss until the group agrees.
7. Run the same three tests on unknowns X, Y and Z in the same order, with the same amounts and times. Record everything, including anything that none of the knowns did.
8. Match each unknown to a known fingerprint. If an unknown does not match any single known, ask whether it could be two knowns mixed together and what evidence would show that.
9. Answer the analysis questions on your own, then compare within the group. Rinse the thermometer, pour liquids down the sink with running water, and bin the cups.

Record your observations

Lab 1 recording sheet: Mystery powders

Starting temperatures: water ____ °C, vinegar ____ °C, baking soda solution ____ °C. Fill in every cell, including 'no change'. After the knowns are done, mark each cell R (reaction) or P (physical change only).

Fingerprints of the known powders

Known powder	Water: dissolves? (all/some/none)	Water: temperature after 60 s (°C)	Vinegar: fizz? (none/slight/strong)	Vinegar: temperature after 60 s (°C)	Baking soda solution: cloudy? bubbles?	R or P for each test
K1 baking soda						
K2 Epsom salt						
K3 calcium chloride						

Unknown powders

Unknown	Water: dissolves? temperature (°C)	Vinegar: fizz? temperature (°C)	Baking soda solution: cloudy? bubbles?	Anything no known did?	Identity	The one test result that ruled out the other knowns
X						
Y						
Z						

1. Which of the three tests found a chemical property of a powder? How do you know it was a chemical property and not a physical one?

2. Which known powder could you identify with the water test alone? Which pair of knowns needed a second test to tell apart, and which test did it?

Analysis questions

3. Unknown Z did something in plain water that none of the three knowns did on its own. Describe what you saw and explain, using the known fingerprints, what Z must be made of.

4. In the water test, two cups changed temperature in opposite directions. Did a new substance form in either of them? What evidence from the other tests supports your answer?

5. When calcium chloride met the baking soda solution, the liquid turned cloudy. Both starting solids dissolve easily in water. What does the cloudiness tell you about the white solid that appeared, and why does that count as evidence of a reaction?

6. A classmate says: 'Y fizzed with nothing, so nothing happened to Y and we learned nothing.' Explain what the three 'no fizz' and 'no cloud' results did tell you about Y.

7. Suppose a fourth white powder fizzes strongly with vinegar. Can you conclude it is baking soda? What would you need before you could say so?

8. Which single test was the most useful for separating the three knowns, and which was the least useful? Use your table to justify both choices.
