Powder Detective

Compare test results to identify unknown substances.

PHS.1.3 "Conduct an investigation to determine the identity of unknown substances by comparing properties to known substances."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the properties of each labeled powder, then circle the results for jars J, K, and L so you can compare them.

The Jars with Missing Labels

1. At a water treatment lab, a torn label leaves a jar of white powder unidentified. Four labeled reference powders are available: sucrose (table sugar), sodium chloride (table salt), sodium bicarbonate (baking soda), and calcium carbonate (powdered chalk). Each is white, so color alone is weak evidence. In room-temperature water, small portions of the first three dissolve readily, while calcium carbonate barely dissolves. When equal masses are dissolved in equal volumes of water, solutions of sodium chloride and sodium bicarbonate conduct electricity well. A sucrose solution conducts poorly because it forms no ions in water.

2. Vinegar provides another comparison. Sodium bicarbonate and powdered calcium carbonate release bubbles of carbon dioxide when mixed with vinegar; sodium chloride and sucrose do not. A technician places equal amounts of each powder in separate cups, then adds the same amount of vinegar. She checks whether bubbles keep forming, not just whether a few trapped air bubbles appear when liquid is poured. She also tests each powder in fresh water before adding vinegar, using a clean cup and a rinsed conductivity probe each time. Mixing powders or reusing a dirty probe could make the evidence misleading.

3. Three unlabeled jars, J, K, and L, reach the lab. J dissolves readily in water, its solution conducts well, and it produces no sustained bubbling with vinegar. K barely dissolves in water and produces sustained bubbling with vinegar. L dissolves readily in water, its solution conducts poorly, and it produces no sustained bubbling with vinegar. The technician repeats the tests with new portions and gets the same results. Her findings support identities for these jars, but they do not prove that no other substance could share these properties. A supplier label or another independent test would strengthen the claim.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which reference powder best matches jar J? Use two test results to support your answer.

2. Which reference powder best matches jar K? Explain why the vinegar test alone would not identify it.

3. Which reference powder best matches jar L? Which result rules out sodium chloride?

4. Jar M dissolves readily, and its solution conducts well. Which two reference powders still fit? What vinegar result would separate them?

3 YOUR TURN

Your own words

A new mystery powder is either cornstarch or citric acid. Cornstarch does not dissolve in cool water and turns blue-black with iodine solution, while citric acid dissolves and does not turn blue-black. Plan a fair investigation using both tests, and explain how the results would identify the powder.

Powder Detective

PART 1 · READ AND MARK

Underline the properties of each labeled powder, then circle the results for jars J, K, and L so you can compare them. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which reference powder best matches jar J? Use two test results to support your answer.	**Sodium chloride. Like J, it dissolves readily and its solution conducts well; it also does not produce sustained bubbling with vinegar.**
2	Which reference powder best matches jar K? Explain why the vinegar test alone would not identify it.	**Calcium carbonate. Both calcium carbonate and sodium bicarbonate bubble with vinegar, but only calcium carbonate barely dissolves in water.**
3	Which reference powder best matches jar L? Which result rules out sodium chloride?	**Sucrose. L's solution conducts poorly, while a sodium chloride solution conducts well.**
4	Jar M dissolves readily, and its solution conducts well. Which two reference powders still fit? What vinegar result would separate them?	**Sodium chloride and sodium bicarbonate still fit. Sustained bubbling with vinegar would support sodium bicarbonate; no sustained bubbling would support sodium chloride.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would put a measured amount of the mystery powder in a measured amount of cool water and stir for the same length of time used with labeled samples of each powder. I would record whether each sample dissolves. Then I would place fresh, equal-sized portions on separate dishes and add the same number of iodine drops to each. A powder that does not dissolve and turns blue-black matches cornstarch; one that dissolves and does not turn blue-black matches citric acid.

Accept identifications supported by the stated test results. For Your Turn, accept other fair procedures that use both properties and keep test conditions consistent.