The Bubble Race

Use reaction evidence to explain changes in rate.

HS-PS1-5 "Construct an explanation based on evidence about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs. (SEP: 6; DCI: PS1.B; CCC: Patterns)"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the evidence that shows how fast each reaction ran. Circle the conditions that changed between trials so you can use fair comparisons in your answers.

What Makes Bubbles Form Faster?

1. A science club wanted to know what makes a fizzing reaction run faster. Members mixed citric acid solution with baking soda solution in a sealed container. The reaction produced carbon dioxide gas, which flowed into a gas syringe. The club measured how much gas collected during the first 10 seconds after mixing. More gas in that time meant a faster reaction. In every trial, members used the same volumes of each solution and the same concentration of baking soda. They changed only the temperature and the concentration of the citric acid solution.

2. The club ran four trials. With dilute acid at 15°C, the syringe collected 8 mL of gas in 10 seconds. With dilute acid at 35°C, it collected 16 mL. With concentrated acid at 15°C, it collected 15 mL. With concentrated acid at 35°C, it collected 29 mL. These measurements show a pattern: both warmer conditions and a higher acid concentration were linked to faster gas production. Comparing trials that differ in just one condition makes it easier to explain which change affected the reaction rate.

3. A chemical reaction occurs when reacting particles collide in a way that allows them to react. At a higher temperature, particles move faster, and more of their collisions have enough energy for a reaction. At a higher concentration, more acid particles occupy the same volume, so they can collide with baking soda particles more often. A gas syringe measures gas collected, not collisions themselves. Still, its readings provide evidence about reaction rate when the club uses the same equipment and measures each trial over the same short time.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare the two dilute-acid trials. How did changing temperature affect the rate? Support your explanation with the gas measurements.

2. Compare the two trials at 15°C. What evidence shows the effect of changing acid concentration, and how do particles explain it?

3. Which pair of trials best tests the effect of temperature when the acid is concentrated? Explain why this is a fair comparison and cite the results.

4. A student says acid concentration made no difference at 35°C. Use evidence and particle collisions to evaluate the claim.

3 YOUR TURN

Your own words

In a new test, identical chalk chips react with equal volumes of vinegar at the same temperature. Concentrated vinegar produces 12 mL of gas in the first 15 seconds, while dilute vinegar produces 5 mL. In three or four sentences, explain this result using particle collisions, predict what warming only the dilute vinegar would do to its reaction rate, and name one condition to keep the same when testing that prediction.

ANSWER KEY

The Bubble Race

HIGH SCHOOL · HS-PS1-5

PART 1 · READ AND MARK

Underline the evidence that shows how fast each reaction ran. Circle the conditions that changed between trials so you can use fair comparisons in your answers. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare the two dilute-acid trials. How did changing temperature affect the rate? Support your explanation with the gas measurements.	**Raising the temperature from 15°C to 35°C increased the rate. Gas collected in 10 seconds rose from 8 mL to 16 mL, consistent with faster particles making more effective collisions.**
2	Compare the two trials at 15°C. What evidence shows the effect of changing acid concentration, and how do particles explain it?	**Concentrated acid produced 15 mL of gas, compared with 8 mL for dilute acid. More acid particles in the same volume can collide with baking soda particles more often.**
3	Which pair of trials best tests the effect of temperature when the acid is concentrated? Explain why this is a fair comparison and cite the results.	**Compare concentrated acid at 15°C and 35°C. Acid concentration stays the same while temperature changes, and gas collected rises from 15 mL to 29 mL.**
4	A student says acid concentration made no difference at 35°C. Use evidence and particle collisions to evaluate the claim.	**The claim is not supported. At 35°C, concentrated acid produced 29 mL of gas in 10 seconds, while dilute acid produced 16 mL. More acid particles in the same volume allow more frequent collisions.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The concentrated vinegar reacted faster because it produced 12 mL of gas in 15 seconds, compared with 5 mL from the dilute vinegar. More reacting acid particles in the concentrated vinegar could collide with the chalk more often. Warming the dilute vinegar should increase its reaction rate because its particles would move faster and make more effective collisions. To test that prediction, I would use identical chalk chips in both trials.

Accept explanations that connect the measured gas produced in a fixed time to reaction rate and use particle collisions to explain the effect of temperature or concentration. For Your Turn, a valid control could be chalk chip size, vinegar volume, vinegar concentration, or measurement time.