When pH Shifts

Use evidence from a lab test to evaluate a buffer.

CHE.9.6 "Enrichment: Obtain, evaluate, and communicate information about how buffers stabilize pH in acid-base reactions."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two pH comparisons that show how well the buffer works, circle the substances that react with added acid or base, and number the two statements in the last paragraph that limit what the results show.

A Dye Test That Depends on pH

1. During a lab test, a color-changing dye must stay near pH 4.8 to give a dependable reading. A student prepares two clear solutions at pH 4.8. One contains acetic acid and its conjugate base, acetate, dissolved from sodium acetate. The other is water adjusted to the same starting pH with a little acid. Both look alike, but their chemical makeup differs. Acetic acid is a weak acid, so only some of its molecules release hydrogen ions into the solution. Acetate can accept hydrogen ions. Together, these substances form a buffer, a mixture that resists changes in pH.

2. The student divides each solution into fresh, equal portions. To one portion of each, she adds the same small amount of strong acid. The buffered portion changes from pH 4.8 to 4.7, while the adjusted water changes from 4.8 to 3.9. In the buffer, acetate reacts with many of the added H^+ ions to make acetic acid. This removes some free H^+ ions that would otherwise drive pH down. The small pH shift does not mean nothing happened. It shows that the buffer reduced the change under these test conditions.

3. She then adds the same small amount of strong base to separate, unused portions. The buffer rises from pH 4.8 to 4.9, but the adjusted water rises from 4.8 to 6.0. Acetic acid donates H^+ ions that react with added OH^- ions to form water, so the pH rises less. These comparisons support the claim that this buffer stabilizes pH against small additions of acid or base. They do not show that its pH never changes. If enough acid or base is added, one buffer component can be used up, and pH may shift sharply.

2 ANSWER WITH EVIDENCE

Use the passage

1. After acid was added, which solution had the smaller pH change? Use both pH results to support your answer.

2. Explain how acetate helps account for the result when acid is added to the buffer.

3. Use the base-addition results and the action of acetic acid to explain how the buffer responds to added base.

4. A student claims, “This buffer holds pH at exactly 4.8, no matter how much acid or base enters.” What evidence and limit in the passage challenge that claim?

3 YOUR TURN

Your own words

A greenhouse team wants irrigation water to stay near a chosen pH when small amounts of acid or base enter it. In 4 to 5 sentences, propose a fair test of buffered and unbuffered water, predict the results, explain what each buffer component would do, and state a limit of the test's conclusion.

When pH Shifts

PART 1 · READ AND MARK

Underline the two pH comparisons that show how well the buffer works, circle the substances that react with added acid or base, and number the two statements in the last paragraph that limit what the results show. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	After acid was added, which solution had the smaller pH change? Use both pH results to support your answer.	**The buffer changed by 0.1 pH unit, from 4.8 to 4.7. The adjusted water changed by 0.9, from 4.8 to 3.9.**
2	Explain how acetate helps account for the result when acid is added to the buffer.	**Acetate accepts added H^+ ions to form acetic acid, reducing the amount of free H^+ that would lower pH.**
3	Use the base-addition results and the action of acetic acid to explain how the buffer responds to added base.	**The buffer rose by 0.1 pH unit, compared with a rise of 1.2 in the adjusted water. Acetic acid supplies H^+ ions that react with added OH^- ions, limiting the rise.**
4	A student claims, "This buffer holds pH at exactly 4.8, no matter how much acid or base enters." What evidence and limit in the passage challenge that claim?	**The buffer's pH changed to 4.7 with acid and 4.9 with base, so it did not stay at 4.8. Enough added acid or base can use up a buffer component and cause a sharp pH change.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would prepare equal volumes of buffered and unbuffered irrigation water at the same starting pH. I would add equal small amounts of acid to fresh portions and compare their pH changes. I would repeat the comparison with base in unused portions. The buffer should change less in both tests because its base component accepts added H^+ ions, while its weak acid component supplies H^+ ions to react with added OH^- ions. The results would show how the buffer handles these small additions, not whether it works after unlimited additions.

Accept equivalent descriptions of the two buffer components without chemical formulas. A fair test keeps starting pH, sample volume, and the amount added the same for each comparison.