

Can You Spot the Buffer?

Target Audience: Students being introduced to pH and buffers

Estimated Time: 10-20 minutes

How can we use changes in pH to determine whether a solution acts as a buffer?

Learner Activity:

1. Before analyzing the data, predict what will happen to the pH of a solution when an acid or a base is added. What would you expect to see if the solution was a buffer?
2. Analyze the following data:

A student is testing three unknown solutions to figure out which one acts as a buffer. They record the starting pH of each solution, then add the same amount of acid or base to separate samples of each solution and record the pH after each addition. The following data is collected:

Unknown Solution	Starting pH	pH after adding acid	pH after adding base
A	7.0	3.2	10.8
B	8.0	7.8	8.3
C	4.0	1.9	6.8

Using the table above answer the following questions:

- a) Which solution has the largest changes in pH?
 - b) Which solution has the smallest changes in pH?
 - c) What patterns do you notice?
 - d) Which solution is most likely a buffer? Use evidence from the data to explain your reasoning.
3. Based on the data, do buffers stop pH from changing at all? Hypothesize what it means for a solution to “resist” a change pH?

Instructor Guide:

Purpose: This activity helps learners understand that buffers resist changes in pH when acid or base is added. Students get to use a data set to identify a buffer and explain their conclusion using evidence.

Materials: All that is needed to complete this activity is access to the provided data set. The activity could be presented using a worksheet, whiteboard, slideshow, or other format that works for the specific learning environment.

Facilitations notes: The facilitator should begin by introducing the scenario and the inquiry question. Before showing the data, have students make an individual prediction and then briefly discuss their reasoning with a partner or group.

The facilitator can then present the data and give students time to analyze, identify patterns and discuss their observations. This can be done in small groups to allow dialogue around different reasonings. Encourage students to use the data when presenting their conclusions.

After students have explained their reasoning, use the final reflection question to dive deeper into what a buffer is and what it means for it to “resist” changes in pH.

Expected responses:

1. Students will likely predict that adding acid lowers pH and adding base raises pH. They should predict that a buffer will show smaller changes in pH than a solution that is not a buffer.
2. a) Solution A
b) Solution B
c) Could observe that acid lowers and base raises pH or that solutions A and C show much larger pH changes (this answer will vary depending on what different students notice)
d) After analyzing the data, students should conclude that **Solution B** is most likely the buffer because it shows the smallest pH changes with acid and base additions.
3. Students should recognize that the pH of Solution B still changed slightly and therefore a buffer does not **prevent** changes in pH, it **resists** them. Discussions could lead to the conclusion that this is because when adding an acid or base to a buffer it is being neutralized, therefore decreasing the amount of pH change. The idea that different buffers vary in what pH range they can stabilize and how much acid or base can be added before the pH will change more could be brought up as well.

Safety notes: No safety concerns are expected during this activity. No extra precautions need to be taken other than normal classroom protocols because students are analyzing a provided data set, rather than handling chemicals directly.

Accessibility notes: Provide the data in a format that works for all different learners, such as a large print data table or verbally describing the data. Students could complete the activity through written responses, oral presentations or group discussions.

Connection to SDG 4: This activity supports SDG 4: Quality Education by providing an active learning environment where students use evidence to answer a scientific question rather than simply memorizing the definition of a buffer. Students practice interpreting data, explaining their reasoning, and coming to their own conclusions which supports scientific literacy and evidence-based thinking. This hands-on learning activity helps build connections between observation and explanation, providing real world examples to deepen student understanding.

References:

1. Openstax. (2019). 4.4 *Acid-base reactions and buffer solutions*. In *Principles of Chemistry*. Thompson Rivers University.

<https://principlesofchemistryopencourse.pressbooks.tru.ca/chapter/4-4/>

2. Pietri, J., & Land, D. (2023). *Introduction to buffers*. Chemistry LibreTexts.

[https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_\(Physical_and_Theoretical_Chemistry\)/Acids_and_Bases/Buffers/Introduction_to_Buffers](https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Acids_and_Bases/Buffers/Introduction_to_Buffers)

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