Activity: What are Buffers?

FOR THE TEACHER

Summary
In this activity, students will complete a card sort that will allow them to understand what makes up a buffer solution and how it works to keep pH from changing.

Grade Level
High School

AP Chemistry Curriculum Framework
This activity supports the following unit, topics and learning objectives:

- **Unit 8: Acids and Bases**
  - **Topic-8.8:** Properties of Buffers
    - **SAP-10.B:** Explain the relationship between the ability of a buffer to stabilize pH and the reactions that occur when an acid or a base is added to a buffered solution.
  - **Topic-8.9:** Henderson-Hasselbalch Equation
    - **SAP-10.C:** Identify the pH of a buffer solution based on the identity and concentrations of the conjugate acid-base pair used to create the buffer.

Objectives
By the end of this activity, students should be able to

- Identify a conjugate acid-base pair and determine which one is the acid and which one is the base.
- Write a chemical equation for the reaction of a strong acid to a buffer.
- Write a chemical equation for the reaction of a strong base to a buffer.
- Explain how a buffer is able to resist changes in pH, regardless of whether an acid or a base is added.
- List two examples of buffers in their everyday life.

Chemistry Topics
This activity supports students’ understanding of

- Acid and bases
- Buffers
- pH
- Conjugate acid-base pairs
- Bronsted-Lowry reaction

Time
Teacher Preparation: 1 hour (if cards need to be cut)
Lesson: 25 minutes

Materials
- Set of activity cards for each group of students (download file)

Safety
- No specific safety precautions need to be observed for this activity.

Teacher Notes
- This activity will require a longer amount of teacher preparation the first time (~1 hour) since you will have to cut out the cards.
• Place each set of cards in a Ziploc bag with a number on the bag. On the back of each card, write that same number. If one of the cards is found on the floor, you can easily put it back in the right spot.
• If students are working at lab tables on the card sort, you can walk around and check what they have completed and ask them guiding questions as needed. You can use whatever size groups you prefer, but I like having 3-4 in a group so they have more academic conversations.
• Groups will finish at different times, so make sure you have something for them to do when they finish. I tell them that they can do another reaction if they want until they all are confident with the concept.
• If possible print the cards in color, since the directions tell them what to do based on the color of the font. If a color printer is not available you can print the cards on different colored card stock, or put the reaction cards (the +, →, NaOH, HCl, and ions) in a separate bag.
• You may want to have students write down their answers from the card sort for future reference.
• Differentiation: In lower levels where you do not teach buffers, you could have students do just steps 1-3. It would be helpful to model an example first.
• For additional questions and information about buffers you can visit this site. Before doing this activity, students should be able to label a Bronsted-Lowry acid base reaction (acid, base, conjugate acid and conjugate base). Students should know the definition of a buffer and have a basic understanding of how it works. Finally it would be helpful if students have solved pH problems of acidic and basic salts.
• I do not have students record anything in the activity, unless they want to, but you can easily tell them to copy the cards for each step after you have checked it.

FOR THE STUDENT

Lesson

What are Buffers?

Background

Buffers are substances that minimize changes in concentration of ions, either H⁺ ions or OH⁻ ions. A buffer solution is that which resists changes in pH and whose pH is not altered to any great extent by the addition of small quantities of either strong acid (H⁺ ions) or a strong base (OH⁻ ions).

Pre-lab Questions

1. Find two examples of buffers from your everyday life.
2. What is a conjugate acid-base pair?

Objective

Sort the given cards into conjugate acid-base pairs. Identify which is the acid and which is the base in the pair. Finally, select a conjugate acid-base pair and use the cards to make a reaction with the strong acid and a then use different pair to react with the strong base.

Procedure

1. Pair the black cards up into conjugate acid-base pairs
2. Figure out which is the base and which is the acid in each conjugate acid-base pair and put them under the correct purple headings of “acid” and “base.”
3. Ask the teacher to check your work.
4. Pick one conjugate acid-base pair and use the green cards to show the equation that would take place when HCl is added to the buffer.
5. Pick one conjugate acid-base pair and use the green cards to show the equation that would take place when NaOH is added to the buffer.
6. Ask the teacher to check your work.

**Conclusion**
1. If given a mixture of KC$_2$H$_3$O$_2$ and HC$_2$H$_3$O$_2$, write a reaction when KOH is added.
2. If given a mixture of KC$_2$H$_3$O$_2$ and HC$_2$H$_3$O$_2$, write a reaction when HBr is added.
3. Explain how a buffer resists changes in pH. Use examples from the activity to help you explain.