Name _____ Date _____ Period _____

ZornScience
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pH and Buffer Virtual Lab

Chemistry and AP Chemistry

Open activities.zornscience.org/ph-buffer-lab/ and follow each step. Record pH to two decimal places, as the lab shows it.

Objective

Use the pH and Buffer Lab to compare strong and weak acids and bases, build buffers with the Henderson-Hasselbalch equation, and test how water and a buffer respond to added acid. Find what limits a buffer's capacity.

NGSS alignment

HS-PS1-6 (changes to a system at equilibrium). Practices: planning and carrying out investigations, analyzing and interpreting data, using mathematics. Crosscutting concept: stability and change.

AP alignment

Topics 8.1, 8.2, 8.3, 8.8, 8.9, 8.10. Skills 2.D, 5.F, 6.G.

Meet the simulation

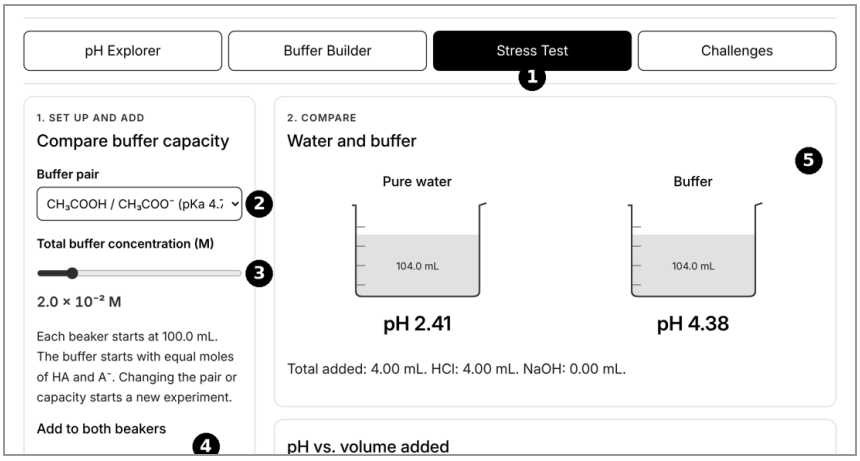


Figure 1. The Stress Test. (1) Mode tabs: pH Explorer, Buffer Builder, Stress Test, Challenges. (2) Buffer pair. (3) Total buffer concentration, which sets the capacity. (4) Buttons that add 0.1, 1.0, or 5.0 mL of 0.10 M HCl or NaOH to both beakers. (5) The pH of each beaker. Below these are the pH graph, the moles of HA and A^-, and a data table you can copy.

Pre-lab

1. Define a strong acid, a weak acid, and a buffer.

2. Predict the pH of 0.010 M HCl. Will 0.010 M CH_3COOH have a higher or lower pH? Why?

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3. A buffer has equal concentrations of CH_3COOH and CH_3COO^- ($pK_a = 4.74$). Use Henderson-Hasselbalch to predict its pH.

Part A. pH Explorer

4. Choose the pH Explorer tab. Set each solute and concentration, then record the pH and % ionized. Then answer: what happens to the % ionized of CH_3COOH when it is diluted from 0.10 M to 0.0010 M? How do strong acids compare?

Solute	Concentration (M)	pH	% ionized
HCl	0.10		
HCl	0.0010		
CH_3COOH	0.10		
CH_3COOH	0.0010		
HClO	0.10		
NaOH	0.10		
NH_3	0.10		

5. Select CH_3COOH at 0.10 M and check Show student method. Record the shortcut pH, the exact pH, and x/C. Repeat for HF at 0.20 M. When is the shortcut $x = \sqrt{(K_a \times C)}$ good enough?

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Part B. Buffer Builder

6. Choose Buffer Builder and the CH_3COOH / CH_3COO^- pair. Set each pair of concentrations and record the pH. Then answer: what happens to the pH when both concentrations are divided by 10? What happens when there is more base than acid?

[CH_3COOH] (M)	**[CH_3COO^-] (M)**	**pH**
0.10	0.10	
0.10	0.30	
0.30	0.10	
0.010	0.010	

7. You need a buffer at pH 9.00. Which pair should you choose: acetate (4.74), phosphate (7.21), or ammonium (9.25)? What ratio [NH_3]/[NH_4^+] do you need? Check it in the lab.

Part C. Stress Test

8. Choose Stress Test, the acetate pair, and 0.020 M total buffer. Add HCl and record both pH values at each volume. Then press Reset, set the total buffer to 0.20 M, and record the buffer pH again.

HCl added (mL)	**0**	**1.0**	**2.0**	**5.0**	**8.0**	**10.0**	**12.0**
pH water							
pH buffer, 0.020 M							
pH buffer, 0.20 M							

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9. Look at the 0.020 M buffer row. Near what volume does it stop working? Use the moles of CH_3COO^- in the buffer (shown in the lab) to explain that volume.

10. Write the net ionic equation for the reaction that happens in the buffer when HCl is added, and when NaOH is added.

Analysis

11. Compare the 0.020 M and 0.20 M buffers. Did they start at the same pH? Which has more capacity, and about how many mL of HCl would it take to use it up?

12. A buffer has more CH_3COO^- than CH_3COOH. Is it better at absorbing added acid or added base? Explain.

13. Blood is buffered by H_2CO_3/HCO_3^- (pK_a = 6.35 in this lab). What ratio $[HCO_3^-]/[H_2CO_3]$ gives pH 7.40? Try it in Challenges.

14. Name two sources of error if you made and tested this buffer in a real school lab.

Conclusion

15. Write a claim, evidence, and reasoning: why does a buffer resist changes in pH, and what limits how much acid it can absorb?

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