FLINN SCIENTIFIC

Name____________________

Properties of Buffers

Observations and Results

Data Table 1. *Initial pH and Indicator Colors*

Solution	1	2	3	4	5	6
	Reference (Acetic Acid)	Buffer Solution A	Buffer Solution B	Buffer Solution C	Reference (Sodium Acetate)	Control (Distilled Water)
measured pH (pH paper)					7.5	6–7
bromcresol green indicator color						
congo red indicator color						

Data Table 2. *Effect of HCl Addition*

	Solution	1	2	3	4	5	6
Row	Indicator Color (Bromcresol Green)	Reference (Acetic Acid)	Buffer Solution A	Buffer Solution B	Buffer Solution C	Reference (Sodium Acetate)	Control (Distilled Water)
A	initial					7.5	6–7
B	5 drops HCl						*1 drop HCl
C	10 drops HCl						
D	20 drops HCl						

Data Table 3. *Effect of NaOH Addition*

	Solution	1	2	3	4	5	6
Row	Indicator Color (Congo Red)	Reference (Acetic Acid)	Buffer Solution A	Buffer Solution B	Buffer Solution C	Reference (Sodium Acetate)	Control (Distilled Water)
A	initial					7.5	6–7
B NaOH	5 drops NaOH						*1 drop
C	10 drops NaOH						
D	20 drops NaOH						

Post-Lab Calculations, Analysis, and Questions

(Use a separate sheet of paper to answer the following questions.)

1. Use the buffer equation to calculate the expected $[H_3O^+]$ and pH values for buffer solutions A, B, and C. Compare the calculated values against the experimental data (Data Table 1) for Buffers A, B, and C (*Hint:* The concentrations of the acetic acid and sodium acetate solutions are the same, and the total volume of the buffer solutions is constant. Therefore, the volume of each component used to prepare the buffer can be substituted directly into the concentration ratio expression in Equation 5). See sample calculation below.

$$[H_3O^+] = K_a \times \frac{[HA]}{[A^-]}$$

Buffer A (9 mL HA/3 mL A^-) $[H_3O^+] = 1.76 \times 10^{-5} \times (9/3) = ?$ $\qquad$ $pH = -\log[H_3O^+]$

2. Summarize from Data Table 2 the number of drops of HCl required to change the color of buffer solutions A, B, C and the distilled water control to yellow (the acid reference color).
3. Did all of the buffer solutions exhibit buffering activity with respect to added HCl in Part 2? Explain. Which buffer solution was most effective with respect to added acid? Explain.
4. The behavior of solution 5 in Data Table 2 demonstrates that a buffer can be made by partial neutralization of the basic component A^- with HCl. (a) Write an equation for the neutralization reaction of sodium acetate in solution 5 upon addition of HCl. (b) Describe and explain the significance of the color changes observed for solution 5 in Data Table 2.
5. Summarize from Data Table 3 the number of drops of NaOH required to change the color of buffer solutions A, B, C and the distilled water control to orange (the base reference color).
6. Did all of the buffer solutions exhibit buffering activity with respect to added NaOH in Part 3? Explain. Which buffer solution was most effective with respect to added base? Explain.
7. The behavior of solution 1 in Data Table 3 demonstrates that a buffer can be made by partial neutralization of the acidic component HA with NaOH. (a) Write an equation for the neutralization reaction of acetic acid in solution 1 upon addition of NaOH. (b) Describe and explain the significance of the color changes observed for solution 1 in Data Table 3.
8. Which buffer solution has the composition of a so-called "ideal buffer?" Do the results in Data Tables 2 and 3 support the conclusion that this buffer is an ideal buffer? Explain.
9. Based on the results and analysis obtained in this lab, estimate the effective pH range of acetic acid–sodium acetate buffer solutions.