Lab G3 (pg 1 of 4) Buffers

Name_____Per___

Introduction:

Buffers are important solutions to acid base chemistry. Let's investigate what they are, how they work, what reactions happen inside a buffer, how to calculate the pH, and what are the ways we can make a buffer?

Reactions

1. What is a buffer?

2. What chemicals must be in a buffer for that buffer to accomplish the purpose of a buffer?

3. Suppose you had 200. ml of a 0.30 M solution of HF (weak or strong acid?).
   a. Is this a buffer solution? Why or why not?

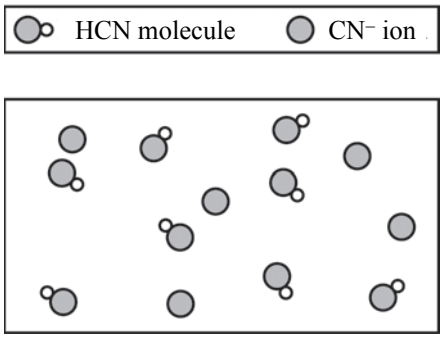
   b. Write a net ionic equation that represents the dissociation of HF in water.
   (You can show the water in your reaction or not, your choice.)

   c. What mass of sodium fluoride would you need to dissolve in 200. ml of a 0.30 M of HF solution (assume no volume change) to produce a buffer equally capable of neutralizing both acid and base.

   d. What is the pH of the buffer described in part (c)? (K_a of HF is 6.8×10^{-4})

   e. Write a net ionic equation that represents the reaction that occurs to help maintain a constant pH if NaOH were added to the buffer described in part (c).

   f. Write a net ionic equation that represents the reaction that occurs to help maintain a constant pH if HCl were added to the buffer described in part (c).



4. Consider a solution made with hydrocyanic acid, HCN as one of the ingredients. A particulate representation of a small representative portion of the buffer solution is shown below. (Cations and water molecules are not shown.)
The K_a of HCN is 5.0×10^{-10}.

   a. Is this solution a buffer? Why or why not?

Put your calculators away!!!

   b. Estimate (no calc the pH of this solution?

   c. If this solution is made with an acid, HCN, why is the pH basic?

   d. If this solution were made with equal quantities of HCN and CN^- would the pH be higher or lower than the pH estimate in part (b)?

   e. Why can you not make a buffer of pH = 7 using hydrocyanic acid?

   f. Given the three weak acids in the table to the right, which weak acid and its conjugate salt would be best for making a buffer solution closest pH 7.00 ? Justify your response.

Acid	K_a	pK_a
cyanic acid, HOCN	3.5×10^{-4}	3.46
hypochlorous acid, HOCl	3.0×10^{-8}	7.52
ammonium chloride, NH_4Cl	5.6×10^{-10}	9.25

   g. To make the buffer you chose for part (f) which particle, the acid or its conjugate base would you need to increase to adjust the pH to exactly 7.00 ?

Break out your calculators.

5. We are going to make a buffer made of **equal moles** of acetic acid, $HC_2H_3O_2$ and acetate ion. K_a 1.8×10^{-5}

   a. Calculate the pH of this buffer with equal acid and base buffering ability. Justify your answer, showing any calculations.

   b. Suppose I gave you 0.091 M acetic acid and access to solid anhydrous sodium acetate (MM = 82.034 g/mol). Describe how you could make up a buffer with the pH you calculated in part (a). You may not use more than 40 ml of the acetic acid, but you must end up with more than 20 ml but less than 45 ml of solution.
   Show your work clearly in the space below.

   c. Suppose gave you 0.091 M acetic acid and 0.112 M NaOH. Describe how you could make a buffer with the pH you calculated in part (a). You may not use more than 40 ml of the acetic acid, but you must end up with more than 20 ml but less than 45 ml of solution. *Show your work clearly in the space below.*

After you have a plan for both methods, you will be assigned one method or the other, and head to the lab to make up your solution. Finished with this? Take the challenge on the next page.

6. This time we would like to shift the pH of the same buffer system slightly to produce different pH values. Again using acetic acid, K_a 1.8×10^{-5}

   a. Suppose I gave you 0.091 M acetic acid and access to solid anhydrous sodium acetate (MM = 82.034 g/mol). Describe how you could make up a buffer with the pH of 5.00 You may not use more than 40 ml of the acetic acid, but you must end up with more than 20 ml but less than 45 ml of solution. *Show your work clearly in the space below.*

   b. Suppose gave you 0.091 M acetic acid and 0.112 M NaOH. Describe how you could make a buffer with the pH of 4.20 You may not use more than 40 ml of the acetic acid, but you must end up with more than 20 ml but less than 45 ml of solution. *Show your work clearly in the space below.*