

## Work Session 19: Ionic Equilibria

1. Explain why sodium acetate and acetic acid together in solution make a buffered solution, but sodium chloride and hydrochloric acid do not make a buffered solution when mixed.
2. Write the appropriate other component for the following substances to make a buffered system. Write the other component below the printed one. If one of the components is shown as an ionic compound with a cation or anion attached, rewrite the substance as the ion that is the actual component of the buffer.  

HIO	NaCN	$C_5H_5NH^+$	HF	$NH_4Cl$	$KNO_2$
-----	------	--------------	----	----------	---------
3. What would you use to get a buffer system with a pH of around 4.2. What would you use to make a buffer with a pH of around 9.2? Describe the process you used.
4. A buffer is made by mixing  $NH_4Cl$  and  $NH_3$ . Which is the acid component and which is the base component? What is the  $K_a$  for the  $NH_4^+$  ion (calculate from the  $K_b$  of its conjugate base)?
5. A buffer is made by mixing 0.30 moles of propanoic acid,  $HC_3H_5O_2$ , and 0.20 moles of sodium propanoate,  $Na C_3H_5O_2$ . What will the pH of the solution be? Note that the formulas are shown in condensed form here.  $K_a$  for propanoic acid is  $1.3 \times 10^{-5}$ .
6. For the mix in question 5, show the reaction that takes place when a strong acid is added to the solution. Show the reaction that takes place when a strong base is added to the solution.
7. When a strong acid is added to a buffer solution, does the pH of the buffer go up or down? Use the Henderson-Hasselbalch equation to explain why this is so. Also use this to explain what happens when a strong base is added to the buffer.

8. Finish and balance the following:  
 $\text{HCl} + \text{NaOH} \rightarrow$   
 $\text{HC}_2\text{H}_3\text{O}_2 + \text{NaOH} \rightarrow$   
 $\text{NH}_3 + \text{HCl} \rightarrow$
- Show each of the ionic products written out as individual ions. Indicate whether the ions would be acidic, neutral, or basic.
9. The reactions in number 8 are for a strong acid/strong base, weak acid/strong base, and weak base/strong acid, respectively. The reactions shown, with equal moles of each substance reacting, occur at the equivalence point. Generalize about the pH at the equivalence point for these three types of titrations.
10. 20 ml of 0.100 M weak acid is titrated with a 0.100 M NaOH solution. Here is data showing the pH as various quantities of base are added:
- |    |      |       |       |       |
|----|------|-------|-------|-------|
| ml | 0 ml | 10 ml | 20 ml | 25 ml |
| pH | 2.37 | 3.74  | 8.22  | 12.05 |
- What is the  $K_a$  of the acid?
- Which of the above points is the equivalence point?
11. Silver sulfate,  $\text{Ag}_2\text{SO}_4$ , dissolves to the extent of 4.84 grams per liter. What is the  $K_{sp}$  of silver sulfate from this data?
12. Which of the following slightly soluble substances are more soluble in acidic solution:  $\text{AgCl}$      $\text{AgCN}$      $\text{CaF}_2$ ?  
Explain why.
13. 50.0 ml of a solution containing 0.010M  $\text{Pb}(\text{NO}_3)_2$  is mixed with 50.0 ml of a solution containing 0.10 M  $\text{NaCl}$ . What will the concentrations of  $\text{Pb}^{++}$  and of  $\text{Cl}^-$  be after the mixing?  $\text{PbCl}_2$  has a  $K_{sp} = 1.7 \times 10^{-5}$ . What is the value of Q for the lead and chloride ions? Will a precipitate form in the mixture? Why or why not.
14. The  $K_{sp}$  for  $\text{PbI}_2 = 7.9 \times 10^{-9}$ . What is the solubility of lead iodide in water? What is the solubility of lead iodide in a 0.10 M  $\text{NaI}$  solution