Chemistry 116 - Fall 2021
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Discussion Worksheet - Week 13

1. a) What is the pH of a 0.10 M formic acid (HCOOH) solution? $K_a = 1.8 \times 10^{-4}$. [2.38]

b) What is the pH of a solution containing 0.10 M HCOOH and 0.25 M NaHCOO? [4.14]

c) What ratio, $[HCOO^-]/[HCOOH]$, do you need to prepare a pH 4.00 buffer? [1.8]

d) How many moles of HCOOH and how many moles of NaHCOO do you need to prepare a liter of the buffer solution in part c) if $[HCOOH] + [HCOO^-] = 0.050$ M? [0.018, 0.032]

2. For each solution below choose the letter on the right corresponding to its pH range.

____ 1.0 M HF
____ 0.5 M NaF
____ 1.0 M HF and 0.5 M NaF
____ 0.5 M HF and 1.0 M NaF
____ 0.5 M HF and 0.5 M NaF

a) $pK_a + 1 < pH$
b) $pK_a < pH < pK_a + 1$
c) $pH = pK_a$
d) $pK_a - 1 < pH < pK_a$
e) $pH < pK_a - 1$

3. 500 mL of a pH=7.30 buffer solution is to be made from HClO ($K_a = 3.0 \times 10^{-8}$) and its sodium salt, NaOCl. How would the buffer be prepared from 0.250 M solutions of HClO and NaOCl if the buffer concentration ($[HClO]+[ClO^-]$) were to be 0.0400 M? [30 mL NaOCl, 50 mL HClO]

4. Two buffer solutions containing CH_3COOH and $NaCH_3COO$ are prepared. 0.10 mol of HCl is added to 1 L of each and to 1 L of distilled water. The following pH measurements were obtained.

	pH before HCl added	pH after HCl added
distilled water	7.0	1.0
buffer 1	4.7	2.7
buffer 2	4.7	4.3

a) Write the balanced net ionic equation that occurs when HCl is added to either buffer.

b) Explain why both buffers have the same pH before HCl is added.

c) Explain why buffer 1 has a lower pH than buffer 2 after HCl is added.

5. Solution A is a 2.0 M solution of a weak acid with $K_a = 4.6 \times 10^{-4}$. Solution B is a 0.50 M solution of NaOH.
a) What is the pH of solution A? [1.52]

b) What is the pH of solution B? [13.70]

c) Solution C is a mixture of 100 mL of solution A and 100 mL of solution B.

1) Is solution C a buffer? Why or why not?

2) What is the pH of solution C? [2.86]

3) What is the pH if 1 mL 2.0 M NaOH is added to solution C? added to 200 mL water? [2.88, 12.00]

4) What is the pH if 1 mL 2.0 M HCl is added to solution C? added to 200 mL water? [2.84, 2.00]

6. Fill in the following table by 1) indicating whether mixing equal volumes of the given molarities would (Y) or would not (N) give a buffer solution and 2) checking the appropriate pH range for each mixture. $K_a(CH_3COOH) = 1.76 \times 10^{-5}$, $K_a(NH_4Cl) = 5.6 \times 10^{-10}$.

	buffer (Y/N)	pH < 7	pH = 7	pH > 7
0.10 M CH_3COOH / 0.10 M NaOH				
0.20 M CH_3COOH / 0.10 M $NaCH_3COO$				
0.10 M NH_4Cl / 0.10 M NH_3				
0.10 M HCl / 0.10 M NaOH				
0.10 M HCl / 0.20 M NH_3				

7. What volume of 0.120 M NaOH must be added to 100 mL of 0.100 M $NaHC_2O_4$ to reach a pH of 4.70? $K_a(HC_2O_4^-) = 6.4 \times 10^{-5}$ [64 mL]

8. What volume of 0.200 M HCl must be added to 500 mL of 0.250 M $NH_3$to have a buffer with a pH of 9.00? $K_a(NH_4^+) = 5.6 \times 10^{-10}$ [400 mL]

9. Consider a mixture which is M_{HA} in the weak acid HA (K_a) and M_{NaA} in the sodium salt of its conjugate base NaA. Do a systematic treatment and give the equations needed to solve the system: a) **number** each required equation and b) **identify** what it is. **DO NOT SOLVE OR SIMPLIFY ANY EQUATIONS**.