Date: ______________________________

IV.19-20 Buffers

You will be able to:

- Describe the tendency of buffer solutions to resist changes in pH
- Describe the composition of an acidic buffer and a basic buffer
- Describe qualitatively how the buffer equilibrium shifts as small quantities of acid or base are added to the buffer; the stress being the change in the concentration of the stronger acid (H_3O^+) or base (OH-)
- Describe in detail a common biological buffer system
- Outline a procedure to prepare a buffer solution
- Identify the limitations in buffer systems

DEFINE: A **BUFFER** is a solution containing ____
____.

Purpose of a buffer:

- It ________________ changes in pH when ____.
- Or we could say it ____ when acid or base is added.

Ex: $WA + H_2O \rightleftarrows H_3O^+ + WCB^-$ *(WCB is "weak conjugate base")*

$CH_3COOH + H_2O \rightleftarrows H_3O^+ + CH_3COO^-$

K_a = __________________ = $[H_3O^+]$ = _________________

Therefore, **pH = pKa**

When _________________________________ of a weak acid and its conjugate base are added to water, the ____.

NOTE: A BUFFER requires **substantial** amounts of ___________________________________.

There are two kinds of **Buffer Solutions**:

- ***ACIDIC BUFFERS***: ____

  Acidic Buffers are useful as buffers in the acidic range (solutions in which pH is 7 or lower)

  Ex: "Mix 1.0 mol of CH_3COOH and 1.0 mol of $NaCH_3COO$ and dilute to 1.0 L solution."

  K_a = _____________________

  Buffer pH = pK_a = __________________________ = ______________

- ***BASIC BUFFERS***: ____

  Basic Buffers are useful as buffers in the basic range (solutions in which pH is 7 or higher)

  .... Ex: "Mix 1.0 mol of NH_3 and 1.0 mol of NH_4NO_3 and dilute to 1.0 L solution."

  K_a = _____________________

  Buffer pH = pK_a = __________________________ = ______________

Preparing a Buffer Solution:

Three concepts to consider:

- ______________________________________
- ______________________________________
- ______________________________________

Ex: Say you had some 1.0 M acetic acid (**CH_3COOH**) solution:

Original equilibrium: $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$

Now, lets add some sodium acetate (**$NaCH_3COO$**) to the equilibrium so that $[CH_3COO^-]$ is 1.0 M.

- When we do this the ___________________________. However, by *LeChatelier's Principle*, the equilibrium will shift to the _________, causing _____________________________ and ___________________________________.

Shifted equilibrium: $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$

Since the acid and the base are both *WEAK*, they don't neutralize each other like a mixture of a SA and SB would. They co-exist in this equilibrium unless disturbed! A **BUFFER SOLUTION** is prepared!

Example 38: How would you prepare a solution in which the pH is buffered close to 7.2?

Step 1: pH = pKa Calculate Ka of buffer	
Step 2: Find acid that has a similar Ka value (from BL table)	
Step 3: Prepare buffer by mixing equal amounts of WA and soluble salt of its conjugate base	

Explaining Buffer Equilibrium Shifts

Work through the example by filling in the blanks…..

Ex: A buffer solution is prepared using 1M NH_3 and 1M NH_4Cl *(Basic Buffer)*

a) Write the **equilibrium equation** describing this buffer.

____

b) When a small amount of HCl (SA) is added, the $[OH^-]$ quickly _______creases (the pH goes ______)

c) As a result, the equilibrium shifts to the _______________, and the $[OH^-]$ gradually _____creases. (the pH goes back __________________________)

d) So, as a result of adding HCl, there was a small **net** _____crease in the $[OH^-]$ (a small **net** ___ crease in pH)

Limitations of buffers:

A buffer cannot hold off pH change beyone its buffering capacity.

- If there is ___________ of conjugate base present, a maximum of __________ of H_3O^+ can be neutralized.
- If there is ___________ of conjugate acid present, a maximum of __________ of OH^- can be neutralized.

Biological buffers:

For Hemoglobin to work properly, the pH of the blood needs to stay very close to 7.35

Equilibrium: $HHb + O_2 \leftrightarrows H_3O^+ + HbO_2^-$

hemoglobin *oxyhemoglobin*

- If pH < 7.20 (**"ACIDOSIS"**), ____.
- If pH > 7.20 (**"ALKALOSIS"**), ____.

TWO BUFFER SYSTEMS:

a) CO_2/HCO_3^- : *buffers human blood plasma*

____

____

"Hyperventilating" will lower $[CO_2]$ in the blood, and ______________________

b) $H_2PO_4^-$ /HPO_4^{2-} : *buffers human cell cytoplasm*

____

Do Hebden set 33: p. 181 #132-133, 136-138, 140; p. 183