

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: $\text{WA} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{WCB}^-$ (*WCB is "weak conjugate base"*)
 $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^-$

$$K_a = \text{_____} = [\text{H}_3\text{O}^+] = \text{_____}$$

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."

$$K_a = \text{_____}$$

$$\text{Buffer pH} = \text{p}K_a = \text{_____} = \text{_____}$$

- **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."

$$K_a = \text{_____}$$

$$\text{Buffer pH} = \text{p}K_a = \text{_____} = \text{_____}$$

Preparing a Buffer Solution:

Three concepts to consider:

- _____
- _____
- _____

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



Now, lets add some sodium acetate (NaCH_3COO) to the equilibrium so that $[\text{CH}_3\text{COO}^-]$ is **1.0 M**.

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



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: $\text{pH} = \text{pKa}$ Calculate K_a of buffer	
Step 2: Find acid that has a similar K_a 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 $[\text{OH}^-]$ quickly _____ increases (the pH goes _____)

c) As a result, the equilibrium shifts to the _____, and the $[\text{OH}^-]$ gradually _____ increases. (the pH goes back _____)

d) So, as a result of adding HCl, there was a small **net** _____ increase in the $[\text{OH}^-]$ (a small **net** _____ increase in pH)

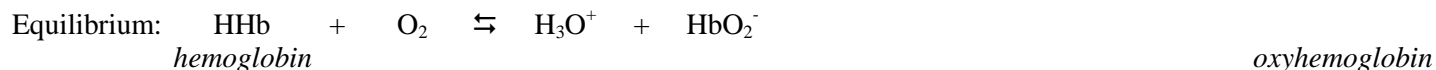
Limitations of buffers:

A buffer cannot hold off pH change beyond 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



- If $\text{pH} < 7.20$ (“ACIDOSIS”), _____.
- If $\text{pH} > 7.20$ (“ALKALOSIS”), _____.

TWO BUFFER SYSTEMS:

a) $\text{CO}_2/\text{HCO}_3^-$: buffers human blood plasma

“Hyperventilating” will lower $[\text{CO}_2]$ in the blood, and _____

b) $\text{H}_2\text{PO}_4^-/\text{HPO}_4^{2-}$: buffers human cell cytoplasm

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