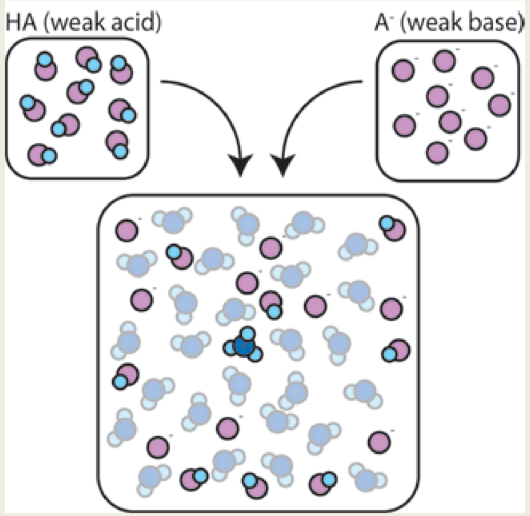
Preparation Of Buffer Solution

BCH 202 [Practical]

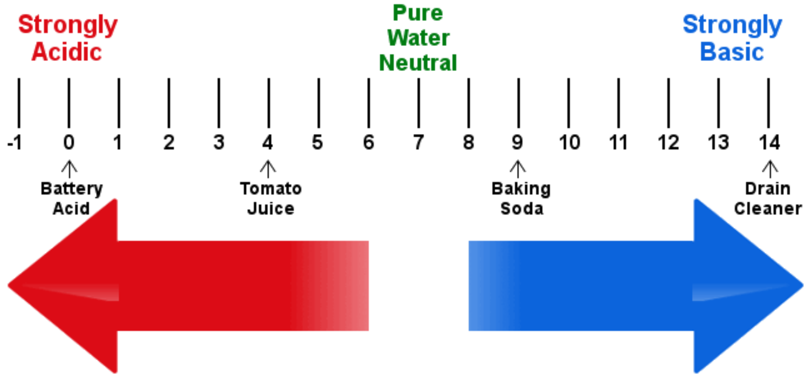


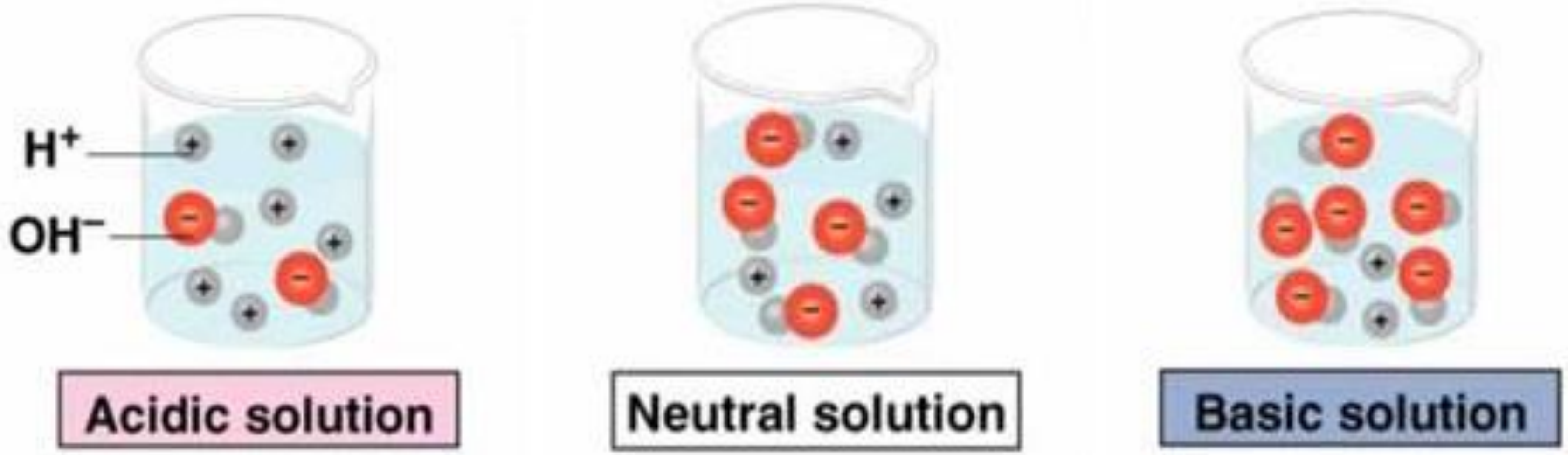
Hydrogen number pH

- The formula that **describe the acidity of certain solutions** by using hydrogen number pH can be defined as: **<u>The negative logarithm of the hydrogen ion concentration</u>**.

- $$\boxed{pH = -Log[H+]}$$

- **Notes**: the pH increase when the concentration of hydrogen ion decrease and vice versa.



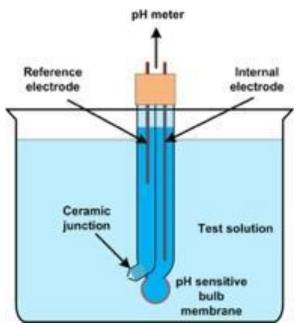

H+
OH−
Acidic solution
Neutral solution
Basic solution

Measuring of hydrogen number

- To measure the hydrogen number in certain solution in very accurate way, we use a special instrument called pH meter.

- It's consist of glass electrode which contain a very thin bulb, blown onto a hard glass tube. which is sensitive to pH.

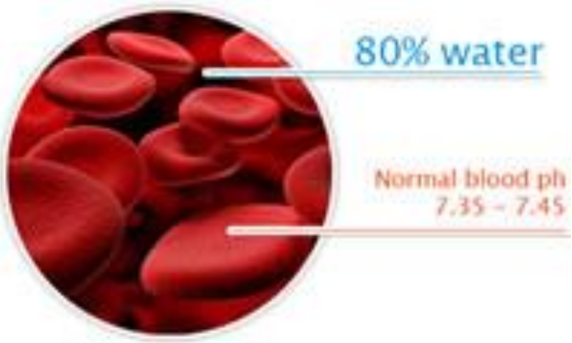
- The bulb contains a solution of hydrochloric acid and is connected to a platinum lead via silver - silver chloride electrode which is reversible with respect to hydrogen ions.

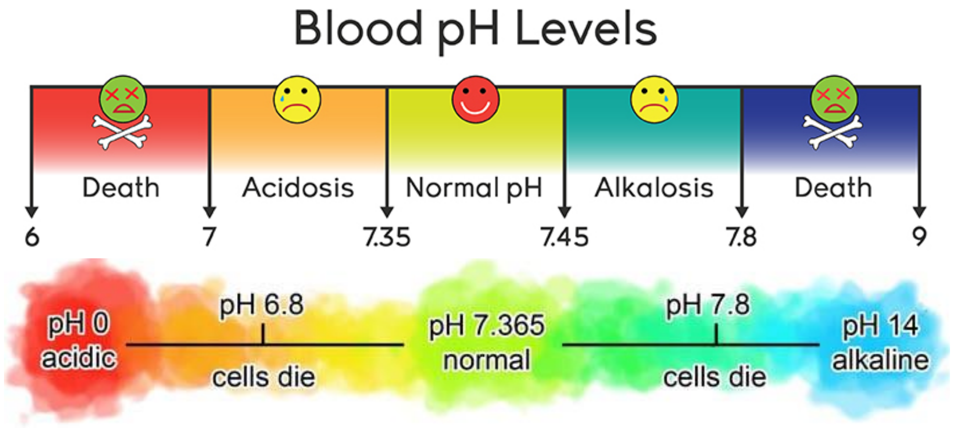


Introduction:

- All **biochemical reactions** occur under strict conditions of the **concentration of hydrogen ion**.
- **Biological life** cannot withstand large changes in hydrogen ion concentrations which we measure as the **pH**.

Those solutions that have the ability to **resist changes in pH** upon the addition of limited amounts of acid or base are called **Buffers**.

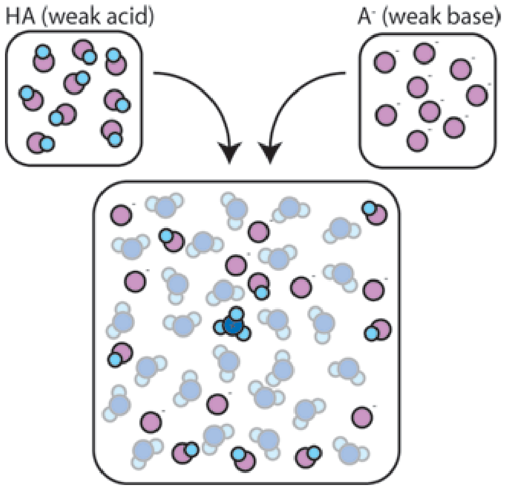


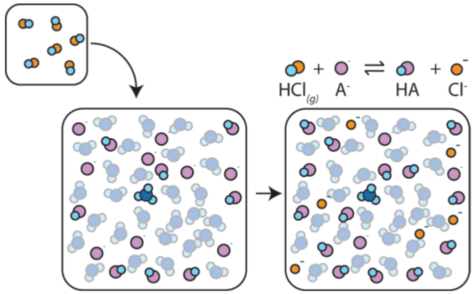


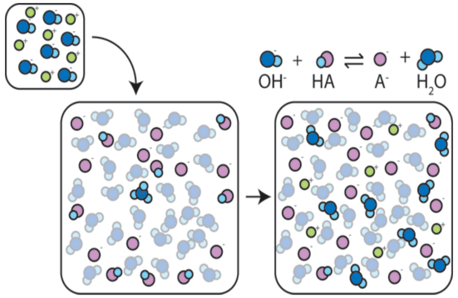
Buffers

- are solutions that have the ability to resist changes in pH. upon the addition of limited amounts of acid or base.

- A buffer is made up of a weak acid and its conjugate base. Or a weak base and its conjugate acid .







Mechanism of Action (Buffer):

How buffers can resist the change in pH?

Example using [HA/A-] buffer

HA: Weak acid. A-: conjugated base [its salt].

$$HA \rightleftharpoons H^+ + A^-$$

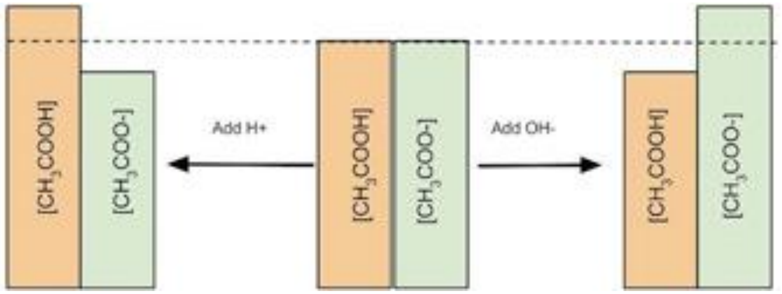
[a] If H+ is added to this buffer system → H+ will react with conjugated base→ to give conjugate acid.

$$A^- \xrightarrow{H^+} \quad A^- \rightleftharpoons HA$$

[b] If OH- is added to this buffer system [HA/ A-]→ OH will react with conjugated acid to give conjugate base and H2O.

$$HA \rightleftharpoons A^- + H_2O$$

Mechanism of Action (Buffer):



- **Example:**
- **Buffer system: CH3COOH / CH3COO- ,** (CH3COOH :acid - CH3COO-: conjugated base)

\- When acid [H+] added: $\longrightarrow$ CH3COO- + **H+** $\longrightarrow$ CH3COOH $\uparrow$

\- When base [OH] added: $\longrightarrow$ CH3COOH + **OH -** $\longrightarrow$ CH3COO- $\uparrow$ + H2O

- **NOTE**: It resists pH changes when it's two components are present in specific proportions.

- Thus a buffer can protect against pH changes from added H+ or OH- ion as long as there is **sufficient** basic and acidic forms respectively. As soon as you run out of one of the forms you no longer have a buffer .

Henderson-Hasselbalch equation

- The Henderson-Hasselbalch equation is an equation that is often used to:

1- To calculate the PH of the Buffer.

2-To prepare Buffer.

$$pH = pK_a + \log \frac{[A^-]}{[HA]}$$

- It relates the **Ka** [dissociation constant] of a weak acid , **[HA]** concentration Of weak acid , **[A-]** concentration Of conjugate base [salt of the weak acid] components and the **pH of the buffer**.

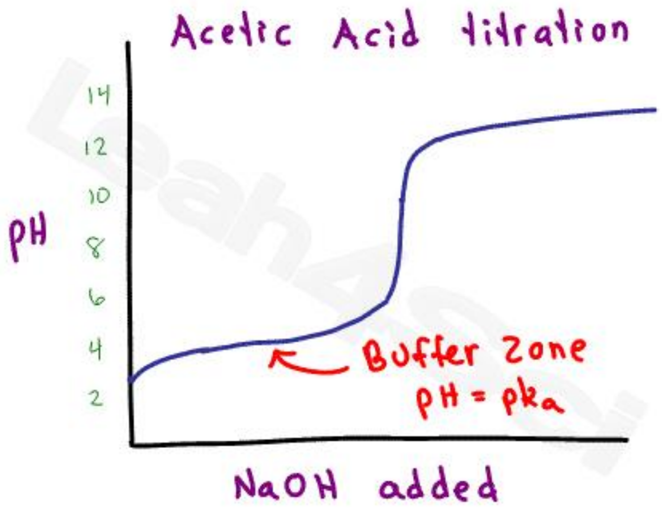
- A buffer is best used close to its pKa.[to act as a good buffer the pH of the solution must be within one pH unit of the pKa].

- The **buffer capacity** is optimal when the **ratio of the weak acid to its salt is 1:1**; that is, when **pH = pKa**

$$pH = pka + \log 1$$

$$pH = pka + 0$$

$$\boxed{pH = pka}$$



Buffer capacity

Quantitative measure of this resistance to pH changes is called **Buffer capacity**

- Buffer capacity can be defined in many ways, it can be defined as:

▶ The number of moles of H+/OH- ions that must be added to one liter of the buffer in order to decrease /increase the pH by one unit respectively.

- **Buffer capacity is directly proportional to the buffer concentration.**

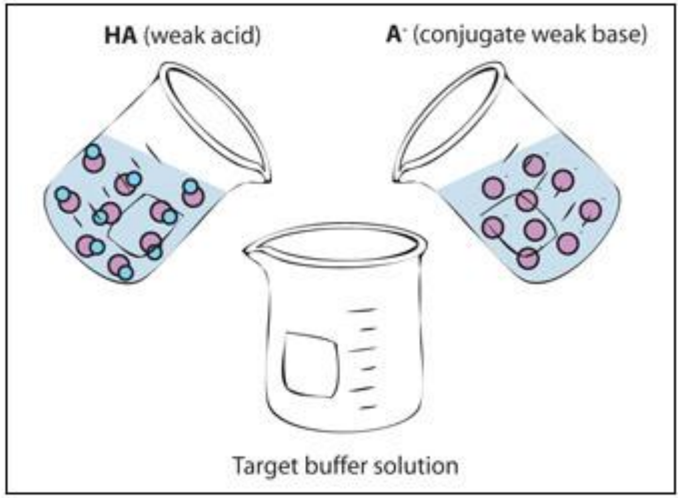
Practical Part

- Buffer solution preparation
- Studying the properties of buffer solutions

Objective:

1) To understand the nature of buffers solutions.

2) To learn how to prepare buffers.

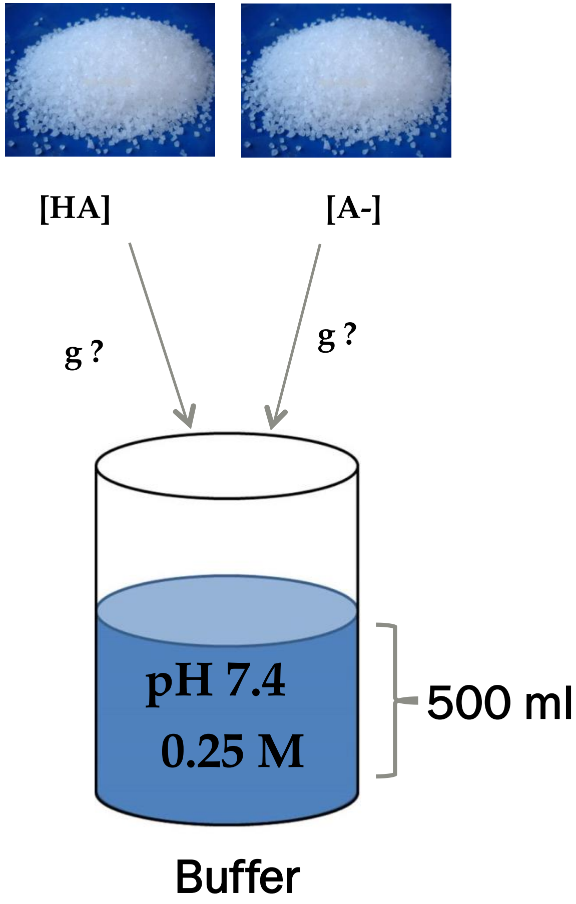


Preparation of phosphate buffer:

Example: Prepare 500ml from phosphate buffer with concentration 0.25M and pH= 7.4, if you know that (pKa=7.2)

You are provided with buffer solution content; Monosodium dihydrogen phosphate NaH_2PO_4 and Disodium hydrogen phosphate Na_2HPO_4.

- **Provided:**
  - Pka = 7.2
  - Final volume of buffer =500ml
  - pH=7.4
  - Conc= **0.25M**
- **Required:**
  - Weight (g) of Monosodium dihydrogen phosphate NaH_2PO_4
  - Weight (g) of Disodium hydrogen phosphate Na_2HPO_4



Calculations

- **To prepare a buffer Henderson-Hasselbalch equation is used:**

  pH = pka+log [A-] \[HA]

1) First calculate the concentrations of HA and A- in the buffer:

Assume [A-] =y , [HA] = 0.25 –y

$$7.4(\text{of buffer}) = 7.2 + \log \frac{y}{0.25-y} \rightarrow 0.2 = \log \frac{y}{0.25-y}$$

by taking the "Anti log for both sides":

$$1.6 = \frac{y}{0.25-y} \rightarrow y = 1.6 \times (0.25-y) \rightarrow y = 0.4 - 1.6y \rightarrow y + 1.6y = 0.4 \rightarrow 2.6y = 0.4$$

- **y= 0.15 M** [which is the concentration of **[A-]** in the buffer]
- Buffer Concentration = [HA] + [A-]   0.25 =[HA] + [A-]
- So, **[HA] =** 0.25 – 0.15= **0.1 M** [which is the concentration of **[HA]** in the buffer]

Calculations Cont’

- **2) calculate the weight needed from [A-] to prepare the buffer, No. of mole of [A-] should be calculated first :**

- **Calculate moles in buffer:** No. of mole (**of A-**) = molarity (**of A- calculated in buffer**) X volume L (**volume of buffer required**)

  =0.15 X 0.5 = **0.075 mole**

- **Calculate the wight of stock A-:** wt in (g) of [A-] = mole X Mw

  = 0.075 x 142 = $\boxed{10.65\ g}$

- **3) calculate the weight needed from [HA] to prepare the buffer, No. of mole of [HA] should be calculated first :**

- **Calculate moles in buffer:** No. of mole (**of HA**) = molarity (**of HA calculated in buffer**) X volume L (**volume of buffer required**)

  =0.1 X 0.5 = **0.05 mole**

- **Calculate the wight of stock A-:** wt in (g) of [A-] = mole X Mw

  = 0.05 x 120 = $\boxed{6\ g}$

Method

- Now take ……….g from NaH_2PO_4 and ………. g from Na_2HPO_4 then complete the volume up to 500 ml by addition of water.

- Check the pH

(2)Testing for buffering behavior:

Method:

- In one beaker add 10ml of 0.25M Phosphate buffer that you have prepared, and in another beaker add 10ml of water.
- Measure the pH.
- Add 0.5ml from 0.1 M HCl to both solutions.
- Measure the pH after the addition.

Solution (10 ml of each)	**Measured pH**	**Add 2M HCl (0.1ml)**	**pH after HCl**
Phosphate buffer		0.1 ml	
water		0.1 ml	

H.W

You are provided with **acetic acid** and **sodium acetate.**
Prepare **100 ml** of a **0.3M** acetate buffer pH =5.2 if you know that pK_a =4.76.