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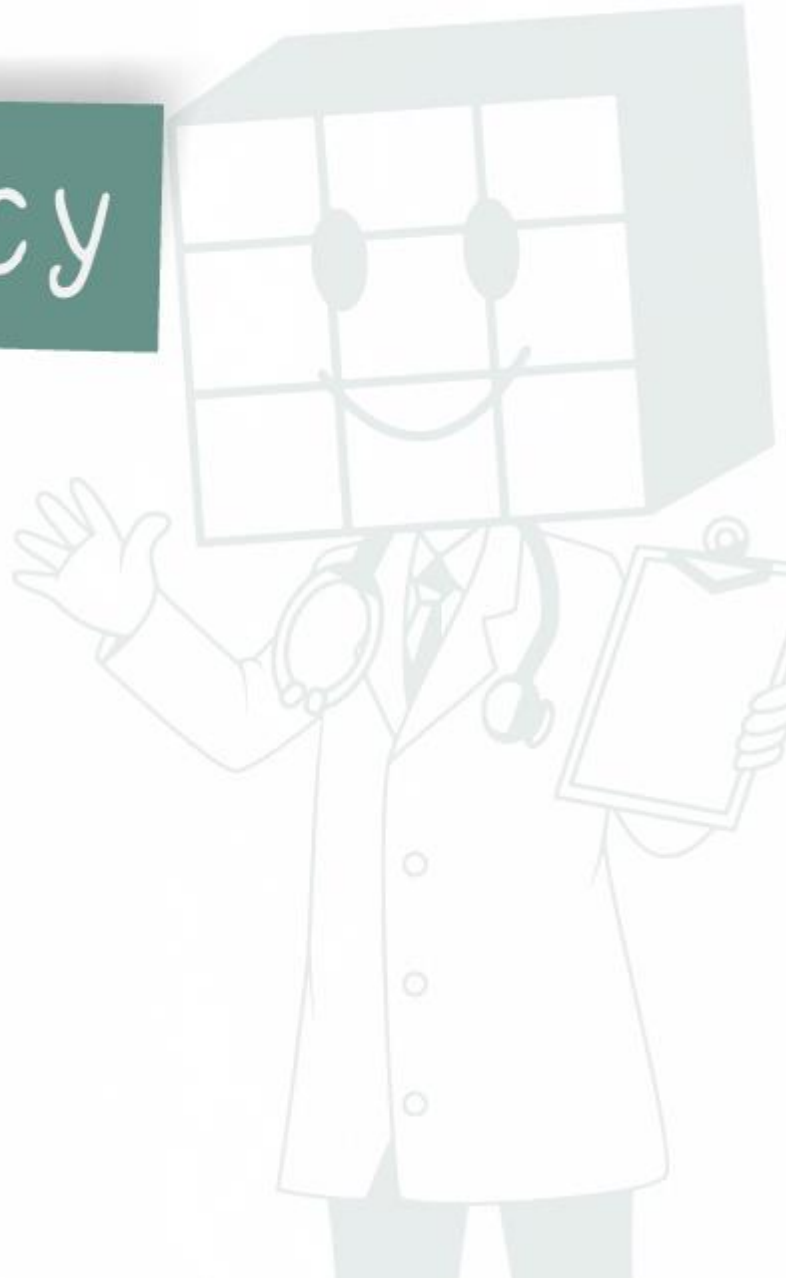
# Physical Pharmacy



## Buffers 1

PH

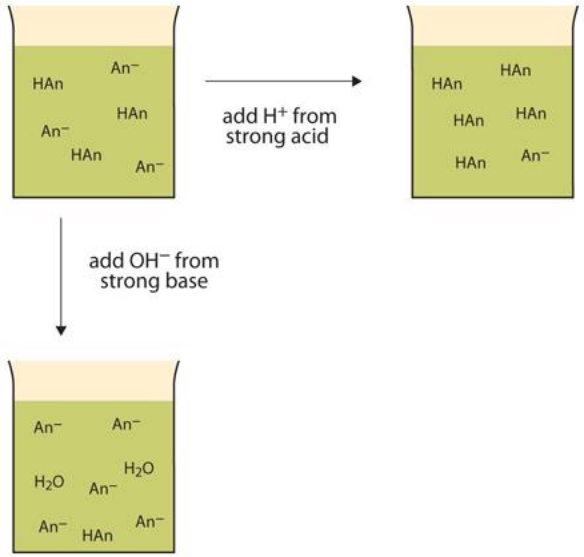
# Buffers

## Buffered and Isotonic Solutions

- **Buffers**: - Are compounds or mixtures of compounds that, by their presence in solution, resist changes in pH upon the addition of small quantities of strong acid or base.

- A combination of a weak acid and its conjugate base (i.e., its salt)like HAC and NaAC , OR a weak base and its conjugate acid (its salt)

- like (Ephedrine and ephedrine HCl) OR (NH3 and NH4Cl) acts as a buffer

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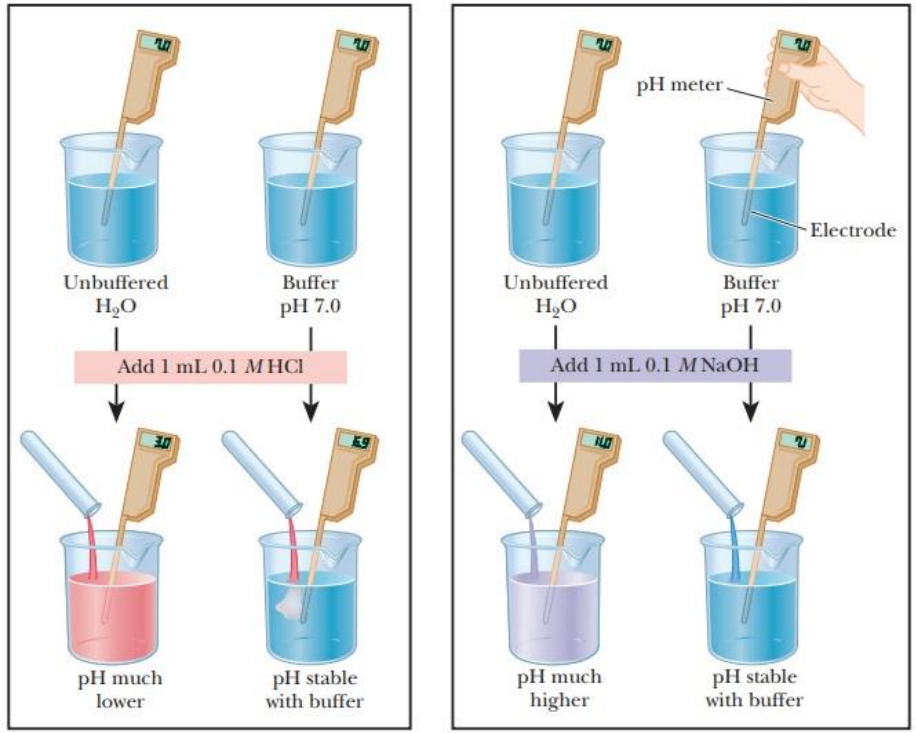
# Buffers

## Buffered and Isotonic Solutions

- Usually buffer solutions are prepared from combination of a weak acid and its salt
- **Buffer action** : It is the resistance of buffer to a change in pH.
- If a small amount of a strong acid or base is added to water or a solution of sodium chloride, the pH is altered considerably; such systems have no buffer action.

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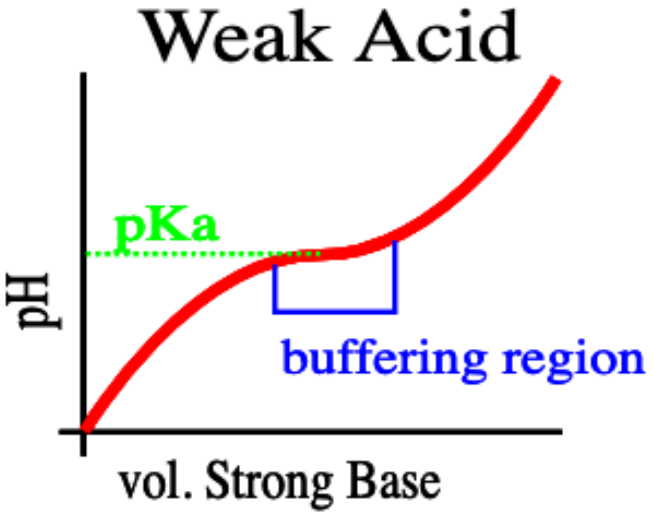
# Buffers

## Buffered and Isotonic Solutions

- **Buffer Capacity β**: The magnitude of the resistance of a buffer to pH changes
- Blood is maintained at **pH 7.4** by the presence of buffer (i,e blood has high buffer capacity)
- **Importance :** Buffers are used frequently in pharmaceutical practice when the pH must be held constant as in ophthalmic and I.V injection.

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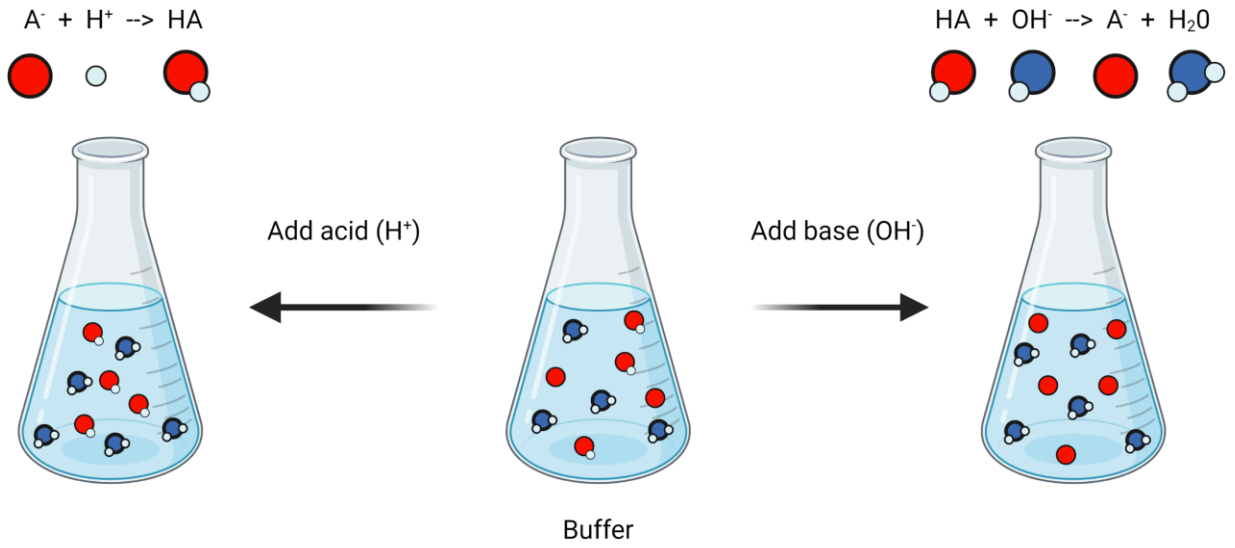
# Buffers

## Buffer Action

- Why buffer can resist changes in pH?
- **Example Weak acid and its salt**

$$CH_3COOH \longleftrightarrow CH_3COO^- + H_3O^+$$

$$CH_3COONa \longleftrightarrow CH_3COO^- + Na^+$$

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## Buffer Action

- **If strong acid ( $H_3O^+$ ) is added to a buffer solution:The solution will be protected by Acetate ($CH_3COO^-$)**

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

- That is mean, the acetate capture the excess protons and uses them to manufacture more weak acid and thus large decrease in pH is prevented

- **If strong base ($OH^-$) is added to buffer solution: The solution will be protected by the acid $CH_3COOH$**

$$CH_3COOH + OH^- \longleftrightarrow CH_3COO^- + H_2O$$

- That is mean, acetic acid converts most of excess OH- to water and thus large increase in pH is prevented.

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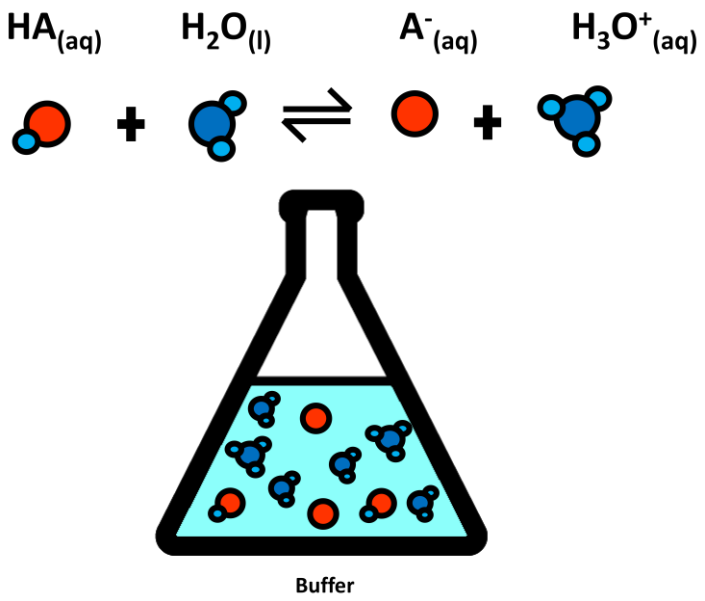
## Buffer Equations (Henderson–Hasselbalch equation)

- For weak acid and its salt: $pH = pKa + \log [salt]/[acid]$
- For weak base and its salt $pH = pKw - pKb + \log [base]/[salt]$

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## Example 9-2 : pH and [Salt]/[Acid] Ratio

What is the molar ratio, [Salt]/[Acid], required to prepare an acetate buffer of pH 5.0? Also express the result in mole percent of salt, Knowing that pKa of acetic acid is 4.76

**Answer :**

pH= pKa + log [salt]/ [acid]

5= 4.76 + log [salt]/ [acid]

5- 4.76 = log [salt]/ [acid]

0.24= log [salt]/ [acid]

[salt]/ [acid] = 1.74 / 1

Mole % of the salt =[salt]/ [acid+salt] x100

1.74/ 1.74+1 x 100=63.5%

Mole % of the acid = [acid]/ [acid+salt] x100

1/ 1.74+1 x 100=36.4%

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## Example 9-3

**What is the pH of a solution containing 0.10 mole of ephedrine and 0.01 mole of ephedrine hydrochloride per liter of solution? Since the pKb of ephedrine is 4.64**

**Answer :**

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## Example 9- 10

The $pK_b$, of pilocarpine is 7.15 at 25°C. Compute the mole percent of free base present at 25°C and at a pH of 7.4.

**Answer :**

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## Buffer Equations (Henderson–Hasselbalch equation)

- Buffer solutions are not ordinarily prepared from weak bases and their salts because of the volatility and instability of the bases and because of the dependence of their pH on pKw, which is often affected by temperature changes.

- **Note:**

**a. $pK_w$ =14 at 24°C**

**b. = 13.83 at 30 °C  $pK_w$ ↓ with ↑ temp.**

**c. = 14.53 at 10°C  $pK_w$ ↑ with ↓ temp.**

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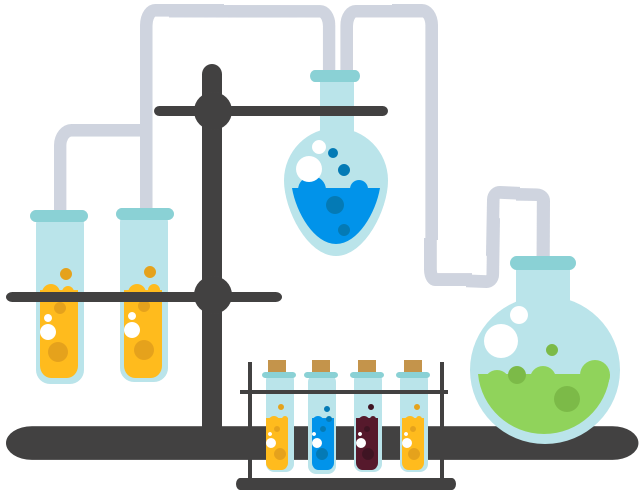
## Some Factors Influencing the pH of Buffer Solutions

- The addition of neutral salts to buffers changes the pH of the solution by altering the ionic strength.

- The addition of water in moderate amounts, although not changing the pH, may cause small positive or negative deviation because it alters activity coefficients and because water itself can act as a weak acid or base.



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## Some Factors Influencing the pH of Buffer Solutions

- **Temperature** also influences buffers:

a. The pH of acetate buffers was found to increase with temperature,

b. whereas the pH of boric acid–sodium borate buffers decreased with temperature

c. The pH of most basic buffers was found to change more markedly with temperature , owing to pKw, which appears in the equation of basic buffers and changes significantly with temperature

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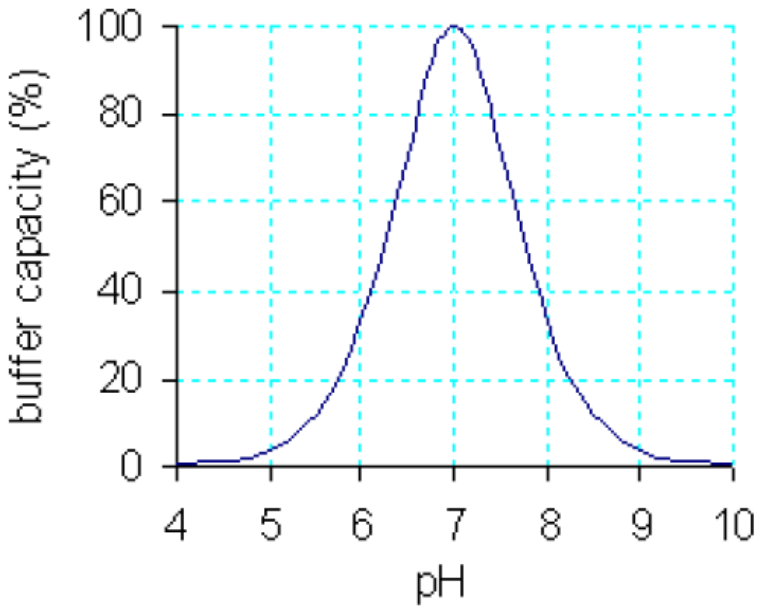
# Buffers

## Buffer Capacity

- The magnitude of the resistance of a buffer to pH changes is referred to as the buffer capacity, **β**.

- It is also known as buffer efficiency, buffer index, and buffer value.

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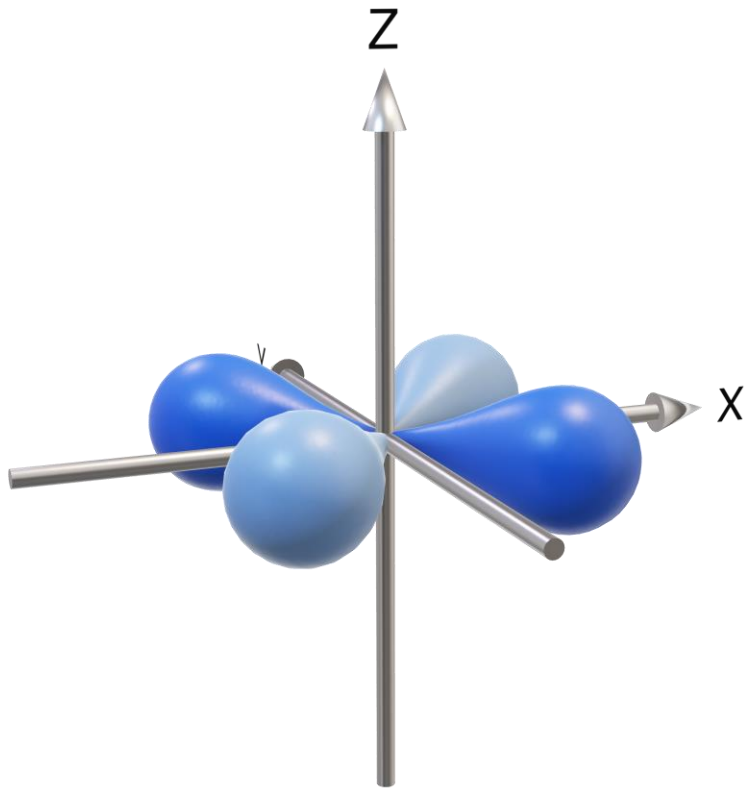
# Buffers

## Buffer Capacity

- Buffer capacity can be measured by three ways

1. **The approximate buffer capacity**
2. **Exact Equation for buffer Capacity**
3. **Maximum buffer capacity**

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# Thank You !

https://t.me/Dr_Cube