Unit- V

pH, Buffers and Isotonic solutions

Sorenson's pH scale:

pH refers to potential of hydrogen ions concentration. Sorenson's has defined pH of a solution as the logarithm of the reciprocal of the hydrogen ions or hydronium ions concentration $[H_3O^+]$.

Mathematically:

$pH = \log 1/[H_3O^+]$ -- (1)

The above equation can be rearranged as

$pH = \log 1 - \log [H_3O^+]$ --- (2)

$\Rightarrow pH = -\log [H_3O^+]$

(or)

$pH = -\log [H^+]$ {as the value of log 1 is Zero}------------------------------- (3)

Hence pH can also defined as the negative logarithm of hydrogen ion or hydronium ions concentration. The concentration of $[H_3O^+]$ is expressed in molarity, mol/L, etc.

In pure water $[H^+] = 1.0 \times 10^{-7}$

So pH of neutral (pure) water is $-\log(10^{-7}) = 7$.

Acidic solution:

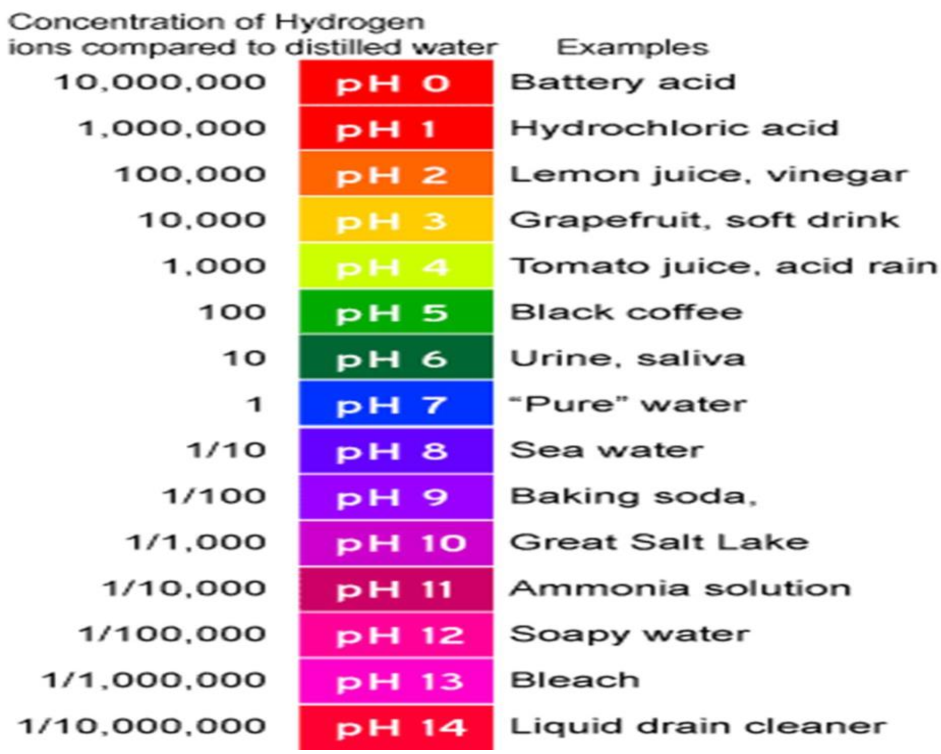
❖ The solutions having $[H^+]$ value greater than 10^{-7} are called acidic solution andthe solutions having $[H^+]$ value less than 10^{-7} are called basic solution.

❖ Hence pH value of all acidic solutions are less than 7 and pH value of all basic solutions are greater than 7.

❖ Sorenson developed a scale based on the pH value and different concentration of H_3O^+ in a solution which is called Sorenson's pH scale.

❖ The magnitude of the hydrogen ion is represented by means of the normality factor with regard to hydrogen ion, and this factor is written in the form of a negative power of 10.

❖ Sorenson employ the name 'hydrogen ion exponent' and the symbol pH for the numerical value of this power.



❖ Sorenson's scale (Table-1) assigns a pH of 0 to 14, with 0 being the most acidic, 14 being the most basic, and 7 being neutral (neither acidic nor basic).

❖ The pH scale works in powers of ten,so each jump in number is a multiple of ten in concentration. For example a pH of 1 is 10 times more acidic than pH 2.

❖ The value 7 at which the hydrogen and hydroxyl ion concentrations are about equal at room temperature is referred to as the neutral point, or neutrality.

❖ The neutralpH at 0ºC is 7.47, and at 100ºC it is 6.15.

Table-1: The pH scale and corresponding hydrogen and hydroxyl ion concentrations

pH	$[H_3O^+]$ (moles/liter)	$[OH^{-1}]$ (moles/liter)	
0	10^0	10^{-14}	
1	10^{-1}	10^{-13}	Acidic
2	10^{-2}	10^{-12}	
3	10^{-3}	10^{-11}	
4	10^{-4}	10^{-10}	
5	10^{-5}	10^{-9}	Neutral
6	10^{-6}	10^{-8}	
7	10^{-7}	10^{-7}	
8	10^{-8}	10^{-6}	Basic
9	10^{-9}	10^{-5}	
10	10^{-10}	10^{-4}	
11	10^{-11}	10^{-3}	
12	10^{-12}	10^{-2}	
13	10^{-13}	10^{-1}	
14	10^{-14}	10^0	

❖ The generalisations reported above regarding the acidity, neutrality and basicity hold good only when,

- ✓ Solvent is water
- ✓ Temperature is 25ºC
- ✓ No other factors present that cause deviations.

Applications:

The pH of the solutions must be controlled in pharmacy particularly in formulations of eye drops, ear drops, injections and liquid orals for the following reasons.

❖ ***Enhancing solubility and stability:***

The pH of the pharmaceutical preparations should be adjusted so as to make the API soluble and remain physically stable in the formulation.

❖ ***Improving purity:***

The purity of the protein can be determined as the amphoteric compounds are least soluble at their isoelectric points.

❖ ***Absorption of drugs:***

The drug molecules are absorbed differently from various parts of the GIT as the later differs in their pH.

❖ ***Optimising biological activity:***

Enzymes have maximum activity at a definite pH value.

❖ ***Comforting the body:***

The pH of the formulations that are administered to different tissues of the body should be optimum to avoid irritation (eyes), haemolysis (blood) or burning sensation (abraded surface).

❖ ***Storage of products:***

Special type of glass is used in case the glass container imparts alkalinity and alters the pH of the contents.

The pH indicators:

The pH indicator is a weak acid or weak base that exists in tautomeric form that readily interconvert. It is a solution when added to test solution produces a colour change, which helps in determining the pH of the test solution. The colour of any indicator depends on the pH of the solution (Table-2).

Example: Phenolpthalein, methyl red, Thymol blue etc.

Universal indicator:

Universal indicator is defined as a mixture of several indicators, which gives different color shades as the pH of the solution varies, in a particular pH range.

Table-2: Some indicators and change of colours with pH.

Name of the indicator	pH range	Colour change	Universal indicator
Methyl yellow	3.1-4.4	Blue-yellow	Mixture of all indicator range of pHis 1 to 11.
Methyl red	4.2-6.2	Red-yellow	
Bromothymol Blue	6.0-7.6	Yellow-blue	
Thymol blue	8.0-9.6	Yellow-blue	