

Concentration of solution is generally expressed as

- **Molarity**
- **Normality**
- **Parts per million**

Molarity(M):-Number of gram mole of solute present in one litre of solution.

M= weight of solute in gram per litre of solution

Molecular weight of the solute

W X1000

M= -----
m X V

Where W=wt.of the solute in gram

m= molar mass of the solute

V= volume of solution in ml

Normality(N):-

Number of gram equivalent of the solute present in one litre of the solution.

Mathematically,

$$N = \frac{\text{No of gram equivalents of solute}}{\text{Volume of solution in litres}}$$

$$= \frac{\text{Weight of solute in grams per litre of solution}}{\text{Equivalent weight of solute}}$$

$$\text{Normality, } N = \frac{W \times 1000}{E \times V (\text{ml})}$$

where W = Weight of solute

E = Equivalent weight of the solute

V = Volume in ml of the solution

pH of a solution

- Scale of acidity of a solution
- Depends on concentration of hydrogen ion (H^+)
- pH scale is a method of expressing hydrogen ion concentration in a solution

Defntion of pH

It is defined as negative logarithm to the base 10 of the concentration of hydrogen ion in a solution.

$$pH = -\log_{10} [H^+]$$

If $[H^+] = [OH^-] \Rightarrow$ the solution is neutral

If $[H^+] > [OH^-] \Rightarrow$ the solution is acidic (H^+ is more than OH^-)

If $[H^+] < [OH^-] \Rightarrow$ the solution is basic (H^+ is less than OH^-)

Q.Is pure water is acidic or basic?

Ans:-pure water is neutral.It contain equal amount of H^+ ions and OH^- ions

Ionic product of water

1. Ionization of water molecules



2. Equilibrium Constant, $K = \frac{[\text{H}^+][\text{OH}^-]}{[\text{H}_2\text{O}]}$

3. Rearranging the equation, $K \frac{[\text{H}_2\text{O}]}{[\text{H}^+][\text{OH}^-]} = 1$

4. $[\text{H}_2\text{O}] \approx 1$ then $K_w = [\text{H}^+][\text{OH}^-]$

Where K_w is the ionic product of water

$$K_w = [\text{H}^+][\text{OH}^-]$$

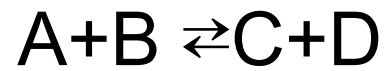
Ionic product of water is the product of concentration of H⁺ ions and OH⁻ ions in water

$$K_w = [H^+] [OH^-]$$

The value of K_w

The ionic product of water at 25°C (298 K) is:

$$\begin{aligned}K_w &= [\text{H}^+] \times [\text{OH}^-] = 10^{-7}\text{M} \times 10^{-7}\text{M} \\&= 10^{-14} \text{ M}^2 \quad (\text{Where M} = \text{moles/litre})\end{aligned}$$



$$K = \frac{[C][D]}{[A][B]}$$

$$K^*1 = K_w$$

pH, pOH and pKw

These terms are defined by the equations

$$\text{pH} = -\log_{10} [\text{H}^+]$$

$$\text{pOH} = -\log_{10} [\text{OH}^-]$$

$$\text{pKw} = -\log_{10} K_w$$

For pure water at 25°C,

$$[\text{H}^+] = 10^{-7} \text{M} \text{ therefore } \text{p}^{\text{H}} = -\log_{10} [\text{H}^+] = -\log_{10} 10^{-7} = 7$$

$$[\text{OH}^-] = 10^{-7} \text{M} \text{ therefore } \text{p}^{\text{OH}} = -\log_{10} [\text{OH}^-] = -\log_{10} 10^{-7} = 7$$

$$K_w = 10^{-14} \text{ M}^2 \text{ therefore } \text{p}^{\text{Kw}} = -\log_{10} K_w = -\log_{10} 10^{-14} = 14$$

Relationship between pH, pOH and pK_w

The ionic product of water $K_w = [H^+] \times [OH^-]$.

Taking logarithms to the base 10 on both sides and putting the negative signs,

$$\begin{aligned}-\log_{10} K_w &= -\log_{10} \{ [H^+] \times [OH^-] \} \\ &= -\{ \log_{10} [H^+] + \log_{10} [OH^-] \} \\ &= -\log_{10} [H^+] + -\log_{10} [OH^-], \text{ or}\end{aligned}$$

4'
$$pK_w = pH + pOH$$

Since K_w is a constant, p^{K_w} is also a constant. At 25°C it is equal to 14. So whenever pH increases, pOH must decrease and vice versa to keep their sum a constant.

Relation between pH and pK_w

p ^H	p ^{OH}	p ^{K_w}
7	7	14
6	8	14
8	6	14
5	9	14
9	5	14
4	10	14
10	4	14
14	0	14
0	14	14

1. Calculate the pH of a solution having hydrogen ion concentration.

I. $[H^+] = 1M$

II. $[H^+] = 0.001M$

III. $[H^+] = 10^{-8}$

IV. $[H^+] = 10^{-13}$

Determination of pH

pH can be determined by using

- a) pH meter**
- b) pH paper**
- c) Universal indicator**

Application of pH:-

1. To find out acidic ,basic or neutral nature of a medium.
2. In production of potable water
3. In agriculture
4. In electroplating
5. In digestive system
6. In textile industry
7. In sugar industry
8. In chemical industry
9. In food preservation
0. pH of human blood =7.36 to7.42, a change in pH by 0.2 result in death hence pH is important to maintain our health.

Buffer solution

A solution which resist the change in pH on addition of small amount of acid and base in it.

Two types of buffer solution

1. Acidic buffer-a mixture of weak acid and its salt with strong base

eg-Acetic acid and sodium acetate

2. Basic buffer- a mixture of weak base and its salt with strong acid

Eg-ammonium hydroxide and ammonium chloride

Buffer capacity- The capacity of a buffer to resist the change in pH.

$$\text{Buffer capacity (} \beta \text{)} = \frac{\text{no. of moles of acid and base added to 1L}}{\text{Change in the pH value}}$$

Application of buffer-

1. To maintain pH of blood
2. In complexometric titration
3. In microbiology