**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.

$$M = \frac{\text{weight of solute in gram per litre of solution}}{\text{Molecular weight of the solute}}$$

$$M = \frac{W \times 1000}{m \times V}$$

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,

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

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

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

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

   $H_2O \rightleftarrows H^+ + OH^-$

2. Equilibrium Constant , $K = \dfrac{[H^+][OH^-]}{[H_2O]}$

3. Rearranging the equation, $K[H_2O] = [H^+][OH^-]$

4. $[H_2O] \approx 1$ then $K_w = [H^+][OH^-]$

Where Kw is the ionic product of water

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

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

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

## The value of Kw

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

$$K_w = [H^+] \times [OH^-] = 10^{-7}M \times 10^{-7}M$$

$$= 10^{-14}\ M^2 \qquad \text{(Where M = moles/litre)}$$

$A + B \rightleftarrows C + D$

$K = [C][D]/[A][B]$

$K*1 = K_w$

## pH, pOH and pKW

These terms are defined by the equations

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

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

$$pKw = -\log_{10} Kw$$

For pure water at 25°C,

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

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

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

## on between pH , pOH and pKW

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

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

$$-\log_{10} Kw = -\log_{10}\left\{\left[H^+\right] \times \left[OH^-\right]\right\}$$

$$= -\left\{\log_{10}\left[H^+\right] + \log_{10}\left[OH^-\right]\right\}$$

$$= -\log_{10}\left[H^+\right] + -\log_{10}\left[OH^-\right], \text{ or}$$

4. $pKw = pH + pOH$

Since Kw is a constant, $p^{Kw}$ 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 pKw

| $p^{H}$ | $p^{OH}$ | $p^{Kw}$ |
|---|---|---|
| 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 nuetral 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 impotant 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.

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

Application of buffer-

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