Acids, Bases and Salts

Contents

1. Definition of Acids, Bases and Salts
2. Strong acids, Weak acids, Strong bases and Weak bases
3. The pH scale
4. Conjugate acids and bases
5. Acidic, Basic and Neutral salts

Definition of Acids, Bases and Salts

Acids are substances that taste sour and turn blue litmus red. They also react with metals to liberate hydrogen gas. According to Arrhenius, acids produce more hydrogen ions [H+] than hydroxyl ions[OH-] when mixed with water. According to Bronsted-Lowry theory, acids are substances that donate proton(H+)

Bases are substances that taste bitter and turn red litmus blue. They are slippery in touch. According to Arrhenius, bases produce more hydroxyl ions [OH-] than hydrogen ions[H+] when mixed with water. According to Bronsted-Lowry theory, bases are substances that accept proton(H+)

Salts are formed when acid and base neutralize each other. Salts are electrolytes which contain positive and negative radicals.

Strong Acids, Strong Bases, Weak Acids, Weak Bases

Strong acids are those which dissociate in water to produce a very high concentration of hydrogen ions. They typically have pH in the range 1-3. Eg. Sulphuric Acid(H_2SO_4), Nitric Acid(HNO_3), Hydrochloric Acid(HCl)

Weak acids are those which dissociate in water to produce a low concentration of hydrogen ions. They typically have pH in the range 5-6.

Eg. Acetic Acid(CH_3COOH), Hydrofluoric acid(HF)

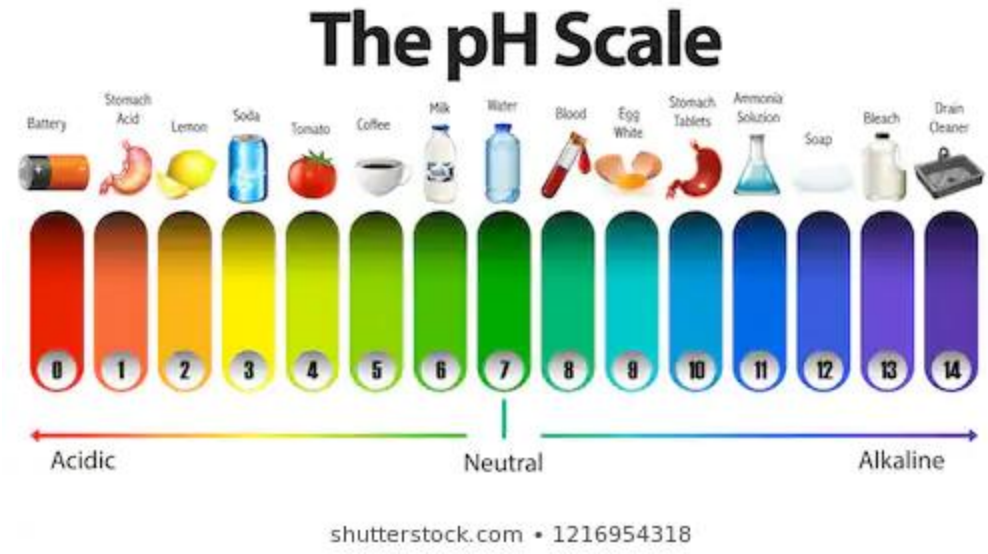
Strong bases are those which dissociate in water to produce a very high concentration of hydroxyl ions. They typically have pH in the range 12-14.
Eg. Potassium hydroxide(KOH), Sodium hydroxide(NaOH), Barium hydroxide($Ba(OH)_2$)
Weak bases are those which dissociate in water to produce a low concentration of hydroxyl ions. They typically have pH in the range 8-10.
Eg. Ammonium hydroxide(NH_4OH), Calcium Hydroxide($Ca(OH)_2$)

When an acid dissociates in water to give hydrogen ions, the number of ions it can give per molecule of the acid is termed as basicity of the acid. For example, HCl is monobasic, H_2SO_4 is dibasic, H_3PO_4 is tribasic and so on.

Similarly, when a base dissociates in water to give hydroxyl ions, the number of ions it can give per molecule of the base is termed as acidity of the base. For example, KOH is monoacidic, $Ca(OH)_2$ is diacidic, $Al(OH)_3$ is triacidic and so on.

The pH scale

The pH scale was introduced by Sorensen to express acidity or basicity of a solution.



pH of a solution is defined as

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

Where [H+] = concentration of [H+] ion in terms of molarity. Molarity of a solution is basically the number of moles of solute dissolved in 1 litre of solution. Molarity is denoted by M.

Q. What is the pH of 0.001 M HCl?

A . 0.001M HCl will have 10^{-3} M of H+ ion(Since 1 molecule of HCl will give only 1 atom of H+). Therefore the pH of the solution will be $-\log_{10}10^{-3} = 3$

Water is considered neutral, having pH=7. This means water has equal concentrations of [H+] and [OH-] ions both of which are 10^{-7}. The product of concentrations of [H+] and [OH-] is always fixed at 10^{-14}.

Q. What is the pH of 0.001 M KOH?

A . 0.001M KOH will yield 10^{-3} M of OH- ions. If the concentration of OH- is 10^{-3}, then the concentration of [H+] will be $10^{-14}/10^{-3} = 10^{-11}$. Therefore pH= $-\log_{10}10^{-11} = 11$.

Conjugate Acids and Bases

According to Bronsted-Lowry Theory, an acid is a substance which can donate a proton and a base is a substance which can accept a proton. The ion that can donate the proton is called a conjugate acid(eg. Hydronium ion(H_3O+) donates a proton to become water(H_2O)). The ion that can accept a proton is called a conjugate base(eg. NH_2- can accept a proton to form ammonia(NH_3))

Acidic, Basic and Neutral Salts

As we have already discussed, salts are formed when acids react with bases. However the nature of salt is different depending upon the nature of acids and bases.

When strong acids react with strong bases, neutral salts are formed.
Eg. Sodium Chloride(formed by neutralization of Hydrochloric acid and Sodium Hydroxide)

When strong acids react with weak bases, acidic salts are formed.
Eg. Ammonium Chloride(formed by neutralization of Hydrochloric acid with Ammonium Hydroxide)

When weak acids react with strong bases, basic salts are formed.
Eg. Sodium acetate(formed by neutralization of Acetic acid with Sodium Hydroxide)