CHEMISTRY

ACIDS, BASES & SALTS

Concepts Covered

- Introduction of Acid, Base and Salt. Their Types
- Physical and Chemical Properties.
- Application and Uses of Acid, Base and Salt. .

Introduction:

A wide variety of materials consists essentially of elements and compounds having different characteristics that exist around us. Some of them are sour, some are bitter, while some are salty in taste.

Example: Sour and bitter tastes of food are due to acids and bases, respectively, present in them. Acids react with bases to produce salt whose properties are different from acid and base.

Acids:

The term "acid" is derived from the Latin word "acidus" meaning sour to taste.

Example: Sour taste of lemon, unripened grapes, Vinegar, tomatoes etc.

According to Arrhenius's theory: "An acid is a substance which dissolved in water, it ionizes and releases hydrogen ions [H^+(aq.)] in solution".

$$\underset{\text{Hydrochloric acid}}{HCl(aq.)} \longrightarrow \underset{\text{Hydrogen ion}}{H^+(aq.)} + \underset{\text{Chloride ion}}{Cl^-(aq.)}$$

OR

$$HCl(g) + H_2O(\ell) \longrightarrow H_3O^{\oplus}(aq.) + Cl^-(aq.)$$

$$\underset{\text{Hydrogen ion}}{H^+} + \underset{\text{Water}}{H_2O} \longrightarrow \underset{\text{Hydronium ion}}{H_3O^+}$$

$$\underset{\text{sulphuric acid}}{H_2SO_4(aq.)} \longrightarrow \underset{\text{Hydrogen ion}}{2H^+(aq.)} + \underset{\text{Sulphate ion}}{SO_4^{2-}(aq.)}$$

$$\underset{\text{Nitric acid}}{HNO_3(aq.)} \longrightarrow \underset{\text{Hydrogen ion}}{H^+(aq.)} + \underset{\text{Nitrate ion}}{NO_3^-(aq.)}$$

Classification of Acids:

(I) Based on their source acids are of two types –

(i) Mineral acids;

(ii) Organic acids

(I) Mineral Acids (Inorganic acids): -

The acids which are usually obtained from minerals are known as inorganic acids.

Name	Chemical Formula	Where found or used
Hydrochloric acid	HCl	In the purification of common salt, in the textile industry as a bleaching agent, to make aqua regia.
Sulphuric acid	H_2SO_4	Commonly used in car batteries, in the manufacture of fertilizers (Ammonium phosphate, Superphosphate detergents etc., in paints, plastics, drugs)
Nitric acid	HNO_3	manufacture of artificial silk, in petroleum refining. Used in the manufacture of explosives (TNT, Nitroglycerine) and fertilizers (Ammonium nitrate, Calcium nitrate, Purification of Au, and Ag.
Carbonic acid	H_2CO_3	In soft drinks and lends fizz, In the stomach as gastric juice, used in the tanning industry
Phosphoric acid	H_3PO_4	Used in antirust paints and fertilizers

(ii) Organic acids:

The acids which are usually obtained from plants and animals are known as organic acids.

Name	Where found or used
Formic acid (HCOOH)	Found in the stings of ants and bees, used in tanning leather, in medicines for treating gout.
Acetic acid (CH_3COOH)	Found in vinegar, used as a solvent in the manufacture of dyes and perfumes.
Lactic acid	Responsible for souring of milk in curd.
Benzoic acid	Benzoic acid is used as a food preservative.
Citric acid	Present in lemon, orange and citrus fruits.
Tartaric acid	Tartaric acid Present in tamarind.

(II) On the Basis of their Basicity:

"The basicity of an acid is the number of replaceable hydrogen atoms present in a molecule that can be produced by the complete ionization of one molecule of that acid in aqueous solution." or

"Basicity of an acid is determined by the number of hydronium ions ($H_3O^+/H^+(aq)$) produced per molecule of an acid on ionization."

(i) Monobasic Acids:

The acid on complete ionization produces one hydronium ion in an aqueous solution.

Example:

Hydrochloric acid (HCl)

Hydrobromic acid (HBr)

Hydrofluoric acid (HF)

Hydroiodic acid (HI)

Nitric acid (HNO_3)

Acetic acid (CH_3COOH)

Formic acid ($HCOOH$)

$$HCl + H_2O \rightarrow \underset{\text{Hydronium ion}}{H_3O^{\oplus}} + \underset{\text{(Chloride ion)}}{Cl^-}$$

$$CH_3COOH + H_2O \rightarrow \underset{\text{Hydronilm ion}}{H_3O^{\oplus}} + \underset{\text{Acetate ion}}{CH_3COO^-}$$

$$HNO_3 + H_2O \rightarrow \underset{\text{Hydronilm ion}}{H_3O^{\oplus}} + \underset{\text{Nitrate ion}}{NO_3^-}$$

(ii) Dibasic Acid:

The acid on complete ionization produces two hydronium ions in an aqueous solution.

Example:

Sulphuric acid (H_2SO_4)

Carbonic acid (H_2CO_3)

Oxalic acid $(COOH)_2$

$$H_2SO_4 + H_2O \rightarrow H_3O^{\oplus} + \underset{\text{Bisulphate ion}}{HSO_4^{2-}} \quad \text{(Step-I)}$$

$$HSO_4^- + H_2O \rightarrow H_3O^{\oplus} + \underset{\text{Sulphate ion}}{SO_4^{2-}} \quad \text{(Step-II)}$$

(iii) Tribasic Acid:

The acid on complete ionization produces three hydronium ions in an aqueous solution. Example: H_3PO_4

Example:

$$H_3PO_4 + 3H_2O \rightarrow \underset{\text{Hydronium ion}}{3H_3O^{\oplus}} + \underset{\text{Phosphate ion}}{PO_4^{-3}}$$

(III) Classification based on their strength:

(i) Strong Acid:

The acid which undergoes complete ionization in an aqueous solution is known as strong acids. Example: HCl, H_2SO_4, and HNO_3.

Example:

$$HCl + Water \rightarrow H^+(aq) + Cl^-(aq.)$$

$$H_2SO_4 + Water \rightarrow 2H^+(aq) + SO_4^{2-}(aq.)$$

$$HNO_3 + Water \rightarrow H^+(aq) + NO_3^-(aq.)$$

(ii) Weak Acid:

The acid which undergoes partial or incomplete ionization in an aqueous solution is known as weak acids.

$$\underset{\text{Acetic acid}}{CH_3COOH} + Water \rightarrow \underset{\text{Acetate ion}}{CH_3COO^-}(aq) + H^+(aq)$$

Example:

Formic acid ($HCOOH$), Oxalic acid $(COOH)_2$

Carbonic acid (H_2CO_3), phosphoric acid (H_3PO_4)

(IV) Classification based on the concentration of the Acid:

(i) Concentrated Acid: The acid which contains a very small amount of water is called a concentrated acid.

(ii)Dilute Acid: The acid which contains more amount of water is called a dilute acid. D "Strength of an acid is not depending upon the concentration of an acid" Strength of an Acid $\propto$ Concentration of hydronium ion.

Bases: Substances with a bitter taste and give a soapy touch are known as bases but many bases have corrosive nature.

Classification of Bases:

(I) Classification based on their strength:

(i) Strong alkalis or bases:

The alkalis or bases which undergo almost complete ionization in an aqueous solution are known as strong alkalis or bases. Example: NaOH, KOH and $Ba(OH)_2$

Examples:

$NaOH(aq.) \rightarrow Na^+(aq) + OH^-(aq)$ — Sodium hydroxide

$KOH(aq.) \rightarrow K^+(aq) + OH^-(aq)$ — Potassium hydroxide

$Ba(OH)_2(aq.) \rightarrow Ba^+(aq) + 2OH^-(aq)$ — Barium hydroxide

} Complete ionisation

(ii) Weak alkalis or bases: -

The alkalis or bases which undergo only partial ionization in an aqueous solution are known as weak alkalis or Bases. Exapmle: $Ca(OH)_2$

Example:

$Ca(OH)_2(aq.) \rightarrow Ca^{2+}(aq) + 2OH^-(aq.)$ — Calcium hydroxide

$Mg(OH)_2(aq.) \rightarrow Mg^{2+}(aq) + 2OH^-(aq.)$ — Magnesium hydroxide

} Partial Ionization

(II) Classification based on their concentration:

(i) Concentrated Base or Alkali: The bases or alkalis which contain a very small amount of water is called concentrated bases or alkalis.

(ii) Dilute Acid: The bases or alkali which contain more amount of water is called a dilute bases or alkalis.

(III) Classification based on their acidity: Acidity of a base is determined by the number of hydroxyls (OH^-) ions produced by per molecule of a Base or Alkali on complete dissociation in water "or"

The "number of hydrogen ions of an acid with which a molecule of that alkali or base react to produce salt and water is known as acidity of an alkali or Base".

Properties of Acid and Bases:

(1) Physical properties of Acid –

(I) Taste: Acids have a sour test.

(II) Physical state: Some acids are solids while others are liquid at room temperature.

Example:

Solid	–	Oxalic acid $(COOH)_2$, Boric acid (H_3BO_3)
Liquid	–	Acetic acid (CH_3COOH), Formic acid $(HCOOH)$, Sulphuric acid (H_2SO_4)
Volatile liquid	–	Carbonic acid (H_2CO_3), Hydrochloric acid (HCl), Nitric acid (HNO_3)

(III) Effect of Indicator: They affect the indicators as given below

Indicator	Change in acidic medium
Blue litmus paper	Blue to Red
Methyl orange	Orange to pink
Phenolphthalein	Remains colourless
Turmeric paper	Remains colourless

Carbonic acid (H_2CO_3) turns blue litmus to pink. Because this is a weak mineral acid.

Litmus: A water-soluble purple dye, extracted from certain lichens, a plant belonging to the division thallophyte and is commonly used as an indicator. The pH range for litmus is 4.5 – 8.3 at room temperature. **Effect on Skin:** All strong mineral acids have a corrosive action on the skin and cause painful burns.
Example: Concentrated Sulphuric acid stains the skin black.

Concentrated nitric acid & hydrochloric acid stain the skin yellow.

(IV) Electrical Conductivity: All mineral acids are good conductors of electricity and conduct electricity in their aqueous solution.

On electrolysis, they decompose liberating hydrogen at the cathode.

(2) Chemical Properties of Acids:

(I) Reaction with metals: Dilute acids like hydrochloric acid (HCl), Sulphuric acid (H_2SO_4) react with certain active metals to evolve hydrogen gas and form their metallic salt

Metals which can displace hydrogen from dilute acid are known as active metals.

Example: Na, K, Zn, Fe, Ca, Mg etc.

(1) Why should curd and sour substances not be kept in brass and copper vessels? **[NCERT]**

(2) Which gas is usually liberated when an acid reacts with a metal? Illustrate with an example. How will you test for the presence of this gas? **[NCERT]**

(3) Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid (HCl) is added to test tube A, while acetic acid (CH_3COOH) is added to test tube B. Amount and concentration taken for both the acids are same. In which test tube will the fizzing occur more vigorously and why? **[NCERT]**

(II) Reaction with metal carbonates and metal Hydrogen Carbonates: Both metal carbonates and hydrogen carbonates (bicarbonates) react with dilute acids to evolve CO_2 gas and form a salt.

Reaction with metallic sulphites and hydrogen sulphites –

Metallic sulphites and hydrogen sulphites react with dilute acids to liberate sulphur dioxide.

$CaSO_3$ (s)	+	H_2SO_4	→	$CaSO_4$(aq)	+	H_2O (l)	+	SO_2 (g)
Calcium sulphite		Dilute						
$NaHSO_3$ (s)	+	HCl	→	NaCl(aq)	+	H_2O (l)	+	SO_2 (g)
Sodium hydrogen Sulphite		Dilute						

(IV) Reaction with metallic sulphides and hydrogen sulphides:

Metallic sulphides and hydrogen sulphides react with dilute acid to liberate hydrogen sulphide gas.

FeS	+	H_2SO_4	→	$FeSO_4$ (aq)	+	H_2S (g)
Iron (II) sulphide		Dilute		Iron sulphate		
KHS	+	HCl	→	KCl (aq)	+	H_2S (g)
Potassium hydrogen sulphide		Dilute		Potassium chloride		
ZnS	+	H_2SO_4	→	$ZnSO_4$ (aq)	+	H_2S (g)
Zinc sulphide		Dilute		Zinc sulphate		

(V) Reaction with metal chlorides:

Metal chlorides react with concentrated acids to produce hydrogen chloride gas. Which gives white dense fumes with ammonia.

2NaCl (s)	+	conc. H_2SO_4	$\xrightarrow{\Delta}$	Na_2SO_4(aq)	+	2HCl(g)
Sodium chloride				Sodium sulphate		
2KCl (s)	+	conc. H_2SO_4	$\xrightarrow{\Delta}$	K_2SO_4 (aq)	+	2HCl(g)
Potassium chloride				Potassium sulphate		

(VI) Reaction with metal nitrates:

Metal nitrate reacts with concentrated acids to produce more volatile nitric acid.

$2NaNO_3$	+	conc. H_2SO_4	$\xrightarrow{\Delta}$	Na_2SO_4 (aq)	+	2 HNO_3
Sodium nitrate				Sodium sulphate		

(VII) The reaction of Acid and Base with each other:

All metallic hydroxides (Bases) react with acids to form their metallic salt and water. This reaction is also known as an acid-base neutralization reaction.

(I) Taste – They are sharp and bitter in taste.

(II)Effect on the skin – They give a feeling of soapy touch and all alkalis have a mild corrosive action on the skin. (III) Effect on Indicator – They affect the indicators as given below –

Indicator	Indicator Change in acidic medium
Red Litmus	Red to Blue
Methyl orange	Orange to yellow
Phenolphthalein	Colourless to pink
Turmeric paper	Yellow to red-brown

(3) Chemical Properties of Bases:

(I) Reaction with Metals:

Bases react with some metals to liberate hydrogen gas.

$Zn\ (s)$	+	$2\ NaOH$	→	$Na_2ZnO_2\ (aq)$	+	$H_2\ (g)\uparrow$
Zinc		Dilute		Sodium Zincate		Hydrogen gas
$2Al\ (s)$	+	$2NaOH$	+	$2H_2O\ (l)$	→ $2NaAlO_2$ +	$3H_2\ (g)\uparrow$
Dilute		Sodium aluminate				

(II) Reaction of Bases with Non-metallic oxide:

Base react with non-metallic oxide to form their respective carbonates and water.

$2NaOH\ (aq)$	+	$CO_2(g)$	→	$Na_2CO_3\ (aq)$	+	$H_2O\uparrow$
Sodium hydroxide		Carbon dioxide		Sodium carbonate		water
$2KOH\ (aq)$	+	$CO_2(g)$	→	$K_2CO_3\ (aq)$	+	$H_2O\uparrow$
Potassium hydroxide				Potassium carbonate		

Some of the alkalis like sodium hydroxide (NaOH) are called deliquescence because they absorb carbon dioxide from the air and their strength decreases with time.

(III) Reaction of Bases with Acids: They neutralize the acids to form salt and water.

Acid	+	Base	→	Salt	+	Water

(IV) Reaction of Bases with ammonium salt:

Bases react with ammonium salt to evolve ammonia gas.

$NaOH\ (aq)$	+	$NH_4Cl(g)$	→	$NaCl\ (aq)$	+	$H_2O\ (l)$	+	$NH_3\ (g)\uparrow$
Sodium hydroxide		Sodium chloride						
$Ca\ (OH)_2\ (aq)$	+	$2NH_4Cl(g)$	→	$CaCl_2\ (aq)$	+	$2H_2O\ (l)$	+	$NH_3(g)\uparrow$
Calcium hydroxide		Calcium chloride						

(V) Reaction of Bases with Salt:

Bases react with a salt solution to form another base and another salt.

$3NaOH\ (aq)$	+	$FeCl_3(aq)$	→	$Fe\ (OH)_3\ (aq)$	+	$3NaCl(aq)$
Sodium hydroxide		Iron (III)		chloride Iron (III) hydroxide		

Base –1 Salt –1 Base –2 (Brown ppt.) Salt–2

$2NaOH\ (aq)$	+	$ZnSO_4(aq)$	→	$Zn\ (OH)_2\ (s)$	+	$Na_2SO_4(aq)$
Sodium hydroxide		Zinc sulphate		Zinc hydroxide (White ppt.)		Sodium sulphate

Uses of Bases or:

S. No.	Base	Use
1	Sodium hydroxide (NaOH)	It is used in the manufacture of washing soap, paper, petrol refining and as a reagent in the laboratory.
2	Potassium hydroxide (KOH)	It is used in the manufacture of soap paper (bathing soap) and alkaline batteries.
3	Calcium hydroxide (Slaked lime) $[Ca(OH)_2]$	It is used in the manufacture of bleaching powder and softening of hard water.

4	Magnesium hydroxide [Mg $(OH)_2$]	It is used as an antacid.
5	Aluminum hydroxide [$Al(OH)_3$]	It is used as a foaming agent in fire extinguishers.
6	Ammonium hydroxide (NH_4OH)	It is used in removing grease stains from clothes.
7	Sodium carbonate (Na_2CO_3)	It is used as a cleaning agent for domestic purposes and for removing the permanent hardness of the water.

What Do All Acids and Bases Have in Common?

A common thing for all the acids is that they produce hydrogen ions [H^+ (aq.)] when dissolved in water.

For Example – Acids like HCl, H_2SO_4, HNO_3, CH_3COOH etc. show acidic character because they dissociate in an aqueous solution to produce hydrogen ions. But all the compounds containing hydrogen are not acids such as glucose ($C_6H_{12}O_6$) and alcohol (C_2H_5OH) also contain hydrogen but they do not show acidic character.

Important Point – Why should water be never added to the dilution of an Acid? Ans. Mixing water with acid is an exothermic process and more heat is produced by the splashing of water. To avoid this. We must add acid into water and not water into acid.

Moreover, the acid must also be added to water in small lots and not in one instalment.

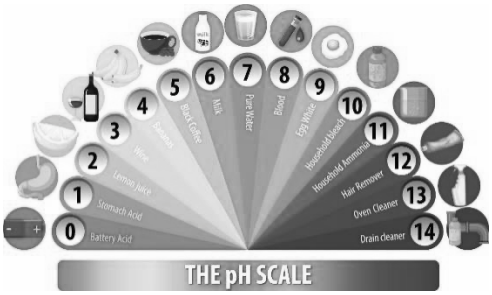
How Strong Are Acid or Base Solution?

Acids and bases on dilution with water decrease the concentration of H^+(aq.) or OH^-(aq.) ions in the acidic and basic solutions respectively.

If we find quantitatively, the amount of H^+(aq.) / OH^-(aq.) ions present in a solution, we can judge how strong an acid or a base is? We can do this with the help of a universal indicator, which is a mixture of several indicators. The universal indicator shows different colours at different concentrations of hydrogen ions or pH values in the solution.

pH Scale –

S.P.L. Sorenson, a Danish Chemist 1909 introduced the concept of measuring the concentration of hydrogen ions (H+ (aq.)] in a solution., The p in pH stands for 'potenz' in German, meaning power. On the pH scale, we can measure pH from "0" (very acidic) to 14 (very alkaline).



The concentration of H^+ (aq.) and OH^- (aq.) ions in pure water are 1×10^{-7} mol $litre^{-1}$. This means that all aqueous solutions contain both H^+(aq.) and OH^- (aq.) ions. The product of the concentration of H^+(aq.) and OH^-(aq.) in water is constant (equal to 1×10^{-14} mol^2 $litre^{-2}$ at 25°C) and is known as the ionic product of water (KW).

KW = $[H^+(aq.)]$ $[OH^-$ (aq.)] = (1×10^{-7}) (1×10^{-7}) = 1×10^{-14} mol^2 $litre^{-2}$ at 25°C

- If $[H^+(aq.)] = [OH^-(aq.)] = 1 \times 10^{-7}$ mol $litre^{-1}$, then the solution is neutral.
- If $H^+(aq.) > OH^-$ (aq.)
- (H^+ (aq.) $> 1 \times 10^{-7}$ mol $litre^{-1}$), then the solution should be acidic.
- And if and if $H^+(aq.) < OH^-(aq.)$ or $H^+(aq.) < 1 \times 10^{-7}$ mol $litre^{-1}$, then the solution should be basic or alkaline.

Solution	pH Value	Solution	pH Value
Conc. Hydrochloric acid	0	Dil. Hydrochloric acid	1.0
Conc. Sodium hydroxide	14.0	Dil. Sodium hydroxide	13.0
Gastric Juice	1.4	Lemon juice	2.5
Vinegar	4.0	Tomato juice	4.1
Saliva (before meals)	7.4	Saliva (after meals)	5.8
Coffee	5.0	Soft drinks	6.0
Blood	7.4	Eggs	7.8
Toothpaste	8.0	Baking Soda Solution	8.5
Washing Soda Solution	9.0	Pure Water	7.0

Importance of pH in everyday life –

Plants and Animals are pH-Sensitive –

The pH plays an important role in the survival of animals, including human beings. Our body works well within a narrow pH range of 7.0 to 7.8. The aquatic animals (Fish) can survive in river water within a narrow range of pH change.

Example:

When the pH of rainwater is about 5.6, it is called acid rain. Too much acid rain can lower the pH of river water to such an extent and make it so acidic that the survival of aquatic animals becomes difficult or kill the aquatic animals.

Soil pH and Plants – Most of the plants grow best when the pH of the soil is close to 7. If the soil is too acidic or too basic (too alkaline), the plants grow badly or do not grow at all.

Treatment of Acidic or Basic Soil – The pH of acidic soil can reach as low as 4 and that of the basic soil can go up to 8.3. Chemicals can be added to soil to adjust its pH and make it suitable for growing plants. If the soil is too acidic, then it is treated with materials like quicklime (calcium oxide) or slaked lime (Calcium hydroxide) or chalk (Calcium carbonate). All these materials are bases and hence react with the excess acid present in soil and reduce its acidity. If the soil is too basic (or too alkaline) then its alkalinity can be reduced by adding decaying organic matter (manure or compost). Which contains acidic materials.

Importance of pH in our digestive system –

As we know our stomach produces gastric juice which contains a large amount of hydrochloric acid (pH of about 1.4). The acid so produced does not harm the stomach walls but kills germs and bacteria which enter our digestive system along with food, thus in a way it protects us from diseases and helps in digestion. Sometimes an excess of acid is produced in the stomach due to overeating or eating spicy foods. This stage is called acidity. To get relief from this pain, we take tablets known as antacids. These contain bases to neutralize the excess acids.

Example - Magnesium hydroxide (milk of magnesia). $Mg(OH)_2$

pH changes as the cause of tooth decay –

Generally, the pH in the mouth is more than 7, as the saliva produced in the mouth is basic in nature. However, when we take food, some food particles remain in the mouth after eating and bacteria present in the mouth produce acids by degradation of food particles. This acid lowers the pH in the mouth, tooth decay starts when the pH of acid formed in the mouth falls below 5.5. Therefore, to prevent tooth decay, it is advised to clean the mouth and use basic toothpaste, for cleaning the teeth. It neutralizes the excess acid and prevents tooth decay.

Self-defence by animals and plants through chemical Warfare –

The sting of the honey bee contains formic acid, this acid causes a lot of irritation and pain. The pain can be reduced by applying baking soda paste to the affected region as the acid gets neutralized. In-plant kingdom nettle (Bichu Booti) is a herbaceous plant which grows in wild. The nettle leaves have stinging hair. When a person happens to touch the leaves of a nettle plant accidentally, the stinging hair of nettle leaves injects methanoic acid (HCOOH) into the skin of the person causing burning pain. The nettle sting, being acidic can be neutralized by rubbing baking soda on the skin. Nature provides the remedy for the nettle sting in the form of a 'dock' plant, which often grows beside the nettle plants. The leaves of the dock plant contain some basic chemicals which neutralize methanoic acid.

Salts –

(1) A substance formed by the partial or complete replacement of H^+(aq.) ions of an acid by a metal or electropositive ion, is called a salt.

Example:

$$H_2SO_4 + NaOH \longrightarrow \underset{\text{Sodium hydrogen sulphate}}{NaHSO_4} + H_2O$$

(Partial replacement: only one hydrogen atom is replaced)

$$H_2SO_4 + 2NaOH \longrightarrow \underset{\text{Sodium sulphate}}{Na_2SO_4} + 2H_2O$$

(Complete replacement: Both the hydrogen atom is replaced)

(2) A substance formed by the neutralization of an acid with a base is called salt.

Example:

$$\underset{\text{Acid}}{HCl\ (aq)} + \underset{\text{Base}}{NaOH\ (aq)} \longrightarrow \underset{\text{Salt}}{NaCl\ (aq)} + \underset{\text{Water}}{H_2O}$$

Naming of Salts –

(A) Salt obtained from "Sulphuric acid" are called "Sulphates". e.g. Na_2SO_4, $CuSO_4$

(B) Salt obtained from "nitric acid" are called "Nitrates" e.g. KNO_3, $NaNO_3$

(C) Salt obtained from "hydrochloric acid" are called "Chlorides" e.g. NaCl, $CaCl_2$, KCl

(D) Salt obtained from "phosphoric acid" are called "Phosphates" e.g. $Ca_3(PO_4)_2$, Na_3PO_4, $Mg_3(PO_4)_2$ (E) Salt obtained from "carbonic acid" are called "Carbonates" e.g. Na_2CO_3, K_2CO_3, $CaCO_3$.

(E) Salt obtained from acetic acid are called "Acetates" e.g. CH_3COONa, $(CH_3COO)_2Ca$, $CH_3(COO)_2Pb$

Solved Examples

(1) What are acids?

Answer: A substance is an acid if it dissolves in water to provide hydrogen ions.

(2) What is a base? Give one example.

Answer: Base is a substance which gives OH^- ions when dissolved in water. An example of a base is NaOH.

(3) Write the equation for the dissociation of hydrochloric acid (HCl) in water.

Answer: $HCl + H_2 \rightarrow \quad H_3O^+ + Cl^-$ or it

can also be written as

$$HCl \xrightarrow[H2O]{} H^+(aq) + Cl^-(aq)$$

(4) While diluting an acid why is it recommended that the acid should be added to water and not water to the acid?

Answer: While diluting an acid, water should not be added to a concentrated acid because the heat generated may cause the mixture to splash out.

(5) How is the concentration of H_3O^+ ions affected when a solution of an acid is diluted?

Answer: The concentration of H_2O^+ ions is reduced when a solution of an acid is diluted.

(6) How is the concentration of hydroxide ions OH^- affected when excess base is dissolved in a solution of sodium hydroxide?

Answer: The concentration of hydroxide ions OH^- is increased when excess base is dissolved in a solution of sodium hydroxide.

(7) What effect does the concentration of H^+ (aq.) have on the acidic nature of the solution?

Answer: A solution is more acidic if it has a high concentration of H^+ (aq.) ions.

(8) Do basic solutions also have H^+ (aq.) ions? If yes, then why are these basic?

Answer: Basic solutions also have H^+ (aq.) ions. A solution of an acid or a base always contains both H^+ (aq.) ions as well as OH^- (aq.) ions. It shows the basic character if it has more OH^- (aq.) ions and the acidic character if it has more H^+ (aq.) ions.

(9) Choose strong acid and a strong base from the following: CH_3COOH, NH_4OH, KOH, HCl.

Answer: Strong acid is HCl and strong base is KOH.

(10) What is meant by the pH of a solution?

Answer: pH value of a solution tells about its acidic or basic nature. Values less than 7 represent an acidic solution and above 7 indicate a basic solution.

(11) Which is more acidic – a solution with pH = 6.0 or a solution with pH = 2.0?

Answer: A solution with pH = 2.0 is more acidic.

(12) Which is more basic, a solution with pH = 9.0 or a solution with pH = 13.0?

Answer: A solution with pH = 13.0 is more basic.

(13) What effect does an increase in the concentration of H^+ (aq.) in a solution have on the pH of the solution?

Answer: pH of the solution decreases when the concentration of H^+ increases.

(14) How would you show that lemon and tomato contain acids?

Answer: Both, lemon juice and tomato juice turn blue litmus red. It shows that both contain acids.

(15) What is the action of the solution of sodium carbonate towards litmus?

Answer: Solution of sodium carbonate will turn the colour of red litmus into blue indicating that it is alkaline in nature.

(16) Dry ammonia gas has no action on litmus paper but a solution of ammonia in water turns red litmus paper blue. Why is it so?

Answer: Ammonia in water forms ammonium hydroxide. These hydroxide ions turn red litmus blue.

(17) What is the action on the litmus of:

(a) Dry ammonia gas?

(b) Solution of ammonia gas in water?

Answer: (a) Dry ammonia gas has no action on litmus.

(b) Solution of ammonia gas in water turns red litmus blue.

(19) Why should curd and sour substances not be kept in brass and copper vessels?

Answer: Curd and sour substance contain acids which react with brass and copper.

(20) Why do HCl, HNO_3, etc. show acidic character in aqueous solutions while solutions of compounds like? C_2H_5OH and glucose do not show an acidic character. **[HOTS]**

Answer: A substance will show an acidic character if it gives H^+ ions when dissolved in water. Among these substances, HCl and HNO_3 provide H^+ ions whereas C_2H_5OH and glucose do not give H^+ ions so they do not show acidic character.

(21) Why does an aqueous solution of acid conduct electricity?

Answer: Aqueous solution of an acid conducts electricity because it dissociates to provide ions.

(22) Given two unlabeled bottles, one containing dilute acid and the other water. How would you decide to label them?

Answer: Acid and water can be identified by testing with litmus. Water will not change the colour of red or blue litmus whereas acid will change blue litmus into the red.

(23) Why does distilled water not conduct electricity, whereas rain water does?

Answer: The electric current is carried by ions in solutions. Distilled water has no ions whereas rainwater is slightly acidic and contains ions so rainwater conducts electricity.

(24) 10 mL of a solution of NaOH is found to be completely neutralized by 8 mL of a given solution of HCl. If we take 20 ml of the same solution of NaOH, the amount of HCl solution (the same solution as before) required to neutralize it, will be:

Answer: 16 mL Since the quantity of NaOH solution is doubled, it will require the double quantity of HCl solutions also.

(25) What happens when carbon dioxide gas is passed through sodium hydroxide solution?

Answer: When carbon dioxide gas is passed through sodium hydroxide solution, sodium carbonate is formed.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

Exercise

OBJECTIVE TYPE QUESTIONS

(1) A solution turns red litmus blue; its pH is likely to be-

(A) 1 (B) 4

(C) 5 (D) 10

(2) A solution reacts with crushed egg-shells to give a gas that turns lime-water milky. The solution contains-

(A) NaCl (B) HCl

(C) LiCl (D) KCl

(3) 10ml of a solution of $NaOH$ is found to be completely neutralised by $8\ mL$ of a given solution of HCl. If we take 20 mL of the same solution of NaOH, the amount HCl solution (the same solution as before) required to neutralize it will be-

(A) 4 mL (B) 8 mL

(C) 12 mL (D) 16 mL

(4) Which one of the following types of medicines is used for treatment indigestion-

(A) Antibiotic (B) Analgesic

(C) Antacid (D) Antiseptic

(5) Milk of magnesia is an –

(A) Acid (B) Antacid

(C) Alkali (D) Rock salt

(6) Noble metals are dissolved in –

(A) Conc. HNO_3 (B) Conc. HCl

(C) Conc. H_2SO_4 (D) Aqua-regia

(7) Which of the following is not a strong acid?

(A) H_2SO_4 (B) CH_3COOH

(C) HNO_3 (D) HCl

(8) Which of the following is a basic salt?

(A) SnCl (B) NaCl

(C) NH_4Cl (D) CH_3COONa

(9) Potash alum is a?

(A) Simple salt (B) Complex salt

(C) Acid salt (D) Double salt

(10) $NaHCO_3$ represent the formula of which one of the following?

(A) Sodium carbonate (B) Baking soda

(C) Sodium acetate (D) Washing soda

(11) The reaction between an acid and which of the following will result in an evolution of carbon dioxide gas?

(A) Metal (B) Metal oxide

(C) Non-metallic oxide (D) Metal carbonate

Answer key

(II) OBJECTIVE TYPE QUESTIONS:

(1)	(D)	(2)	(B)	(3)	(D)	(4)	(C)
(5)	(B)	(6)	(D)	(7)	(B)	(8)	(D)
(9)	(D)	(10)	(B)	(11)	(D)		