Chapter → 2

Acids Bases and Salts

Acid are (generally) sour in test. Acid contains H^+ ions in aqueous solution.

? Base are Bitter in test. Base contains (OH^-) ions in aqueous solution

Indicators :—

Some chemical substances show a sharp change in their colour or odour in an acidic or basic medium. Such substances are called acid - base indicator

(i) Indicators that show a change in colour
(ii) Indicators that show a change in odour [Olfactory Indicators]

In Litmus is a purple coloured dye [Mauve or pale purple] obtained from lichens that belong to Thallophyta division of plant kingdom

Types of litmus papers.

Red	Neutral	Blue
Acid → no change	Pale Purple/Mauve	Acid → Red
Neutral → no change	Acid → Red	Neutral → No change
Base → Blue	Base → Blue	Base → No change

Natural Indicators	Neutral Solution	Acidic Solution	Base Solution
1. Turmeric paste -	Yellow	Yellow	Red
2 Hydrangea flower - Petals	Blue Soil	Blue soil	Pink Soil

Artificial Indicators or Man Made

3	Phenolphalein	colourless	colourless	Pink
4	Methyl orange	Orange	Red / Pink	Yellow
Natural 5	china rose solution	Light pink	Dark Pink (Magenta)	Green

Indicates show a change in colour (Olfactory Indicat
Base Acid Base
a) Onion odoured cloth strips — Smell remains same — Smell van
b) Vanilla essence — Smell remains same — Smell vanis
c) Clove oil. — Smell remains same — Smell vanish

On the basis of source acids are classified into:

(i) Organic
source: (i) Plants & Animals
These are not corrosive
Special condition :- (i) C and H are present.
(ii) Atleast one C is directly bonded to H

Examples :-

Natural source	Acid
Tamarind	Tartaric
Tomato	Oxalic
Citrus fruit	citric
Tomato	Oxalic
Vinegar	Acetic (CH_3COOH)

(ii) Inorganic
Rocks & minerals Earth crust
These are corrosive

Examples :-
Hydrochloric acid (HCl)
Sulphuric acid H_2SO_4
Nitric acid (HNO_3)
Carbonic acid (H_2CO_3)

Physical properties of Acids

(i) Physical state :-
Some acids are found in solid-state while others found in liquid state at room temperature 25°C

Examples :-

Acid	Physical state (At 25°C)
a) Boric acid (H_3BO_3)	Solid.
b) Tartaric acid ($C_4H_6O_6$)	
c) Oxalic acid $(COOH)_2$	
a Hydrochloric acid (HCl)	Liquid.
b) Carbonic acid (H_2CO_3)	
c) Sulphuric acid (H_2SO_4)	
d) Nitric acid (HNO_3)	

(ii) Corrosive nature :- Generally all mineral acids are corrosive and can cause painful burns if fallen on the skin.

Chemical properties of Acids

(i) Reaction with Metals : Dilute acids react with metal to form metallic salts and hydrogen gas with effervescence.

Metal + Dil acid → salt + Hydrogen gas ⇒ Metal-non metal displacement reaction

Displace Hydrogen of acid

when reactivity of metal > hydrogen

Effervescence → Evolution of gas from a solution in the form of bubbles along with Fizzing and foaming.

↓ Sometimes.

$Zn(s) + 2\,dil.\,HCl(aq) \rightarrow ZnCl_2(aq) + H_2(\uparrow)$

$Mg(s) + 2\,dil\,H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(\uparrow)$

Experimental Verification of evolved Hydrogen:

On bringing a burning splinter near the mouth of the test tube or beaker in which the

reaction take place a 'squeaky pop' sound is heard this confirms the presence of Hydrogen gas which is highly inflammable and explodes when ignited in the presence of air (or oxygen)

1) Hydrogen → Colourless & odourless gas.
2) Hydrogen explodes in presence of oxygen (air) with a squeaky pop sound.

Hydrogen-Oxygen mixture is Detonting.

(iii) Reaction with metal carbonate/bicarbonates: Acids react with metal carbonates and metal hydrogen carbonate to produce corresponding salt, water and carbon dioxide gas with effervescence.

Metal carbonate/ + Acids → Salt + water + Carbon dioxide

$CaCO_3(s) + CH_3COOH(aq) \rightarrow Ca(CH_3COO)_2(aq) + H_2O(l) + CO_2\uparrow$

$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(\uparrow)$

Experimental Verification of evolved carbon dioxide:
When carbon dioxide is passed through limewater (saturated solution of $Ca(OH)_2$), it turns the limewater milky or turbid due to the formation of insoluble Calcium carbonate and confirms the presence of carbon dioxide gas.

$Ca(OH)_2(aq) + CO_2(g) \rightarrow CaCO_3(s) + H_2O(l)$

(iv) Reaction with metal oxides: Acids react with metal oxides to form a salt and water.

Metal oxide + Acid → Salt + water

$CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

Blue/Green

$CaO(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$

Role of water in Dissociation of Acid

Preparation of HCl

I $NaCl(s) + Conc.\ H_2SO_4(aq) \rightarrow NaHSO_4(aq) + HCl(g)$

II Dry litmus paper does not show any change in colour when brought near the mouth of the test tube

III Moist / wet blue litmus paper turns red when brought near the mouth of the test tube, indicating the presence of an acid, which in this case is HCl

* Acid (here HCl gas) shows its acidic character in presence of water.

Acids → comes in contact with water → Dissociate (Breaks) into ions → Then it shows its acidic character.

Important condition

During the humid climate hydrogen chloride gas is first passed through a gerard tube containing anhydrous calcium chloride which absorb the moisture and makes the gas dry. → Drying Agent.

Conclusion

Acid show their acidic character only in the presence of water. In the dissolved case HCl gas dissolves in water and

dissociates into ions e.g hydrogen ions (H^+) and chloride ions (Cl^-) as:

$$HCl(g) + H_2O(l) \rightarrow H^+(aq) + Cl^-(aq)$$

$H^+(aq)$ → Hydrate / Aqueous ions → Surrounded by water molecules
$Cl^-(aq)$

Arrhenius concept → Any substance that release H^+ ions in water.

Are H^+ and $H^+(aq)$ are same?
No H^+ and $H^+(aq)$ are not same.

Does (H^+) ions have an independent existence?
No $H^+ + H_2O \rightarrow H_3O^+ / H^+(aq)$
↓ Hydronium Ion

Hydrogen
↓ 1 electron
↓ 1 Proton
↓ 1 electron lost
unstable H^+ ← 1 Proton only

What happens when water is added to acid?

(i) The reaction between acid and water is exothermic i.e it will release a large amount of heat. So if the water is added to the acid some water consists to water vapour on the interface and a mixture of acid and water vapour ~~on the~~ splash out and cause burns.

(ii) The beaker in which the dilution is carried out may also break due to excessive local heating

Why we should add acid to water ?

To slow down the exothermic reaction, dilution of concentrated acid is always done by slowly adding concentrated acid into a sufficient amount of water with gentle stirring.

Types of Acids

① Hydrea Acids
Hydrogen + Non Metal
① Hydrochloric Acid
Hydrogen & chlorin
(HCl), HBR, HI, HF

② Oxy Acids
Hydrogen + Polyatomic anion containing Oxygen
SO_4^{-2}, NO_3^{-}, CO_3^{2-} etc
Sulphuric acid
$HSO_4^{-}(aq) + 2H_2O(l) \rightarrow 2H_3O^{+} + SO_4^{2-}(aq)$
$SO_4^{2-} + 2H_2O \rightarrow 2H_3O^{+} + SO_4^{2-}$

What are Bases ?

Metal oxides [CaO, MgO, Na_2O, K_2O etc]
Metal hydroxides [$Ca(OH)_2$, $Mg(OH)_2$, NaOH, KOH etc]
~~ammonium hydroxide~~ (NH_4OH) (Non Metal)

Physical Properties of Bases

(i) Taste and texture : they taste bitter and they are slippery in touch
(ii) Corrosive nature : Some bases, like Sodium Hydroxide (NaOH caustic soda) and potassium hydroxide (KOH) etc produce a burning sensation on the skin. So it is advisable to not touch or taste any basic substance. All Bases are not corrosive
(iii) Electricity conduction : Like acids, bases also conduct electricity in their aqueous solution (bases dissolved

ion (water. → Any Metal atom

Ex :- $MOH(aq) \rightarrow M^+(aq) + OH^-(aq)$

$NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$

General form :

If any Metal atom $OH \rightarrow H^+(aq) + OH^-(aq)$

The bases which are soluble in water and furnish hydroxyl ions (OH^-) in aqueous solution are known as alkalis

Alkali → Na_2O, K_2O, MgO, CaO, KOH

Base → Na_2O, CuO, Fe_2O_3, CaO, KOH

cation

Cation move to cathode, Anion move to Anode

Chemical Properties of Bases

Not all metals react with bases to form salt and Hydrogen gas. Only amphoteric metals (S, A, B, P, Z Tin (Sn), Aluminium (Al), Beryllium (Be), Lead (Pb), Zinc (Zn) reacts with both acid & Base to form salt and Hydrogen gas.

(i) Metal (Amphoteric) + Alkali + water → salt + Hydrogen

$Zn(s) + 2NaOH(aq) + 2H_2O(l) \rightarrow Na_2Zn(OH)_4(aq) + H_2(\uparrow)$

Or $Zn(s) + 2NaOH(aq) \rightarrow Na_2ZnO_2(aq) + H_2(\uparrow)$

(ii) Reaction with non Metal oxides : Bases react with non metal oxides to form a salt and water.

Non-metal oxide (Acids/Neutral) + Base (Alkali) → Salt + water

The above reaction is a type of Neutralisation reaction.

* Non metalic oxides are neutral and acedic in nature

(i) Strong Acids : The acids that dissociate completely into ions when dissolved in water and and produce large amounts of $H^+(aq)$ in the solution are known as strong acids. → or H_3O^+

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

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

* All mineral / inorganic acids are strong acids with exception including carbonic/(weak) acid (H_2CO_3) and more

(ii) Weak Acids : The acids that partially dissociate into ions when dissolved in water and produce small amounts of $H^+(aq)$ in the solution are known as weak acid

$CH_3COOH(aq) \rightleftharpoons H^+(aq) + CH_3COO^-(aq)$

$H_2CO_3(aq) \rightleftharpoons 2H^+(aq) + CO_3^{2-}(aq)$

Organic acids are weak acids

(iii) Strong Bases : The bases that dissociate completely into ions when dissolved in water and produce large amounts of $OH^-(aq)$ in the solution are known as strong bases.

Hydroxide ion

Caustic soda → $NaOH(aq) \rightarrow Na^+(aq) + OH^-(aq)$

Caustic potash → $KOH(aq) \rightarrow K^+(aq) + OH^-(aq)$

Ex: $NaOH$, $Ca(OH)_2$, $Mg(OH)_2$, KOH

(iv) Weak Bases :- The bases that partially dissociate into ions when dissolved in water and produce small amounts of $OH^-(aq)$ in the solution are known as weak bases

Ammonium hydroxide $NH_4OH(aq) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

Copper hydroxide $Cu(OH)_2(aq) \rightleftharpoons Cu^{2+}(aq) + OH^-(aq)$

Introduction to PH

A room temp. 25°C the solution may have PH from 0 to 14 for different solutions

the PH values will be:

Neutral Solution : PH = 7

Acidic Solution : PH < 7

Basic Solution : PH > 7

PH scale

If the PH value decrease than 7, the H^+ ions concentration increases and hence the acidic character increase.

If the PH value increase than 7 the H^+ ions concentration decrease or OH^- ions concentration increases and hence the basic character increase

Universal Indicator

The PH of a solution can be measured using a universal indicator which is a mixture of thymol blue, phenolphthalein etc.

It shows different colours at different H^+ ions concentration in the solution.

Generally a paper strip impregnated in the universal indicator is used for measuring the

PH of the solution. This paper strip is known as PH Paper

Salt :- Salts are ionic compounds that contain a positively charged ion (cation) usually a metal ion except NH_4^+ and negatively charged (anion) is a non-metal ion

Salt	Formula	Positive ion	Negative ion
Sodium chloride	$NaCl$	Na^+	Cl^-
Magnesium chloride	$MgCl_2$	Mg^{2+}	$2Cl^-$
Potassium nitrate	KNO_3	K^+	NO_3^-
Sodium carbonate	Na_2CO_3	$2Na^+$	CO_3^{2-}
Ammonium chloride	NH_4Cl	NH_4^+	Cl^-

cations comes from Base, Anion comes from Acid.

Acid + Base → Salt + water

$HCl + NH_4OH \rightarrow NH_4Cl + H_2O$ PH < 7 when dissolve in water

strong + weak → Acidic + water

Acid Base Salt

What is iodised salt ? Why it is used ?

Sodium iodided / Potassium iodide is added in common salt To fullfill demand of iodine in body

→ Deficiency in body by lack of iodine.

→ Goitre :- lack of iodine during pregnancy → mentally retarded child

Sodium hydroxide - Manufacturing and uses.

Common name → caustic soda ; chemical formula : $NaOH$

Manufactured by: chlor Alkali Process
Chlor [chlorine by product] NaOH [Main product]
Manufacturing of NaOH

I Brine solution [common salt dissolve in water]
$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$

II At anode [Oxidation - loss of electrons]
$Cl^- \rightarrow Cl + e^-$ - $[2Cl^- \rightarrow Cl_2 + 2e^-]$

III At cathode [Reduction Gain of e^-]
$H^+ + e^- \rightarrow H$ $[2H^+ + 2e^- \rightarrow H_2]$
Na^+ & OH^- ions are left near cathode.
self ionisation of water $H_2O \rightleftharpoons H^+ + OH^-$

IV $2NaCl(aq) + 2H_2O(l) \xrightarrow{Electricity} 2NaOH(aq) + H_2(g) + Cl_2(g)$
Complete reaction this process.

Materials obtained and uses
$H_2(g) + Cl_2(g) \xrightarrow{Sunlight} 2HCl(g)$

* to HCl use for cleaning steel, medicines, cosmetics
* H_2 use for fules, margarine, ammonia for fertilisers
* Cl_2 use for water treatment, swimming pools, PVC, disinfectants, CFCs, pesticides.
* uses of NaOH formed near cathode - De greasing metals, soaps and detergents, paper making, artificial fibers

Calcium Oxychloride - Manufacturing and uses.
Calcium oxychloride [$CaOCl_2$]
common name Bleaching Powder [yellowish white
Manufacture by: Hasenclever plant and Beckmann plant.

Principle of manufacture :- The chlorine gas obtained as a by-product from the chlor alkali process when reacts with dry slaked lime [$Ca(OH)_2$] produces bleaching powder

Beckmann's plant [vertical]

$Ca(OH)_2(s) + Cl_2(g) \rightarrow CaOCl_2(s) + H_2O(g)$

Slaked lime — Bleaching Powder — water vapour

Hasenclever plant

$Ca(OH)_2(s) + Cl_2(g) \rightarrow CaOCl_2(s) + H_2O(g)$

Uses of Bleaching powder ($CaOCl_2$)

a) It is used in the textile industry for bleaching cotton and linen (Natural fiber obtained from flax plant)
b) It is used as an oxidising agent in chemical industries.
c) It is used for disinfecting drinking water by killing germs. → because of chlorine gas.

Baking Soda - Manufacturing and uses.

Baking Soda [common name]

Chemical formula → $NaHCO_3$

Chemical Name → Sodium hydrogen carbonate / bicarb

Manufactured by → Ammonia soda process / Solvays proc

Ammonia - Soda process / Solvay process - Flow chart

Brine solution [NaCl + H_2O] → Ammonia Tower [NH_3]

↓

Ammoniated Brine [NaCl + H_2O + NH_3]

↓

Carbonating Tower

Lime kiln

* $CaCO_3(s) \xrightarrow{Heat} CaO(s) + CO_2(g)$
* $CaO(s) \xrightarrow{H_2O} Ca(OH)_2$

$NaCl(aq) + H_2O(l) + NH_3(g) + CO_2(g) \rightarrow NH_4Cl(aq) + NaHCO_3$

Filter out

↓

Main product

* When we get $Ca(OH)_2 + NH_4Cl \rightarrow CaCl_2 + NH_4OH$

$CaCl_2 + NH_4OH \rightarrow [NH_3 + H_2O]$

Uses of Baking Soda

a) It is used to make baking power (mixture of baking soda, mild edible acid such as tartaric acid and cornstarch [absorb moisture to avoid wet the baking soda & tartaric acid.
b) It is used in soda-acid fire extinguishers
c) It is used as an ingredient of antacid Medicines.

Manufacture of Soda Ash

Soda Ash [Na_2CO_3

Chemical Name: Sodium carbonate

Manufactured By: Solvays / Ammonia Soda process

Thermal decomposition of Baking Soda

$2NaHCO_3(s) \xrightarrow{\Delta} Na_2CO_3(s) + H_2O(g) + CO_2(g)$

↓

Soda ash

Washing Soda: preparation and uses

Washing Soda [common name] formed of Sodium Carbonate. Chemical formula → $Na_2CO_3 \cdot 10H_2O$

Chemical Name → Sodium carbonate decahydrate

Preparation :- We have observed that on heating, sodium hydrogen carbonate ($NaHCO_3$) decomposes to give sodium carbonate (Na_2CO_3); crystallisation of Na_2CO_3 gives washing soda. It is also basic salt.

$$Na_2CO_3(s) + 10H_2O(l) \rightarrow Na_2CO_3 \cdot 10H_2O(s)$$

(Hydrated salts)

Water of Crystallisation

The fixed number of water molecules that are attached to one formula unit salt and makes the salt crystalline is called water of crystallisation.

* Water that provides a salt → crystal like structure
↳ definite geometrical shape occurs of regular arrangements of atoms.

Uses of washing soda.

1. It is used to remove permanent hardness of water
2. It is used to manufacture sodium compounds such as borax (Sodium tetraborate decahydrate, $Na_2B_4O_7 \cdot 10H_2O$).
3. It is used a cleaning agent to remove stubborn stain from coffee.

Water

① Hard water
dissolved salts
est ← → t

Easily removed by boiling ← Temporary Because of bicarbonates of Ca & mg

Permanent Because of chlorides & sulphate of Ca & mg

② Soft water
No dissolved salt or distilled water

* Plaster of paris : Preparation and uses.

Plaster of paris [common name]

Chemical formula → $CaSO_4 \cdot \frac{1}{2} H_2O$ or $(CaSO_4)_2 \cdot H_2O$

Chemical name → calcium sulphate hemihydrate

Prepared by → when gypsum ($CaSO_4 \cdot 2H_2O$) is heated in a kiln (भट्ठा) at 100°C or 373K, it loses three-fourth of its water of crystallisation forming the plaster of paris.

$$CaSO_4 \cdot 2H_2O(s) \xrightarrow{100°C/373K} CaSO_4 \cdot \frac{1}{2} H_2O(s) + 1\frac{1}{2} H_2O(g)$$

Calcium sulphate dihydrate

Dead Burnt plaster : $CaSO_4 \cdot 2H_2O(s) \xrightarrow{\text{T}>100°C} CaSO_4(s) + 2H_2O(l)$

Anhydrous calcium sulphate

Setting of pop → when plaster of paris is mixed with water and left for half an hour to one hour, it rehydrates to form a hard mass, i.e gypsum.

$$CaSO_4 \cdot \frac{1}{2} H_2O(s) + 1\frac{1}{2} H_2O(l) \rightarrow CaSO_4 \cdot 2H_2O(s)$$

uses of plaster paris

a) It is used for setting fractured bones in the right position.

b) It is used for making toys, decorative items, statues and more.

c) It is used to make the surface of walls and ceilings smooth.

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