New Chapter

Date __/__/__

Saathi

→ Acid, Bases and Salts.

Compound

↙ Original/Source

↘ categorised as :-

Composition/Behaviour

1) Organic compound

2) Inorganic compound

i) Acid
ii) Base
iii) Salt

Indicator

→ An acid indicator is a substance that assumes different colors or gives smell to indicate presence of acid, base or salt, is known as indicator.

Indicators

↙ Colour based ↘ Synthetic

Natural

↳ Litmus

↳ Turmeric

1) Phenolphathalein

2) Methyl orange

Bases, Acids and Salts

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Indicators - Smell based

Olfactory Indicators

↓

Onion juice

Vanilla

- The smell changes based on the result/the solution added.

Sample - 1

Aqueous sol. of Sodium hydroxide → caustic sod

- Ph paper changes colour to dark blue indicating, estimated ph 14.

Sample - 2

Acetic acid (CH_3COOH)

- It is a weak acid.
  Acetic acid has smell of vinegar → Ethanoic Acid.

→ Ph paper colour indicates to Orange,
  PH = 3 or 4.

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Sample 3.

→ Sample no. 3 → Dil. H_2SO_4.

Change of colour on ph paper → pinkish-red

Approx. ph – 1

Sample 4.

→ Dil. HCl acid.

ph → 1-2

• Colour change on ph paper → pink-re

Sample 5

→ $NaHCO_3$ solution.

→ Colour change on ph paper → light blue.

Ph → 8-9 approx.

Sample 6.

→ Tap water

→ Colour change → green.

Ph → 7 approx.
– 7.5

Draw tables.

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PH → Potenz of hydrogen

↓

German for power

- PH is determined by colour change observed on the PH paper or universal indicator.
- Less than 7 indicates Acidic substance.
- 7 indicates neutral substance.
- More than 7 to 14 indicates Alkaline nature.

Acid

- Arrhenius concept is the oldest concept on this topic.

→ Acid is ~~att~~ a substance that releases ~~of~~ or liberates H^+ ion on dissolving in water.

→ Bronsted - Lowry concept.

- Based on reaction between acid & base.

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Nature of Acids.

- Acids are sour in taste.
- Acids contain hydrogen atom.
- Acids turn blue litmus red.
- Aq. solution of Acids → good conductor electricity.
- Acids are oily in touch and corrosive in natur

Chemical properties of Acids

$

Classification of Acids

(i) Classification of Acid

→ is on the basis of constituent element.

→ Oxyacid → Acids which contain O_2 and H_2

→ ~~hydroo~~ hydracid

↳ an acid which contains hydrogen and ~~other~~ ~~non-metallic elements~~ except oxygen.

In oxyacids,

Ex - HNO_3, H_3PO_4, H_2SO_4, H_2BrO_3, CH_3COOH.

In hydracid,

Ex - HCl, HBr, HCN, HI, HF.

→ (ii) On the basis of source/origin

→ Organic acid → Obtained from biotic s

→ Inorganic acid → Obtained synthetically

↓

They are also called Mineral Acid.

Oleum
→ $H_2S_2O_7$

HClO?
~~Per~~ H_3PO acids?

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Ex - Methanoic Acid → (HCOOH)
Malic Acid → C) → Apple
Tanic Acid → ( )
Citric Acid → ( ) → Tea
Acetic Acid → (CH_3COOH) → Citric fruit
Oxyalic Acid
Lactic Acid
Abscorbic Acid → Vitamin C.

Inorganic acid

HNO_3 → Nitric
H_2SO_4 → Sulfuric
HCl → Hydrochloric
HCN →

→ (iii) On the basis of No. of Replaceable Hydrogen/ release of H^+ ion.

→ Strong Acid → Release all H^+ ion.
→ Weak Acid → Release some, retain a few H^+ ions.
Hydrogen

- Carbon including acids are weak acids as carbon doesn't let go easily Hydrogen.

Strong Acid,
Ex - HCl, H_2SO_4, H_3PO_4

Weak Acid,
Ex - HCO_3, CH_3COOH, HCOOH,

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Concept

Basicity of Acid

→ No. of hydrogen that can be taken out from 1 Molecule

→ Monobasic
→ Dibasic
→ Tribasic

Concentrated and dilute acid

- On the basis of concentration of acid in aqueous solution.

① Concentrated Acid
② Dilute Acid.

- Commonly scaled on ppm.

Parts per million: Solubility $\times 10^6$.

Chemical properties of Acid

① Reaction with Metal:

Metal + Acid → Metallic ~~Acid~~ Salt + H_2(g)

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This is a displacement reaction which is ~~acidic in nature~~ exothermic in nature.

→ All ~~acid~~ active metal will react with acid to form metal salt and release H_2 (↑) gas.

↑ Active Metal → Metals more reactive than H_2.

- Nitric acid is a strong oxidising agent, it oxidises the H_2 gas into H_2O and there is a release of NO(g) and NO_2(g) as per concentration of Nitric Acid.

NO → low conc.
NO_2 → high conc. { brown fumes }

$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2(\uparrow)$.

$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2(\uparrow)$

$Cu + HNO_3$ (conc.) $\longrightarrow Cu(NO_3)_2 + NO_2 + H_2O$.

→ Cu reacts with acids regardless of Cu being lower than H_2 in reactivity series.

- All acids are oxidising agent.

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$Mg + HNO_3 \longrightarrow Mg(NO_3)_2 + H_2(\uparrow)$

$Mn + HNO_3 \longrightarrow Mn(NO_3)_2 + H_2(\uparrow)$

↓

Exception to oxidative property of Nitric Acid.

16/7/25

Liebig Concept: According to Liebig an acid is a substance that contains hydrogen, which can be released partially or completely by a metal or a group of atom acting like a metal to produce salt.

conc. → able to completely remove H.

$Na + H_2SO_4 \longrightarrow Na_2SO_4 + H_2(\uparrow)$

dil. → unable to completely remove H.

$Na + H_2SO_4 \longrightarrow NaHSO_4 + H_2(\uparrow)$

- Sodium (Na) more reactive than hydrogen displaces it.

$NH_4^+ + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_2(\uparrow)$.

$(NH_4)^+$, ion of NH_3, is acting like a base. (NH_3 → ammonia)

~~dissolution~~

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- Method of collection of H_2 (↑) g during reaction is collected by ~~downward~~ downward displacement of water.
  - This is applied because :-
    - (i) is hydrogen not soluble in H_2O.
    - (ii) hydrogen also less dense than H_2O.
    - (iii) Specific heat capacity of H_2O is higher among all liquids, so it will absorb the heat released during exothermic displacement reaction.

S.H.C → Amount of heat required to raise temperature by ~~1°C~~. 1°C.

↓

Specific heat capacity.

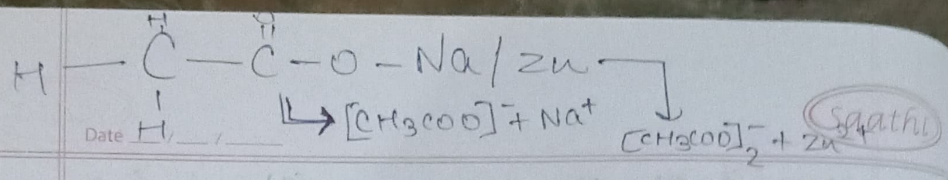
$$Zn + 3HNO_3 \xrightarrow{\text{Conc.}} Zn(NO_3)_2 + NO_2 + H_2O.$$

* HNO_3 oxidised H into H_2O.
  causes release of NO or NO_2.

- $2Na + 2CH_3COOH \longrightarrow 2CH_3COONa + H_2$ (↑).
  (Sodium acetate).

$$Zn + 2CH_3COOH \longrightarrow (CH_3COO)_2Zn + H_2 \text{ (↑)}$$

- Zinc acetate is used as Medication.



- Metallic Carbonate
-

Base

- According to Arrhenius, base is a substance that releases OH^- ion on dissolving in H_2O. (hydroxyl ion)

- General properties of base

Chemical properties of Base

(1) Reaction with metal

Metal + Base ⟶ Metallic Salt + H_2

$Zn + 2NaOH \longrightarrow Na_2ZnO_2 + H_2$

- In this reaction external heat is given as zinc doesn't easily react with base.

(2) Reaction with non-mettalic oxide

Non-metallic oxide + Base ⟶ Salt + Water.

↓

Acidic in nature

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$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

- Carbonate, sulphate, nitrates all are salts.

$Cl_2O + NaOH \rightarrow NaOCl + H_2O$.

Neutralization reaction

→ A reaction in which acid and base react to form salt + water, this reaction is known as neutralization reaction.

$HCl + NaOH \rightarrow NaCl + H_2O$

Acid + Base → Salt + water.

→ It is exothermic reaction but heat is produced in less quantity which is barely evident.

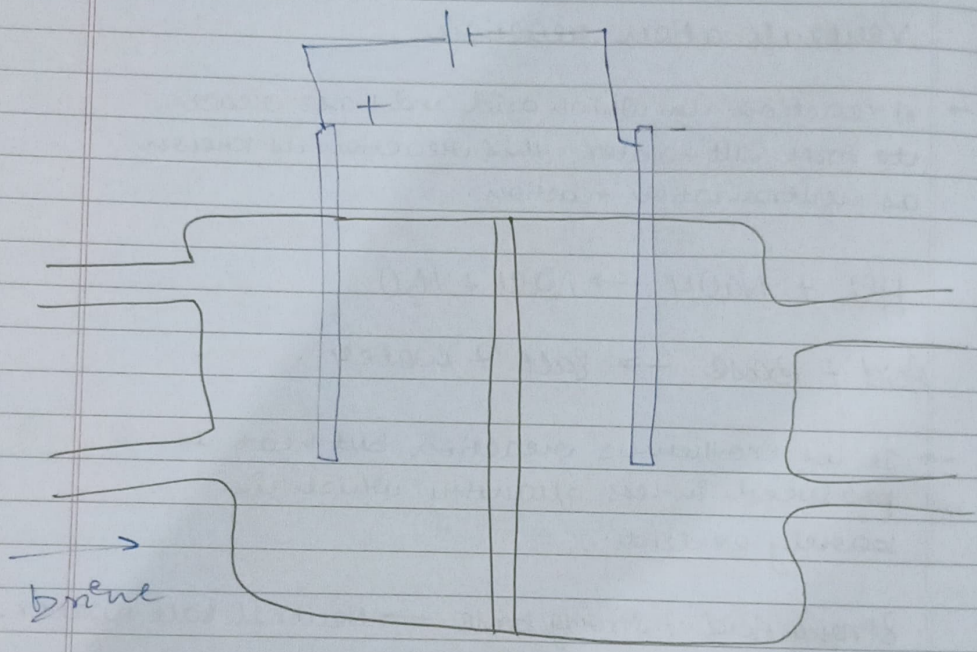
Strong Acid + Strong base → Neutral salt + water

Strong Acid + weak base → Acidic salt + water

Strong Base + weak acid → Basic salt + water.

① NaCl → Sodium chloride
② Pottassium nitrate → KNO_3.
③ Aluminium Chloride → $AlCl_3$
④ Zinc Sulphate → $ZnSO_4$
⑤ Copper sulphate → $CuSO_4$

(6) Sodium Acetate → CH_3COONa
(7) Sodium carbonate → Na_2CO_3
(8) Sodium hydrogen carbonate → $NaHCO_3$.



• H_2SO_4 is a strong dehydrating agent.

Raw Material

NaCl → H_2, Cl_2, NaOH → $NaCl + H_2O$ / Brine | Chlo Alka proce

H_2SO_4 → $NaHCO_3$, Na_2CO_3 | Solvay process

HCl(g)

↳ Materials made with NaCl as raw material

Chlor-Alkali Process

① $NaCl(s) \rightleftharpoons Na^+ + Cl^-$

② $H_2O \rightleftharpoons H^+ + OH^-$

At anode,

$2Cl^- - 2e^- \longrightarrow Cl_2(g)$.

At Near Cathode,

$Na^+ + OH^- \rightarrow NaOH$

At Cathode,

$2H^+ + 2e^- \rightarrow H_2(g)$.

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Solvay process

$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$

Brine

$NaHCO_3$ is not soluble in NH_4Cl, so $NaHCO_3$ will be filtered and then it will be dried for use.

$NaHCO_3$ is baking soda.

Action of heat.

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

→ $NaHCO_3$ is antacid. It relieves acidity.

Na_2CO_3 is Soda ash.

↳ Basic salt.

Baking powder → Baking Soda + Acetic Acid

↓

When Na_2CO_3 is produced,

Na_2CO_3 + Tartaric Acid → Sodium Tartarate + $CO_2(g) \uparrow$ + H_2O.

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(1) $NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$

(2) Action of heat

$2NaHCO_3 \longrightarrow Na_2CO_3 + H_2O + CO_2$

(3) $Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3 \cdot 10H_2O$

Sodium carbonate decahydrate. ✓

water of crystallization.

Water of crystallization.

↳ Gives shape of crystal.

↳ Gives colour of salt.

for ex - $FeSO_4 \cdot 7H_2O$ → Green
↳ Green vitrol.

- $CuSO_4 \cdot 5H_2O$ → Blue
↳ Blue vitrol.

- When such salts are heated they lose their water of crystallization, hence they become anhydrous salt and will lose the colour.

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Bleaching powder

Chemical name: Calcium oxychloride / calcium hypochlorite.

Formula: $CaOCl_2$

Preparation: Dry slaked lime treated with chlorine gas.

$$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$$

$Ca(OH)_2$ → Calcium hydroxide

$CaOCl_2$ → PH: 11-13.

$$CaOCl_2 + H_2SO_4 \text{ (dil.)} \longrightarrow CaSO_4 + Cl_2 + H_2O$$

Cl_2 → Bleaching Agent.

Gypsum

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Gypsum

Chemical: Calcium sulphate dihydrate.

Formula: $CaSO_4 \cdot 2H_2O$.

- Available as mineral, also synthetically created.

Thermal Decomposition

$$CaSO_4 \cdot 2H_2O \xrightarrow[100°C]{373K} CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O$$

On applying heat, the water is removed.

→ $CaSO_4 \cdot \frac{1}{2}H_2O$ → Plaster of Paris.

$$CaSO_4 \cdot \frac{1}{2}H_2O + \frac{3}{2}H_2O \rightarrow CaSO_4 \cdot 2H_2O$$

↳ Rehydration of POP results into Gypsum.

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Action of Water on Acid

{H_3O^+}.

→ According to Arrhenius concept, on dissolving acid into water, there will be release of H^+ ion.

↳ H^+ ion can not be in free state. It bonds with water molecule.

↓

$H^+ + H_2O \rightarrow H_3O^+$

{Hydronium ion}.

↓

This conversion is a highly exothermic process.

→ As a result, acid should be added in water, not water in acid. The reaction's heat can be absorbed by the specific heat-capacity of H_2O.

Monobasic acids dissociate into hydronium ion in 1 step.

$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$

Acetate ion.

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Dibasic Acids take 2 steps to completely dissociate :-

$H_2SO_4 + H_2O \rightleftharpoons H_3O^+ + HSO_4^-$.

($H_2O + H^+ \rightarrow H_3O^+$)

$HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{2-}$.

Tribasic Acids take 3 steps :-

$H_3PO_4 \xrightarrow{+H_2O} H^+ + H_2PO_4^-$

$H_2PO_4^- \xrightarrow{+H_2O} H^+ + HPO_4^{2-}$.

$HPO_4^{2-} \xrightarrow{+H_2O} H^+ + PO_4^{3-}$.

$H_2O + H^+ \rightarrow H_3O^+$.

Reaction of Salt with Acid

$NaCl + H_2SO_4 \rightarrow Na_2SO_4 + HCl(g)\uparrow$

↓

Double-displacement reaction.

Sulfuric acid is a strong dehydrating agent so it will absorb all the water during reaction.

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→ There will be no aqueous solution of sodium sulphate formed during reaction.
The HCl (g) will be dry and will not show acidic nature.

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