Acids, Bases and Salts

Properties of Acids

Acid: a substance that produces hydrogen ions (H^+) when dissolved in water.

Definition of Acids: **Proton donors**.

Indicators

- Have a pH between 1 (strong) and 6 (weak)
- Turns blue **litmus** red
- Turns **methyl orange** indicator red
- Colourless in **Thymolphthalein**

Weak and Strong Acids

These are the acid which are strong except these all acids are weak: H_2SO_4 , HNO_3, $HClO_4$, HCL, HBr, HI.

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1. **Strong acids: completely dissociated in aqueous solution** producing lots of H^+ ions: e.g: $HCl\ (aq) \rightarrow H^+\ (aq) + Cl^-\ (aq)$
2. **Weak acids: partially dissociated in aqueous solution** producing few H^+ ions e.g: $CH_3COOH\ (aq) \rightleftharpoons H^+\ (aq) + CH_3COO^-\ (aq)$

<u>Which Acid forms which Salt</u>

1. **Hydrochloric acid (HCl)** forms chloride salts: **Cl^{1-}**
2. **Sulfuric acid (H_2SO_4)** forms sulfate salts: **SO_4^{2-}**
3. **Nitric acid (HNO_3)** forms nitrate salts: **NO^{3-}**
4. **Phosphoric acid (H_3PO_4)** forms phosphate salts: **PO_4^{3-}**
5. **Acetic acid (CH_3COOH)** forms acetate salts: **CH_3COO^{1-}**
6. **Hydrofluoric acid (HF)** forms fluoride salts: **F^{1-}**

Chemical properties

- Acid + metal → salt + hydrogen gas
- Acid + base → salt + water
- Acid + metal carbonate → salt + carbon dioxide + water
- Acid + metal hydroxide → salt + water
- Acid + metal oxide → salt + water

Neutralization Reaction:

A neutralization reaction is a chemical reaction between an acid and a base that results in the formation of water and a salt. In this reaction, the acidic hydrogen ions (H^+) from the acid combine with the basic hydroxide ions (OH^-) from the base to form water (H_2O). The remaining ions combine to form a salt, which is typically composed of the cation from the base and the anion from the acid.

The general equation for a neutralization reaction can be represented as:

acid + base → salt + water

For example, a common neutralization reaction is the reaction between hydrochloric acid (HCl) and sodium hydroxide (NaOH), which produces sodium chloride (NaCl) and water (H_2O):

$HCl + NaOH \rightarrow NaCl + H_2O$

Neutralization reactions are important in various applications, such as in the pharmaceutical industry for producing medications, in agriculture for soil treatment, and in everyday situations like antacid tablets neutralizing excess stomach acid.

Properties of Bases

Bases: substances which neutralise acids to form salt and water only.

Definition of Bases: They are **proton acceptors** (form OH^- ions)

Indicators

- Have a pH between 8 (weak) and 14 (strong)
- Turns red **litmus** blue
- Turns **methyl orange** indicator yellow
- Turns Blue in **thymolphthalein**

Indicators	Color in Acid	Neutral Color	Color in Alkalis
Litmus	Red	Purple	Blue
Thymolphthalein	Colorless	Colorless	Blue
Methyl Orange	Red	Orange	Yellow

Difference between Bases and Alkalis

Base: A substance that can neutralize an acid. Bases can either dissolve in water (alkalis) or remain insoluble.

Alkali: A base that dissolves in water, producing hydroxide ions (OH-) in solution.

So, alkalis are a type of base that specifically dissolve in water.

"All Alkalis are Bases but not all Bases are Alkalis."

Weak and Strong Alkalis (Soluble Bases)

1. **Strong alkalis:** completely dissociates in aqueous solution, producing lots of OH^- ions e.g.: $NaOH\ (aq) \rightarrow Na^+\ (aq) + OH^-\ (aq)$
2. **Weak alkalis** partially ionize in water producing OH^- ions

   e.g: $NH_4OH\ (aq) \rightleftharpoons NH_4^+\ (aq) + OH^-\ (aq)$

Chemical properties

- Base + acid → salt + water (+ CO_2 when base is a metal carbonate)
- Base + ammonium salt → salt + ammonia gas + water

Examples of Ammonium Salts

ammonium carbonate, ammonium chloride, and ammonium nitrate.

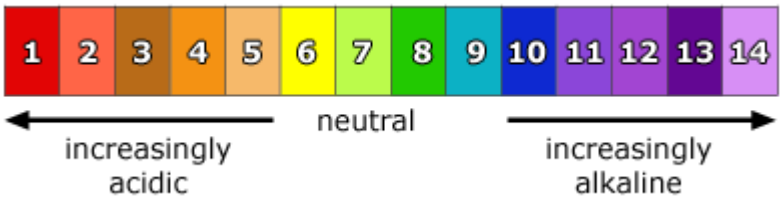
NaOH + NH4CL → NaCl +NH3+ H2O

Neutral

- Neutral substances are pH 7.
- **pH scale**

  pH is the concentration of H^+ ions per dm^3 of solution

  Universal indicator solution is used to determine the pH of a substance by matching the color change to the pH color chart.



Types of Oxides

- Metal oxides are **basic,** e.g. Copper oxide and Calcium oxide
- Non-metal oxides are **acidic,** e.g., sulfur dioxide and carbon dioxide
- Aluminium and zinc form **amphoteric oxides,** e.g. zinc oxide
- Oxides that react with neither acids nor bases are **neutral,** e.g. nitrous monoxide and carbon monoxide

Colours of Transition Metal Compounds

Metal Compounds	Colour
Copper (II) Sulfate	Blue
Copper (II) Oxide	Black
Copper (II) Carbonate	Green
Manganese (IV) Oxide	Black
Iron (II) Salts	Pale Green
Iron (III) Salts	Brown or Orange

Preparation of Salts

Soluble Salts

Method A: Soluble Salts from Excess Insoluble Bases (metal, metal oxide, carbonates)

1. Warm acid (increases the speed of reaction)
2. Add an excess reactant + stir
3. Filter mixture
4. Transfer to evaporating basin
5. Heat using a Bunsen burner
6. Leave to cool until crystallisation point
7. Wash crystals with distilled water
8. Dry crystals on filter paper

Method B: Titration

1. Place a known volume of alkali into a conical flask using a volumetric pipette.
2. Add indicator (e.g., thymolphthalein)
3. Titration: add acid using a burette until the endpoint has reached
4. Record the volume of acid added
5. Repeat without indicator
6. Transfer to evaporating basin
7. Heat with Bunsen burner
8. Leave to cool until crystallisation point
9. Wash crystals with distilled water
10. Dry crystals on filter paper

Which Acid forms which Salt

1. **Hydrochloric acid (HCl)** forms **chloride** salts: **Cl^{1-}**
2. **Sulfuric acid (H_2SO_4)** forms **sulfate** salts: **SO_4^{2-}**
3. **Nitric acid (HNO_3)** forms **nitrate** salts: **NO^{3-}**
4. **Phosphoric acid (H_3PO_4)** forms **phosphate** salts: **PO_4^{3-}**
5. **Acetic acid (CH_3COOH)** forms **acetate** salts: **CH_3COO^{1-}**
6. **Hydrofluoric acid (HF)** forms **fluoride** salts: **F^{1-}**

Insoluble Salts

Precipitation: Insoluble Solid forms between two aqueous solutions.

1. Mix two soluble salts
2. Filter to remove the precipitate
3. Wash the precipitate with distilled water
4. Leave to dry

Water of Crystallisation and General Solubility Rules

Water of Crystallisation

- A salt is a compound formed when a metal replaces all the hydrogen atoms of an acid.
- Naming salts involves two parts: the name of the metal and the acid-ending

  eg. calcium + hydrochloric acid = calcium chloride
- The Water of Crystallisation is the **water molecules present in hydrated crystals.**

Type of Salt	Acid used
Sulfate	Sulfuric acid
Nitrate	Nitric acid
Chloride	Hydrochloric acid
Ethanoate	Ethanoic acid

General Solubility Rules

Soluble Salts	Insoluble Salts
All sodium, potassium and Ammonium salts	None
All nitrates	None
Chlorides	Except for silver and lead
Sulfates	Except for barium, lead and calcium
Potassium, Sodium and Ammonium Carbonates	All other carbonates
Sodium, Potassium and Ammonium Hydroxides (partially calcium hydroxide)	Nearly all hydroxides