Acids, bases and salts

Acids:

An acid is a substance which forms H^+ ions when dissolved in water.

E.g. HCl → H^+ + Cl^-

The H^+ ion is a proton, which is a hydrogen atom which had lost its electron.

Acids therefore are called proton donors, because they provide H^+ ions.

General properties of acids:

The H^+ ions are responsible for all the general chemical reactions to all acids.

- Turns BLUE litmus paper RED

- Acids reacts with reactive metals to produce metal salt + hydrogen

  Metal + Acid → Metal Salt + Hydrogen Gas
  Magnesium + Hydrochloric acid → Magnesium Chloride + Hydrogen
  Mg + HCl → $MgCl_2$ + H_2

- Acids react with bases to produce metal salt and water

  Metal (oxide or hydroxide) + Acid → Metal Salt + Water
  Magnesium Oxide + Hydrochloric Acid → Magnesium Chloride + Water
  MgO + HCl → $MgCl_2$ + H_2O

- Acids react with carbonates to produce metal salt, water and carbon dioxide

  Metal Carbonate + Acid → Metal Salt + Water + Carbon Dioxide
  Magnesium Carbonate + Hydrochloric Acid → Magnesium Chloride + Water + Carbon Dioxide
  $MgCO_3$ + HCl → $MgCl_2$ + H_2O + C_2O

Examples of Common acids:

- Hydrochloric Acid
- Sulphuric Acid
- Nitric Acid

Strong and Weak Acids:

A strong acid is and acid that is completely ionized in solution.

E.g. $HCl \rightarrow H^+ + Cl^-$

Common strong acids:

- Hydrochloric acid
- Sulphuric acid
- Nitric Acid

A weak acid is an acid which is partially ionized in solution.

Some molecules remain unionized in solution.

e.g.

$CH_3COOH \leftrightharpoons CH3COO^- + H^+$

Common weak acids:

- Ethanoic acid
- Carbonic acid
- Sulphurous acid

How to distinguish between a strong and weak acid:

- At the same concentration, the stronger acid would have the lowest pH
- The stronger acid would be a better conductor of electricity at the same concentration
- At the same concentration and temperature, the stronger acid will react faster with solids

Bases:

A base is a substance that can accept H^+ ions, and therefore is a proton acceptor.

Bases are metal oxides and metal hydroxides, e.g.

- Copper (II) Oxide (CuO)
- Iron (III) Oxide (Fe_2O_3)
- Copper (II) Hydroxide ($Cu(OH)_2$)
- Iron (III) Hydroxide ($Fe(OH)_3$)

Bases which are soluble are called alkalis, e.g.

- Sodium Hydroxide (NaOH)
- Potassium Hydroxide (NaOH)

Alkalis dissolve in water forming alkaline solutions. Alkaline solutions turn RED litmus paper BLUE.

Sodium Oxide + Water ➔ Sodium Hydroxide

$Na_2O + H_20 \rightarrow 2\ NaOH$

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

It is the OH- ion that causes the red litmus paper to turn blue.

Strong and weak alkalis:

A strong alkali is an alkali which is completely ionized in solution.

e.g.

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

Common strong alkalis are:

- Sodium hydroxide
- Potassium hydroxide

A weak alkali is an alkali which is a partially ionized in solution.

E.g. Ammonium hydroxide (Ammonia gas dissolved in water)

$NH_3 + H_2O \rightarrow NH_4OH$ $\qquad$ $NH_4OH \leftrightharpoons NH_4^+ + OH^-$

How to distinguish between a strong and a weak alkali:

- The stronger alkali at the same concentration has the highest pH
- At the same concentration the strongest alkali would be the best conductor of electricity

pH scale:

pH scale is a scale of numbers, which usually ranges from 0 to 14. The pH number of a solution is a measure of its acidity or alkalinity.

Concentration of Hydrogen ions compared to distilled water		Examples of solutions at this pH
10,000,000	pH= 0	Battery acid, Strong Hydrofluoric Acid
1,000,000	pH = 1	Hydrochloric acid secreted by stomach lining
100,000	pH = 2	Lemon Juice, Gastric Acid Vineger
10,000	pH = 3	Grapefruit, Orange Juice, Soda
1,000	pH = 4	Acid rain Tomato Juice
100	pH = 5	Soft drinking water Black Coffee
10	pH = 6	Urine Saliva
1	pH = 7	"Pure" water
1/10	pH = 8	Sea water
1/100	pH = 9	Baking soda
1/1,000	pH = 10	Great Salt Lake Milk of Magnesia
1/10,000	pH = 11	Ammonia solution
1/100,000	pH = 12	Soapy water
1/1,000,000	pH =13	Bleaches Oven cleaner
1/10,000,000	pH = 14	Liquid drain cleaner

0-1 = Very strong acid

2-4 = Strong acids

5-6 = Weak acids

7 = Neutral

8-9 = Weak alkalis

10-13 = Strong alkalis

14 = Very strong Alkalis

Universal indicator:

It is a very useful indicator, which is a mixture of different dyes and gives a greater range of colour changes. It can be used to determine the pH value of a solution.

pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Colour														

Can also be used to determine the strength of the acid or the alkali.

Types of oxides:

1. Basic oxides – oxides of metals

These react with acids to make salt and water.

E.g. $CuO + 2HCl \rightarrow CuCl_2 + H_2O$

- Most basic oxides are insoluble in water
- The ones soluble are called alkalis

2. Acidic oxides

These are oxides of non-metals

React with bases to form salt and water:

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

Most acidic oxides dissolve in water to form acids.

Carbon dioxide + water → Carbonic acid

3. Neutral oxides

Neutral oxides are oxides of some non-metals

e.g.

- Carbon monoxide
- Nitric Acid
- Hydrogen Oxide

These don’t react with any acid or alkali.

4. Amphoteric oxides

These are oxides of some metals such as aluminium, zinc, and lead.

They show both acidic and basic properties, i.e. they react with both alkalis and acids forming salts and water.

e.g. Hydrochloric acid + Aluminium oxide ➔ Aluminium chloride + water

$6\ HCl + Al_2O_3 \rightarrow 2\ AlCl_3 + 3\ H_2O$