Leaving Cert Chemistry

Free Notes

Acids and Bases

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- Acids are substances that turn **blue litmus red** and **react** with metals like Zinc, thus releasing **hydrogen gas**.
- **Hydrochloric Acid (HCl), Sulfuric Acid (H_2SO_4) and Nitric Acid (HNO_3) are all examples of strong acids**

- **Bases** are substances which turn **red litmus blue**.
- **Sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3) and ammonia (NH_3) are examples of bases.**
- A base that **dissolves** in **water** are known as an **alkali**.
- Sodium hydroxide is an alkali; therefore sodium hydroxide solution is obviously **alkaline**.

Everyday acids: Vinegar, lactic acid in milk as it goes sour, citrus fruits & hydrochloric acid in the stomach necessary for digestion and killing micro organisms

Everyday bases: oven cleaner, bleach, caustic soda, toothpaste & washing up liquid.

Laboratory acids: Hydrochloric Acid (HCl), Sulfuric Acid (H_2SO_4) and Nitric Acid (HNO_3)

Laboratory bases: Sodium hydroxide (NaOH), sodium carbonate (Na_2CO_3) and ammonia (NH_3)

Bases → neutralise acids
Alkalis → water soluble bases

Monobasic, dibasic and tribasic acids:
Monobasic acids: Refers to an acid which donates one proton per molecule e.g. HCl and HNO_3

Dibasic acids: Refers to an acid which donates 2 protons per molecule e.g. H_2SO_4

Tribasic acids: Refers to an acid which donates 3 protons per molecule e.g. H_3PO_4

Arrhenius theory of an acid:

- He suggested that an acid is a substance which dissociates in aqueous solution to form H+ ions : $HX_{(aq)} \rightarrow H^+ + X^-$

Note:

- In solution, strong acids and bases are fully dissociated and weak acids and bases partially dissociated.
- A base (MOH) dissociates in water to form a hydroxide ion and a cation: $MOH \rightarrow OH^- + H^+$

Limitations to the above theory
1) It is limited to reactions taking place in water,
2) H^+ ions does not exist in water on its own (Joins with a H_2O molecule and forms H_3O^+)

Arrhenius theory of a base:

- A base is a substance that dissociates in aqueous solution to produce OH- ions

$NaOH_{(aq)} \rightarrow Na^+ + OH^-$

Limitations to the above theory
1) It is limited to reactions taking place in water, other solvents like methylbenzene or liquid ammonia were exceptions.
2) Substances such as NH_3 would not be classified as bases (do not produce OH^- ions)

Q) According to Arrhenius how would an acid react with a base i.e. neutralisation reaction?

- In solution, the acid molecules dissociates and forms H^+ ions
- The base molecules dissociates and form OH^- ions
- The H^+ ions and OH^- ions react and form H_2O.

Note: A salt is mostly formed in such reactions

Neutralisation reactions:

- This is one in which an acid and a base react to form a salt and water
- A common example is when we consume an indigestion tablet to combat excess stomach acid.

$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_20$

HIGHER LEVEL:

Bronsted – Lowry theory of an acid:

- An acid is a proton donor (H^+) therefore a strong acid is a strong proton donor
- A base is a proton acceptor

The advantages of the Bronsted Lowry's theory:

- Does not just deal with reactions in water

e.g: $HCl + NH_3 \rightarrow NH_4Cl$

Q) What is a conjugate base?
Species formed when an acid has donated a proton: $HCL \rightarrow C^{l-}$
(acid) (conjugate base)

More examples of conjugate base formations
$HNO_3 > NO_3^-$
$H_2S > HS^-$
$H_2PO4^- > HPO4^{2-}$

Strong acid:

- This is an acid which dissociates fully into ions in an aqueous solution e.g. $HCl \rightarrow H^+ + C^{l-}$
- Every HCl molecule breaks up into ions

Weak acid:

- This is an acid which only slightly dissociates into ions in a aqueous solution

e.g.: $CH_3COOH\ (aq) \rightarrow CH_3COO^- + H^+$

- Very few of these acid molecules dissociates or break up into ions

Q) Why is H_2SO_4 considered to be a strong acid?

- This acid fully dissociates into ions when in an aqueous solution
- It has a great tendency to break/ give protons

Q) Explain why strong acids form weak conjugate bases.

H_2SO_4 → HSO_4^-
(strong acid) (weak conjugate base)

- A strong acid such as sulphuric acid readily donates a proton and forms a conjugate base HSO_4^-
- The conjugate base i.e. HSO_4^- is a weak base as it does not readily accept a proton

Q) Show that a conjugate base H_2SO_4 can itself act as an acid

- The H_2SO_4 loses a proton and forms the conjugate base HSO_4^-

$H_2SO_4 \longrightarrow HSO_4^-$

- The conjugate base HSO_4^- then donates a proton i.e. behaves as an acid

$HSO_4^- \longrightarrow SO_4^{2-}$

Q) What is a conjugate acid?

- Species formed when a base has accepted an H^+ proton: $NH_3 > NH^{4+}$
  (base) (conj. Acid)

Q) Write a conjugate acid for the following

$H_20 > H_3O^+$
$H_2PO_4^- > H_3PO_4$
$NH_2 > NH_3$

$SO_3^{2-} > HSO_3^-$

Q) Define conjugate acid/bond pair

- These are 2 substances which differ by an H^+ or a proton. E.g. HCl <> Cl^-

Q) Indicate which species are acting as acids and bases in the following:

1) $HNO_3 + H_2F_2 \rightleftharpoons H_2NO_3^+ + HF_2^-$
(Acid) (Base) (Conj. Base) (Conj. acid)

3) $H_20 + H_20 \rightleftharpoons H_30^+ + OH^-$
(Acid) (Base) (conj. base) (conj. acid)

Amphoteric substances:

- This is a substance which can behave as an acid or a base depending on what it reacts with

e.g. 1) H_2O behaves as a base (accepts a proton)
e.g. 2) H_20 molecules loses a proton (behaves as an acid)

Acidity: The acidity of a solution depends on the concentration of H^+ ions in the solution

- H^+ concentration > more acidic the solution is