



**Leaving Cert Chemistry**

**Free Notes**

**Acids and Bases**



## Acids and Bases

- Acids are substances that turn **blue litmus red** and **react** with metals like Zinc, thus releasing **hydrogen gas**.
- **Hydrochloric Acid (HCl), Sulfuric Acid (H<sub>2</sub>SO<sub>4</sub>) and Nitric Acid (HNO<sub>3</sub>) are all examples of strong acids**
- **Bases** are substances which turn **red litmus blue**.
- **Sodium hydroxide (NaOH), sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>) and ammonia (NH<sub>3</sub>) 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<sub>2</sub>SO<sub>4</sub>) and Nitric Acid (HNO<sub>3</sub>)

**Laboratory bases:** Sodium hydroxide (NaOH), sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>) and ammonia (NH<sub>3</sub>)

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<sub>3</sub>

**Dibasic acids:** Refers to an acid which donates 2 protons per molecule e.g. H<sub>2</sub>SO<sub>4</sub>

**Tribasic acids:** Refers to an acid which donates 3 protons per molecule e.g. H<sub>3</sub>PO<sub>4</sub>

### Arrhenius theory of an acid:

- He suggested that an acid is a substance which dissociates in aqueous solution to form H<sup>+</sup> ions :  $\text{HX}_{(aq)} \rightarrow \text{H}^+ + \text{X}^-$

#### **Note:**

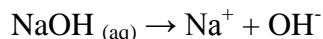
- In solution, strong acids and bases are fully dissociated and weak acids and bases partially dissociated.
- A base (MOH) dissociates in water to form a hydroxide ion and a cation:  $\text{MOH} \rightarrow \text{OH}^- + \text{H}^+$

### **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



### **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)

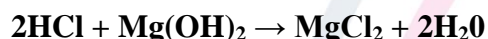
### **Q) According to Arrhenius how would an acid react with a base i.e. neutralisation reaction?**

- 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.



### **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:**

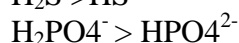
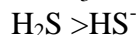
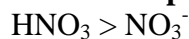
- Does not just deal with reactions in water

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

#### **Q) What is a conjugate base?**

Species formed when an acid has donated a proton:  $HCl \rightarrow Cl^-$   
(acid)      (conjugate base)

### More examples of conjugate base formations



#### Strong acid:

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

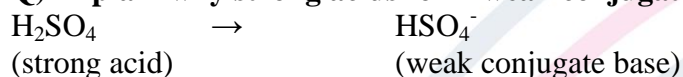
#### Weak acid:

- This is an acid which only slightly dissociates into ions in a aqueous solution  
e.g.:  $\text{CH}_3\text{COOH} (\text{aq}) \rightarrow \text{CH}_3\text{COO}^- + \text{H}^+$
- Very few of these acid molecules dissociates or break up into ions

#### Q) Why is $\text{H}_2\text{SO}_4$ considered to be a strong acid?

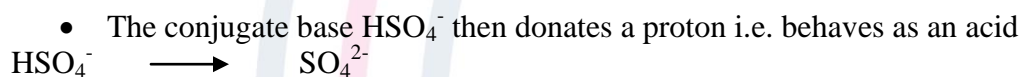
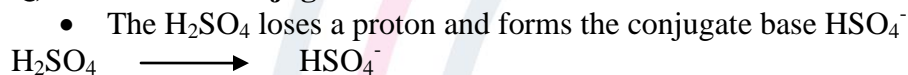
- This acid fully dissociates into ions when in an aqueous solution
- It has a great tendency to break/ give protons

#### Q) Explain why strong acids form weak conjugate bases.



- A strong acid such as sulphuric acid readily donates a proton and forms a conjugate base  $\text{HSO}_4^-$
- The conjugate base i.e.  $\text{HSO}_4^-$  is a weak base as it does not readily accept a proton

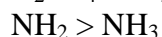
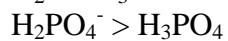
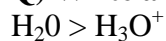
#### Q) Show that a conjugate base $\text{H}_2\text{SO}_4$ can itself act as an acid

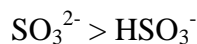


#### Q) What is a conjugate acid?

- Species formed when a base has accepted an  $\text{H}^+$  proton:  $\text{NH}_3 > \text{NH}_4^+$   
(base) (conj. Acid)

#### Q) Write a conjugate acid for the following

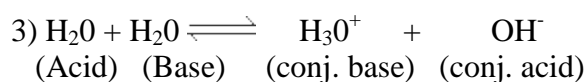
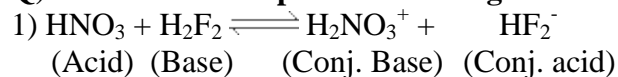




**Q) Define conjugate acid/bond pair**

- These are 2 substances which differ by an  $\text{H}^+$  or a proton. E.g.  $\text{HCl} \leftrightarrow \text{Cl}^-$

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



**Amphoteric substances:**

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

**e.g. 1)**  $\text{H}_2\text{O}$  behaves as a base (accepts a proton)

**e.g. 2)**  $\text{H}_2\text{O}$  molecules loses a proton (behaves as an acid)

**Acidity:** The acidity of a solution depends on the concentration of  $\text{H}^+$  ions in the solution

- $\text{H}^+$  concentration > more acidic the solution is

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