

## 1.2 Types of chemical reactions

- Combination
- Decomposition
- Displacement
- Double displacement

1.2.1 Combination Reaction - When two or more substances (elements or compounds) combine to form a single product, the reactions are called Combination reactions.

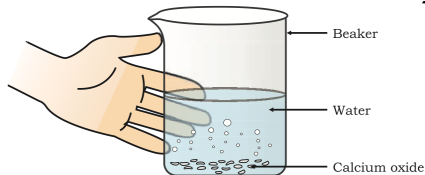
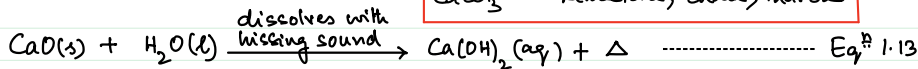


**Figure 1.3**  
Formation of slaked lime by the reaction of calcium oxide with water

### Activity 1.4

- Take a small amount of calcium oxide or quick lime in a beaker.
- Slowly add water to this.
- Touch the beaker as shown in Fig. 1.3.
- Do you feel any change in temperature?

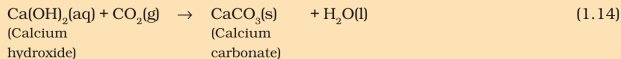
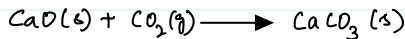
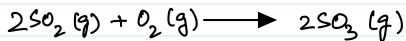
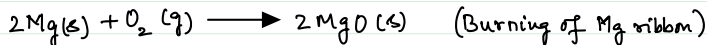
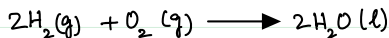
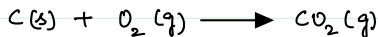
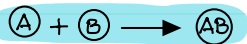
CaO - Quicklime  
Ca(OH)<sub>2</sub> - Slaked lime  
CaCO<sub>3</sub> - Limestone, chalk, marble



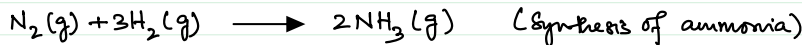
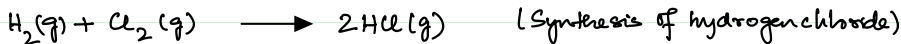
Calcium oxide reacts vigorously with water to form calcium hydroxide, releasing a large amount of heat.

## Do You Know?

A solution of slaked lime produced by the reaction 1.13 is used for whitewashing walls. Calcium hydroxide reacts slowly with the carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of whitewashing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also  $\text{CaCO}_3$ .

Examples

**Synthesis reactions** are combination reactions in which a compound is formed from its constituent elements.

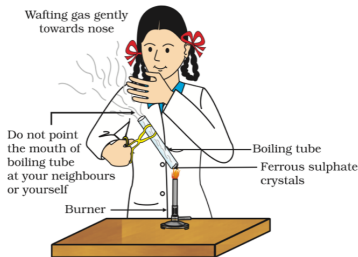
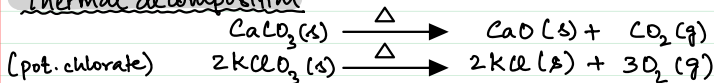


1.2.2. Decomposition Reaction - A reaction in which a substance is broken down into two or more simpler substances is known as decomposition reaction.



- A decomposition reaction is the opposite of a combination reaction.
- Decomposition reactions take place only when some energy is supplied in the form of
  - heat ——— Thermal decomposition.
  - light ——— Photodecomposition.
  - electricity ——— Electrolytic decomposition.

### Thermal decomposition



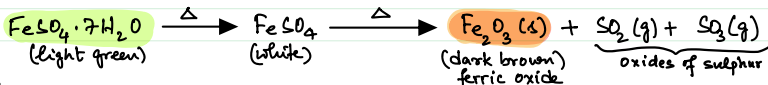
### Activity 1.5

- Take about 2 g ferrous sulphate crystals in a dry boiling tube.
- Note the colour of the ferrous sulphate crystals.
- Heat the boiling tube over the flame of a burner or spirit lamp as shown in Fig. 1.4.
- Observe the colour of the crystals after heating.

Green vitriol

light green ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ )

white ( $\text{FeSO}_4$ )  
anhydrous ferrous sulphate



## Q U E S T I O N S

1. Why do HCl,  $\text{HNO}_3$ , etc., show acidic characters in aqueous solutions while solutions of compounds like alcohol and glucose do not show acidic character?
2. Why does an aqueous solution of an acid conduct electricity?
3. Why does dry HCl gas not change the colour of the dry litmus paper?
4. While diluting an acid, why is it recommended that the acid should be added to water and not water to the acid?
5. How is the concentration of hydronium ions ( $\text{H}_3\text{O}^+$ ) affected when a solution of an acid is diluted?
6. How is the concentration of hydroxide ions ( $\text{OH}^-$ ) affected when excess base is dissolved in a solution of sodium hydroxide?



1. Acidic character is due to presence of  $\text{H}^+(\text{aq.})$  or  $\text{H}_3\text{O}^+$  ions in solution. These are present in HCl,  $\text{HNO}_3$  etc. These ions are not present in alcohol ( $\text{C}_2\text{H}_5\text{OH}$ ) or glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ). Hence they do not display acidic properties.
2. Since only in an aqueous solution can an acid produce  $\text{H}^+(\text{aq.})$  ions and an anion which can conduct electricity.
3. Dry HCl is incapable of producing  $\text{H}^+(\text{aq.})$  ions. Hence no effect litmus.
4. Water must NOT be added to acid, since the heat generated
  - may cause the mixture to splash out & cause burns.
  - may break the glass container.
5. When a solution of an acid is diluted, the concentration of hydronium  $\text{H}_3\text{O}^+$  ions decreases per unit volume.
6. When excess base is dissolved in NaOH solution, the concentration of  $\text{OH}^-$  ions increases.

## 2.3 HOW STRONG ARE ACID OR BASE SOLUTIONS?

### Key Questions

1. Can we find quantitatively the amount of  $H^+$  (aq.) ions in acids &  $OH^-$  (aq.) ions in bases?
  2. Can we then judge how strong an acid or a base is?
- The concentration of  $H_3O^+$  ions &  $OH^-$  ions can be determined using the pH scale
  - Judging the relative strength of an acid or base can be done using a Universal Indicator.

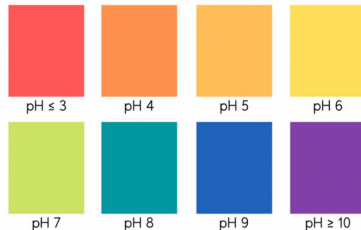
$H_3O^+$  ions

**Universal Indicator** : The universal indicator is a mixture of indicator dyes that give a spectrum of colours indicating how acidic or alkaline a solution is.

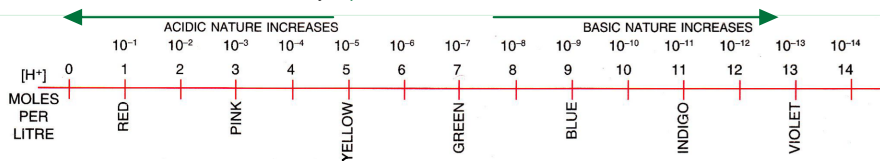
Decides whether acid or base      Tells how strong

- The universal indicator shows different colours for different concentrations of  $H_3O^+$  ion in the solution.
- Universal indicators give different colours at different concentrations of hydrogen ions in a solution
- Colour changes from blue to indigo to violet as pH increases from 7 to 14. (Basic range).

Universal Indicator Chart



- Colour changes from yellow to pink to red as pH decreases from 7 to 1 (acidic range).

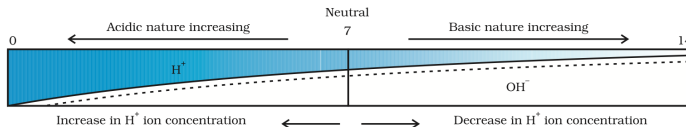


*Colour changes in the universal indicator (for different pH values).*

The pH scale : • Devised by a Danish scientist Sorensen (1909).

- pH stands for potential of hydrogen (*'potenz'* in German = power)  
↳  $H^+(aq.)$  or  $H_3O^+$  ions.
- It is a scale for measuring hydrogen ion concentration in a solution.
- pH may be considered as a number which indicates 2 things.
  - (i) Acid or base.
  - (ii) How strong an acid or base is.
- Range of pH scale is from 0 (Very acidic) to 14 (very alkaline).
- 0 to 6 → Acidic ; 8-14 Alkaline ; 7 - Neutral.
- Higher the concentration of  $H_3O^+$  ions, more acidic, lower the pH value

- Higher the concentration of  $\text{OH}^-$  ions, more alkaline, higher the pH value.



- Generally a paper strip impregnated with the universal indicator is used for measuring pH.

### Difference between Concentration & Strength of Acids & Bases

**Concentration**: Refers to the amount of acid/base present in a definite amount of its aqueous solution.

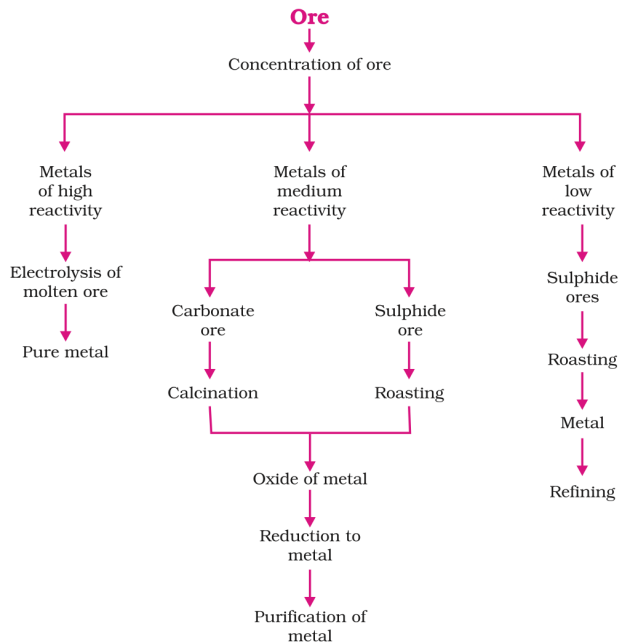
**Precaution**: To dilute an acid, DO NOT pour water to acid.

**Strength**: Refers to the number of  $\text{H}_3\text{O}^+$  ions (in acidic sol<sup>y</sup>) or  $\text{OH}^-$  ions (in alkaline sol<sup>y</sup>) produced in their aqueous solutions.

A dilute solution of HCl is stronger than a concentrated solution of acetic acid. Explain why.

- Concentration simply tells us about the amount of water present in the acid and not about strength.  
The strength of an acid is the measure of its  $\text{H}_3\text{O}^+$  ion concentration in solution. HCl produces more  $\text{H}_3\text{O}^+$  ions than acetic acid and hence is stronger.

# Steps involved in the extraction of metals from ores



| <i><b>Metal</b></i>       | <i><b>Method of extraction</b></i>                |
|---------------------------|---------------------------------------------------|
| K<br>Na<br>Ca<br>Mg<br>Al | Electrolysis of molten chloride or oxide          |
| Zn<br>Fe<br>Pb<br>Cu      | Reduction of oxide with carbon                    |
| Cu<br>Hg                  | Heating sulphide in air (Reduction by heat alone) |
| Ag<br>Au<br>Pt            | Found in native state (as metals)                 |

### 3.4.2 Enrichment of Ores or Concentration of ore.

The process of removal of gangue, present in an ore is known as

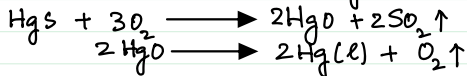
- Concentration of ore
- Ore dressing
- Enrichment of Ore

**Gangue** - Earthly impurities including sand, mud etc. associated with ore are known as gangue

### 3.4.3 Extracting Metals Low in the Activity Series

- Very unreactive metals
- Oxides of these metals are reduced to metals by heating alone.
- Example: • **Cinabar (HgS)** is an ore of mercury

First HgS is heated in air to form HgO which is then reduced to Hg on further heating.



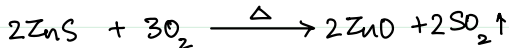
- **Cu** is found as **Cu<sub>2</sub>S** (Chalcocite) in nature, and is reduced to Cu by heat.



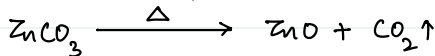
### 3.4.4 Extracting Metals in the Middle of the Activity Series

- Metals in the middle of the activity series such as Fe, Zn, Pb, Cu are moderately reactive.
- These metals are usually present in nature as sulphides or carbonates.
- The metal sulphides & carbonates are first converted to their oxides, either by calcination or roasting.

**Roasting** — Sulphide ores are converted into oxides by heating strongly in the presence of excess air, in a process called roasting.



**Calcination** — Carbonate ores are changed into oxides by heating strongly in limited air in a process called calcination.

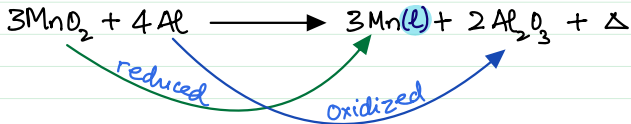


- The metal oxides are then reduced to their corresponding metals by suitable reducing agents like carbon.



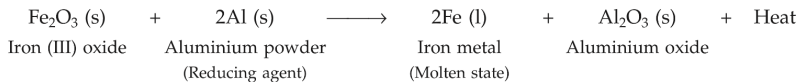
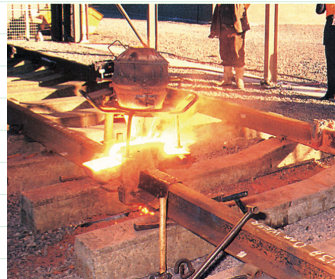
- Highly reactive metals like Na, Ca, Al etc. are sometimes used as reducing agents to displace metals of lower reactivity.

Eg: Al acts as a reducing agent and reduces  $\text{MnO}_2$  to Mn.



### Thermit reaction

- The reduction of a metal oxide to form metal by using Al powder as a reducing agent is known as thermit reaction.
- The reaction produces a large amount of heat (highly exothermic) due to which the metals are produced in the molten state.
- This property of reducing metals by producing enormous heat is made use of in thermit welding to join broken pieces of heavy iron objects like railway tracks, girders etc.

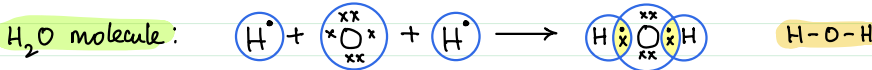
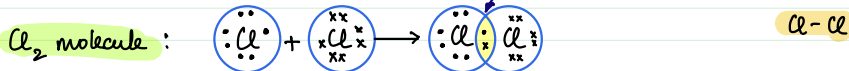
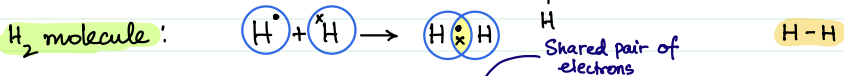


## Types of Covalent Bonds

1. Single
2. Double
3. Triple
4. Combination

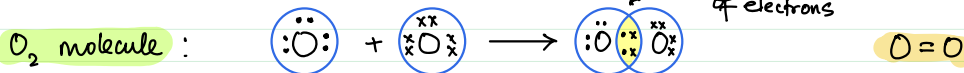
1. Single Covalent Bond — formed by sharing 1 electron pair  
— Denoted by '-'

Eg:  $H-H$ ,  $Cl-Cl$ ,  $H-Cl$ ,  $H-N-H$ ,



2. Double Covalent Bond : formed by sharing 2 electron pairs  
Denoted by '='

Eg:  $O=O$



# IUPAC Nomenclature (1957)

Basic principle of Naming : Name is split into 2 parts

Front part  
(Prefix)

Back part  
(Suffix)

- Always start naming from **back part (suffix)**

Decided by the homologous series

|                   |       |            |
|-------------------|-------|------------|
| → Alkanes         | _____ | ane        |
| → Alkenes         | _____ | ene        |
| → Alkynes         | _____ | yne        |
| → Alcohols        | _____ | ol         |
| → Aldehydes       | _____ |            |
| → Carboxylic acid | _____ | anoic acid |
| Ketones           | _____ | one        |

al

- Now name the **front part (prefix)**

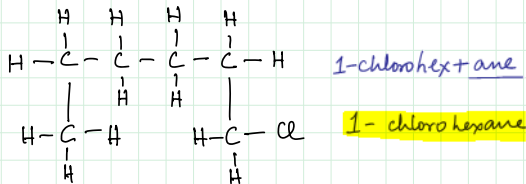
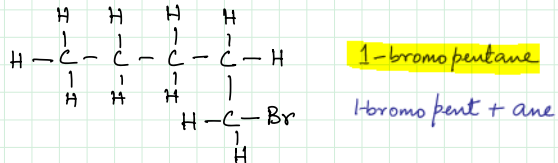
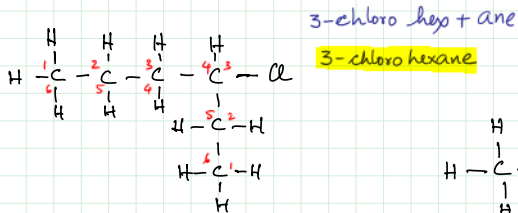
Decided by number of Carbon atoms.

|           |           |
|-----------|-----------|
| meth — 1C | hept — 7C |
| eth — 2C  | oct — 8C  |
| prop — 3C | non — 9C  |
| but — 4C  | dec — 10C |
| pent — 5C |           |
| hex — 6C  |           |

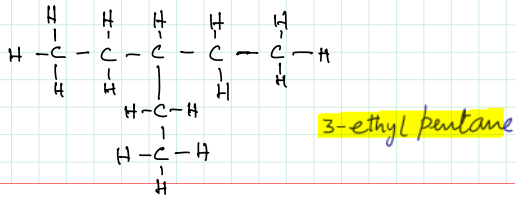
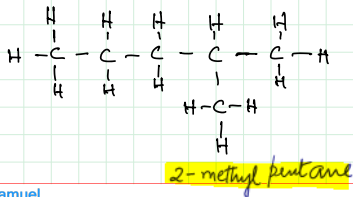
| Number of carbon atoms |                 | Root Word (Greek name) |
|------------------------|-----------------|------------------------|
| One carbon atom        | C <sub>1</sub>  | Meth                   |
| Two carbon atoms       | C <sub>2</sub>  | Eth                    |
| Three carbon atoms     | C <sub>3</sub>  | Prop                   |
| Four carbon atoms      | C <sub>4</sub>  | But                    |
| Five carbon atoms      | C <sub>5</sub>  | Pent                   |
| Six carbon atoms       | C <sub>6</sub>  | Hex                    |
| Seven carbon atoms     | C <sub>7</sub>  | Hept                   |
| Eight carbon atoms     | C <sub>8</sub>  | Oct                    |
| Nine carbon atoms      | C <sub>9</sub>  | Non                    |
| Ten carbon atoms       | C <sub>10</sub> | Dec                    |

## LEVEL 2: One Branch a) Non-Carbon Branch

|    |          |
|----|----------|
| F  | — fluoro |
| Cl | — chloro |
| Br | — bromo  |
| I  | — iodo   |



## b) Carbon Branch — Add 'yl' at end of branch name



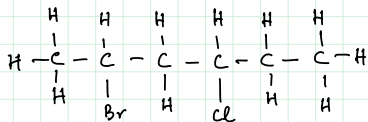
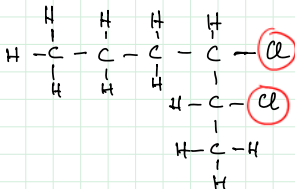
(iv) Simple nomenclature.

Simple nomenclature of the hydrocarbons with simple functional groups – (double bond, triple bond, alcoholic, aldehydic, carboxylic group) longest chain rule and smallest number for functional groups rule – trivial and IUPAC names (compounds with only one functional group).

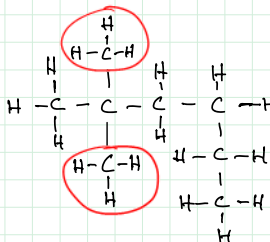
### LEVEL 3 : Two Branches

- \* For 2 branches use keyword 'di'
- \* Mention position number for each branch.
- \* Numbering should be such that functional group gets the smallest possible number.

2,3-dichlorohexane



2-bromo 4-chloro hexane



2,2-dimethyl heptane

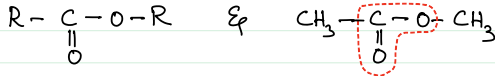
- \* In case of different branches, arrange & name alphabetically

## Activity 4.8

- Take 1 mL ethanol (absolute alcohol) and 1 mL glacial acetic acid along with a few drops of concentrated sulphuric acid in a test tube.
- Warm in a water-bath for at least five minutes as shown in Fig. 4.11.
- Pour into a beaker containing 20-50 mL of water and smell the resulting mixture.

→ Gives a Sweet smell due to formation of **ester**

- Esters are denoted as  $\text{RCOOR}$



- Esters are sweet smelling substances, used in making perfumes & as flavouring substances.

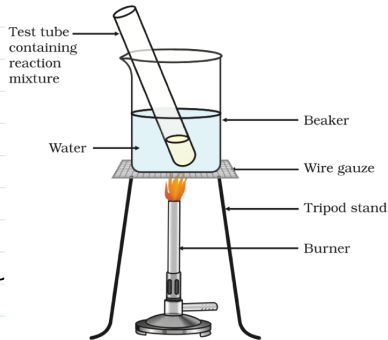


Figure 4.11  
Formation of ester

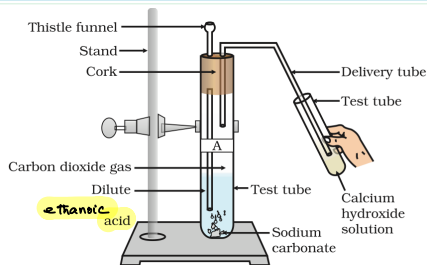
### (iii) Reaction with carbonates & hydrogen carbonates



Ethanoic acid reacts with carbonates & hydrogen carbonates to give a salt,  $\text{H}_2\text{O}$  &  $\text{CO}_2$ .

#### Activity 4.9

- Set up the apparatus as shown in Chapter 2, Activity 2.5.
- Take a spatula full of sodium carbonate in a test tube and add 2 mL of dilute ethanoic acid.
- What do you observe?
- Pass the gas produced through freshly prepared lime-water. What do you observe?
- Can the gas produced by the reaction between ethanoic acid and sodium carbonate be identified by this test?
- Repeat this Activity with sodium hydrogencarbonate instead of sodium carbonate.



- A gas evolves with effervescence.
- Lime water turns milky.
- Yes, it is  $\text{CO}_2$
- Same result.