

# Unit 1 Chemical Substances: Nature & Behaviour



## Chapter 3:

# Metals & Non-Metals

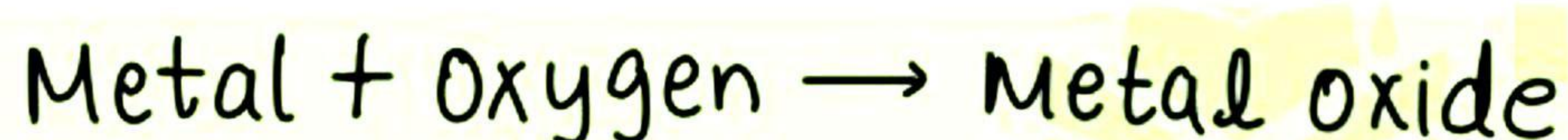
➔ **Metals** - Metals like iron and copper, exhibit luster conductivity (thermal / electrical), malleability, ductility, high melting / boiling points. They lose electrons, forming cations in reaction. Notable for their versatile industrial applications.

### ⚙️ Physical Properties of Metals

- Solid at room temperature except mercury
- Ductile (drawn into wires)
- Malleable (beaten into thin sheets)
- Sonorous (produce sound)
- Lustrous (natural shine)
- Have high melting point. Cesium and gallium have low melting point.
- Generally good conductor of heat and electricity, except lead and mercury which are comparatively poor conductors. Silver and copper are best conductors.
- Have high density. Sodium and potassium can be cut with knife they have low density.

### ⚙️ Chemical Properties of Metals.

1. Reaction with oxygen :- Metals react with oxygen to form metal oxides. The general equation for this reaction is



⚠️ **NOTE** - Potassium and sodium are stored in kerosene oil to prevent reactions with oxygen, moisture and carbon dioxide in the air, which can cause them to catch fire.



➔ **Non-metals** - A nonmetal is an element that lacks metallic properties, such as conductivity, luster and malleability. They often have low densities and melting points and can exist in various physical states. Example - carbon, oxygen, and nitrogen

### ❁ Physical Properties of Non-metals

- Occur as a solid or gas. Bromine is liquid
- Generally bad conductors of heat and electricity. carbon is a good conductor.
- Non-sonorous
- Non-lustrous, only iodine has lustre.
- Metals form basic oxides like Magnesium oxide (MgO), while non-metals form acidic oxides (as in acid rain).

### ❁ Chemical properties of Non-metals

- Combust (eg hydrogen, carbon)
- React with oxygen to form oxides (eg sulfur dioxide).
- Engage in acid-base reactions to create salts (eg sulfuric acid with sodium hydroxide).
- Accept electrons to form anions when reacting with metals.
- Share electrons to form covalent bonds with other non-metals.
- React with water to yield acids (eg sulfur, phosphorus).
- Displace less reactive metals from their salts, forming new compounds.

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### ➔ **Electronic Configuration of Some Elements**

Types of Element	Element	Atomic Number	Numbers of electrons in shells			
			K	L	M	N
Noble Gases	Helium (He)	2	2			
	Neon (Ne)	10	2	8		
	Argon (Ar)	18	2	8	8	

Metals	Sodium (Na)	11	2	8	1	
	Magnesium (Mg)	12	2	8	2	
	Aluminium (Al)	13	2	8	3	
	Potassium (K)	19	2	8	8	1
	Calcium (Ca)	20	2	8	8	2
Non-Metals	Nitrogen (N)	7	2	5		
	Oxygen (O)	8	2	6		
	Fluorine (F)	9	2	7		
	Phosphorus (P)	15	2	8	5	
	Sulphur (S)	16	2	8	6	
	Chlorine (Cl)	17	2	8	7	

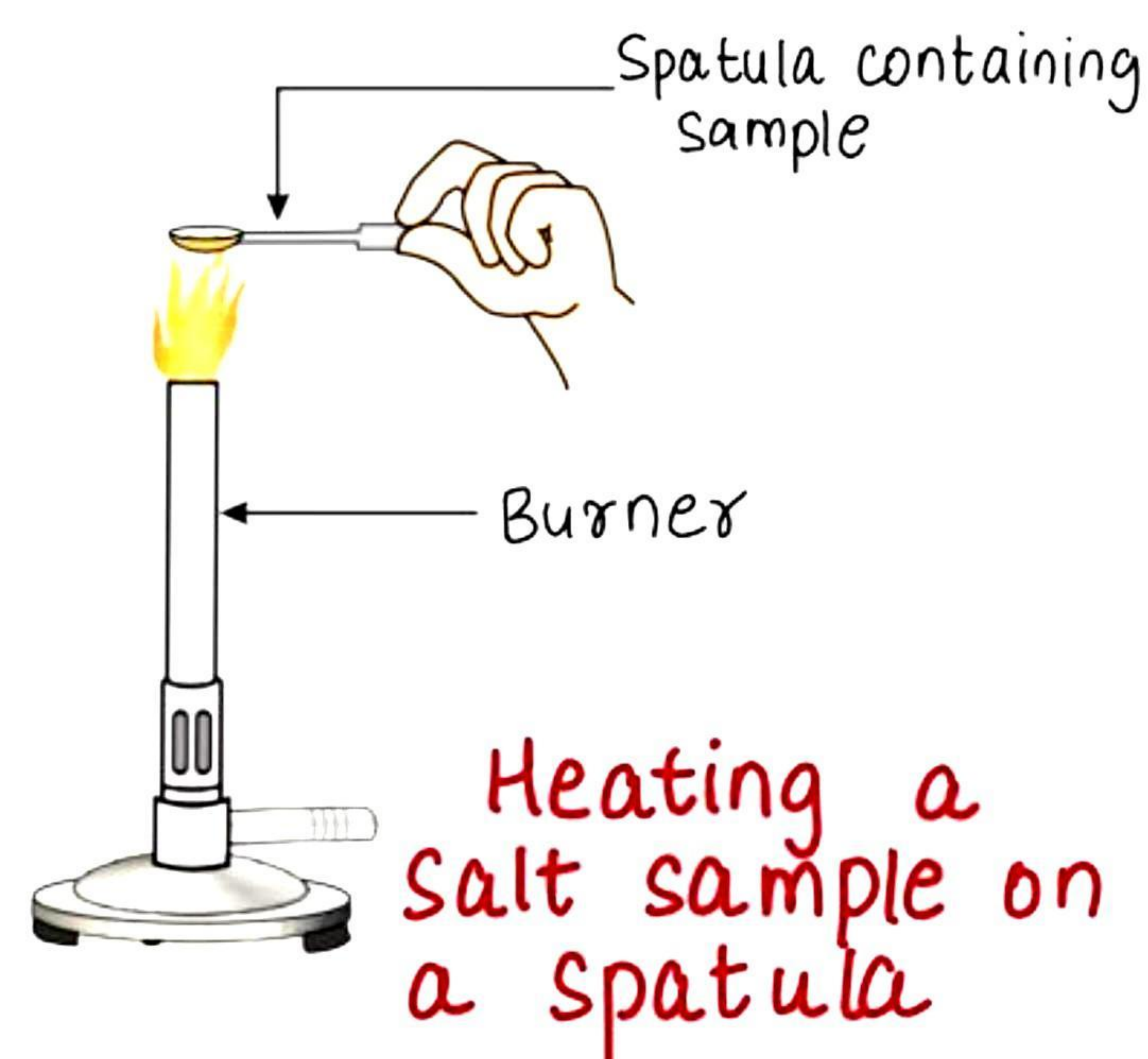
➔ **Ionic Compound** - Ionic compound is formed by electron transfer from metals to non-metals, creating oppositely charged ions. Examples:  $\text{NaCl}$ ,  $\text{KCl}$ ,  $\text{MgO}$

#### \* Properties

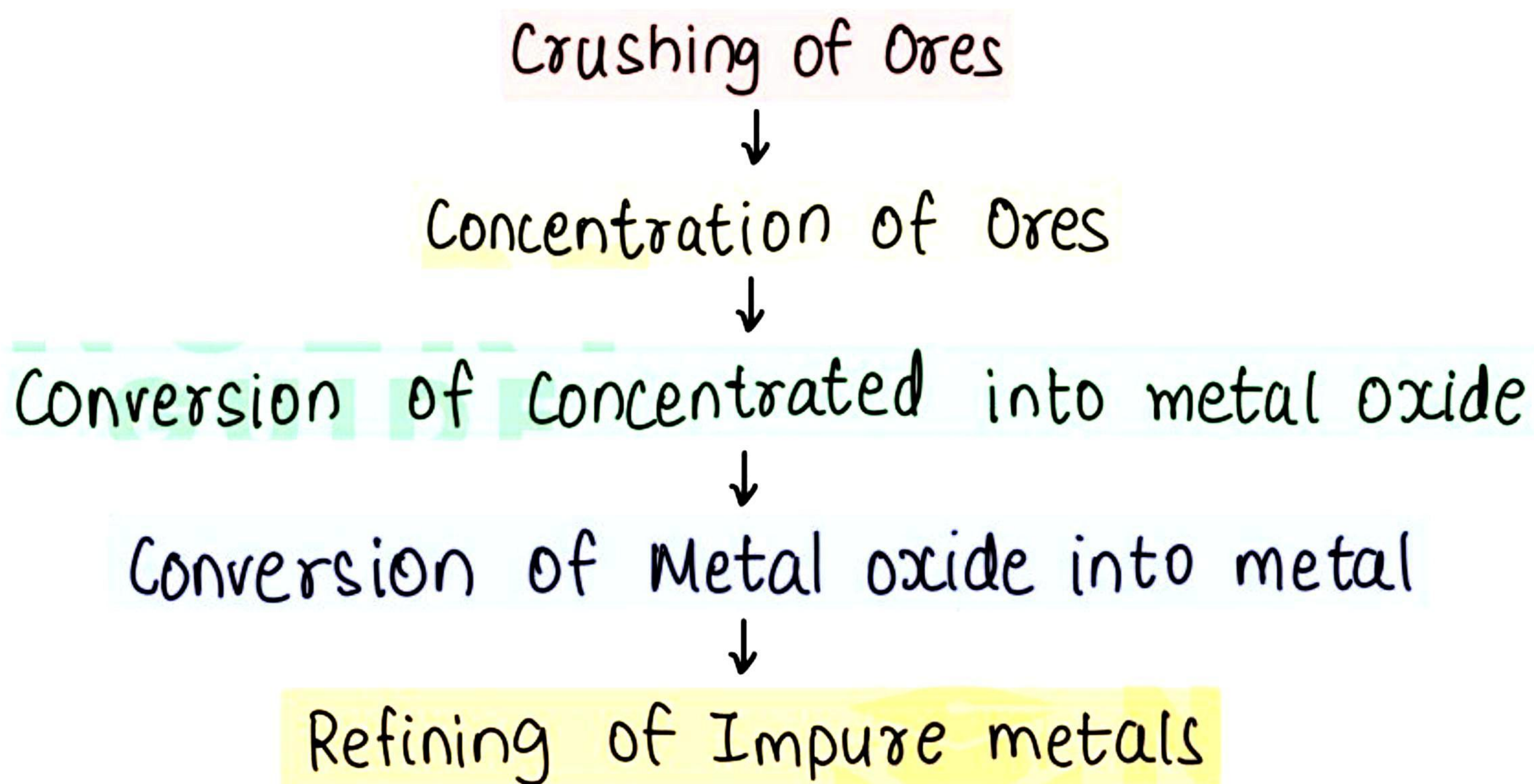
- High Melting/boiling points
- Typically solid at Room temperature
- Conduct electricity when dissolved/melted due to free ions.

#### ⚙️ Properties of Ionic compound

- High melting and boiling points due to strong ion electrostatic attractions in lattice structure.
- Solubility in water facilitated by water molecules separating ions
- Conductivity in solution or molten state as ions become mobile.
- Brittleness attributed to repulsion between similarly charged layers under stress.



➔ **Occurrence of Metals** - Metallurgy involves extracting metals from ores and refining them. Key steps include ore concentration, reduction to obtain the metal, purification, and shaping for practical use, ensuring valuable resources.



➔ **Extraction of Metals from Ores** - Metallurgy is the structured approach to obtaining metals in pure form from ores and refining them for practical applications.

🎓 **Extraction Techniques Based On Reactivity**  
Extraction methods vary depending on reactivity of metals with in the activity series.

🎓 **Highly Reactive Metals**  
Metals exhibiting high reactivity, such as Potassium (K), Sodium (Na), Calcium (Ca) and Magnesium (Mg) are typically obtained through electrolysis. Their strong affinity with other elements prevents simple reduction through heating with carbon.

🎓 **Moderately Reactive Metals**  
Moderately Reactive metals like Zinc (Zn), Iron (Fe) and Lead (Pb) are commonly extracted via reduction processes utilizing agents like coke (C).

🎓 **Less Reactive Metals**  
Metals with lower reactivity, such as Copper (Cu) and Mercury (Hg) are obtained from their oxides through heating alone a method referred to as self-reduction.

🎓 **Very Low Reactive Metals**  
Metals with extremely low reactivity, such as Silver (Ag), Gold (Au) and Platinum (Pt) occur naturally in metallic form and therefore do not necessitate extraction processes.

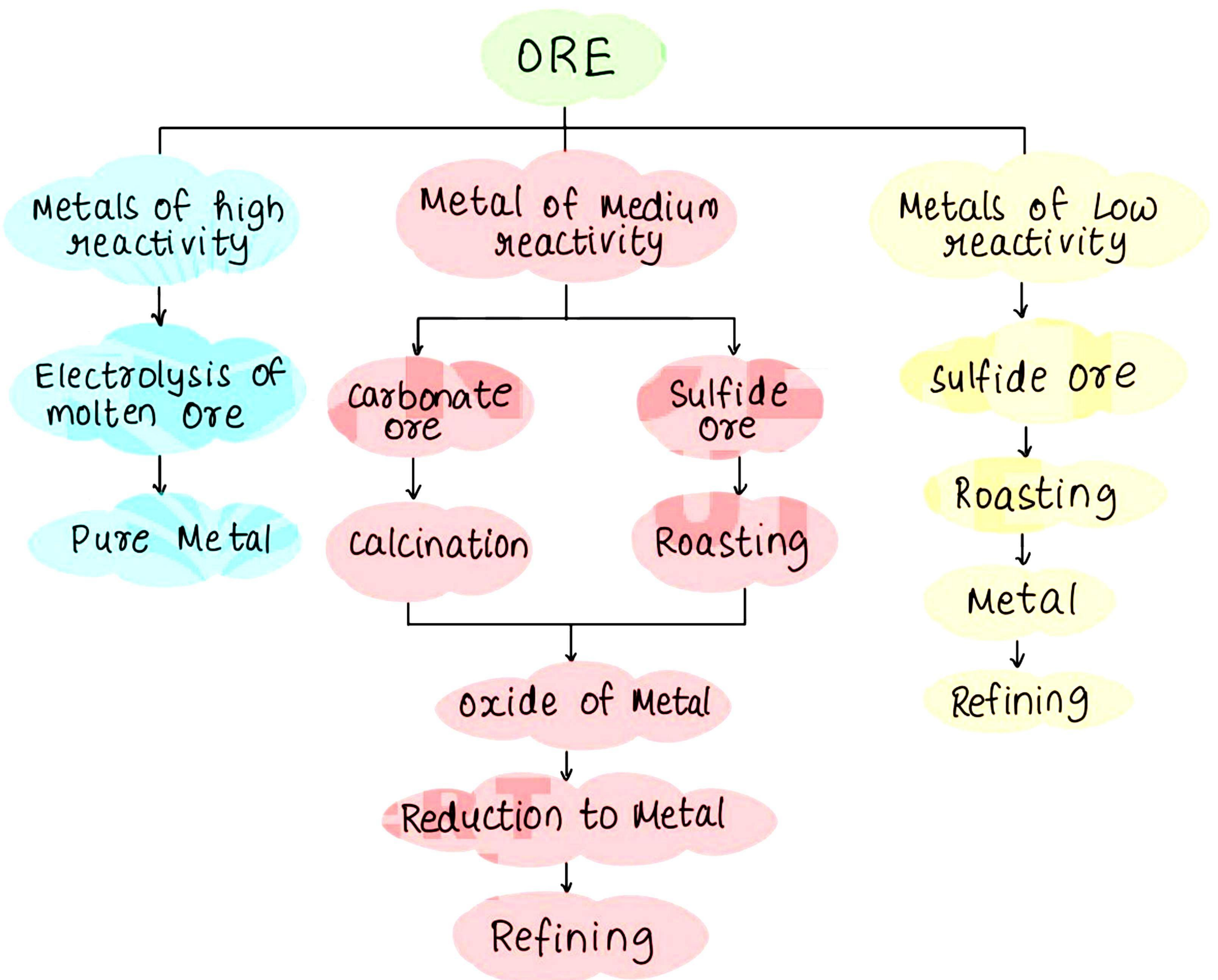
⚠ **Note**

- A list common metals arranged in order of their decreasing reactivity is known as an activity series.

The extraction of metals from their ores and then refining them for use is known as **metallurgy**.

An alloy is a homogeneous mixture of two or more metals or a metal and a non-metal.

The surface of some metals, such as iron is corroded when they are exposed to moist air for a long period of time. This phenomenon is known as **corrosion**.



### → Concentration Of Ores

• Impurities and Gangue: Undesirable impurities, such as soil and sand present in ores are termed as **gangue** or **matrix**.

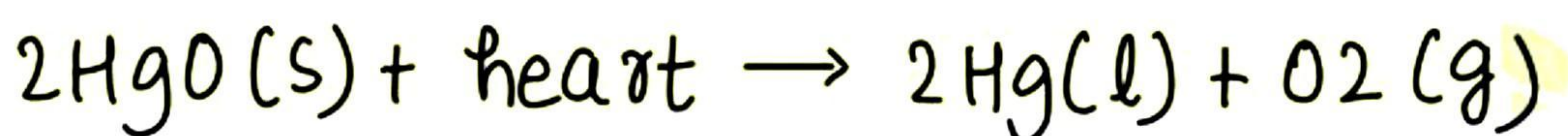
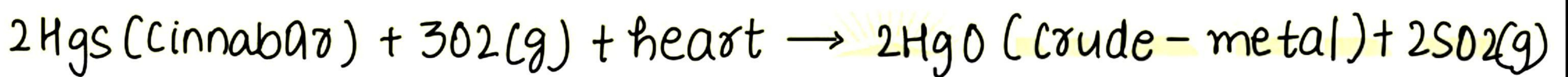
• Enrichment or Concentration: The process of removing gangue from the ore is known as **Enrichment** or **Concentration** of the ore.

## → Extraction of Metals of Low Reactivity

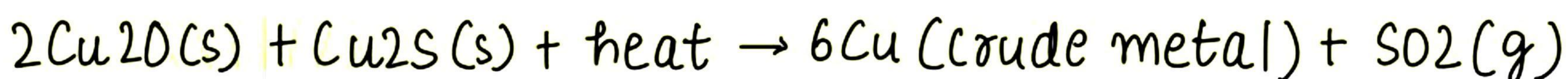
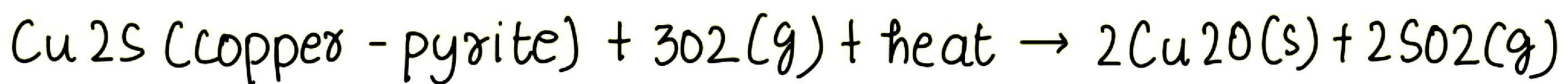
- **Self Reduction**: sulfide ores of less electropositive metals like **Mercury (Hg)**, **Lead (Pb)** and **Copper (Cu)** undergo self reduction when heated in air. No external reducing agent is used in this process.

### Examples

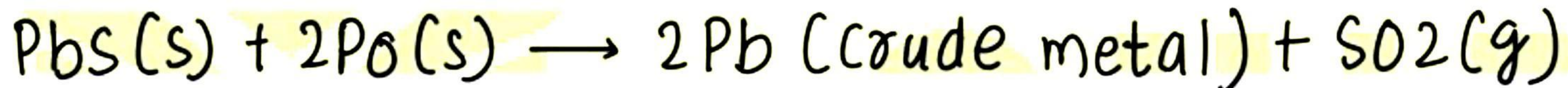
#### 💡 Cinnabar (HgS)



#### 💡 Copper Glance (Cu<sub>2</sub>S)



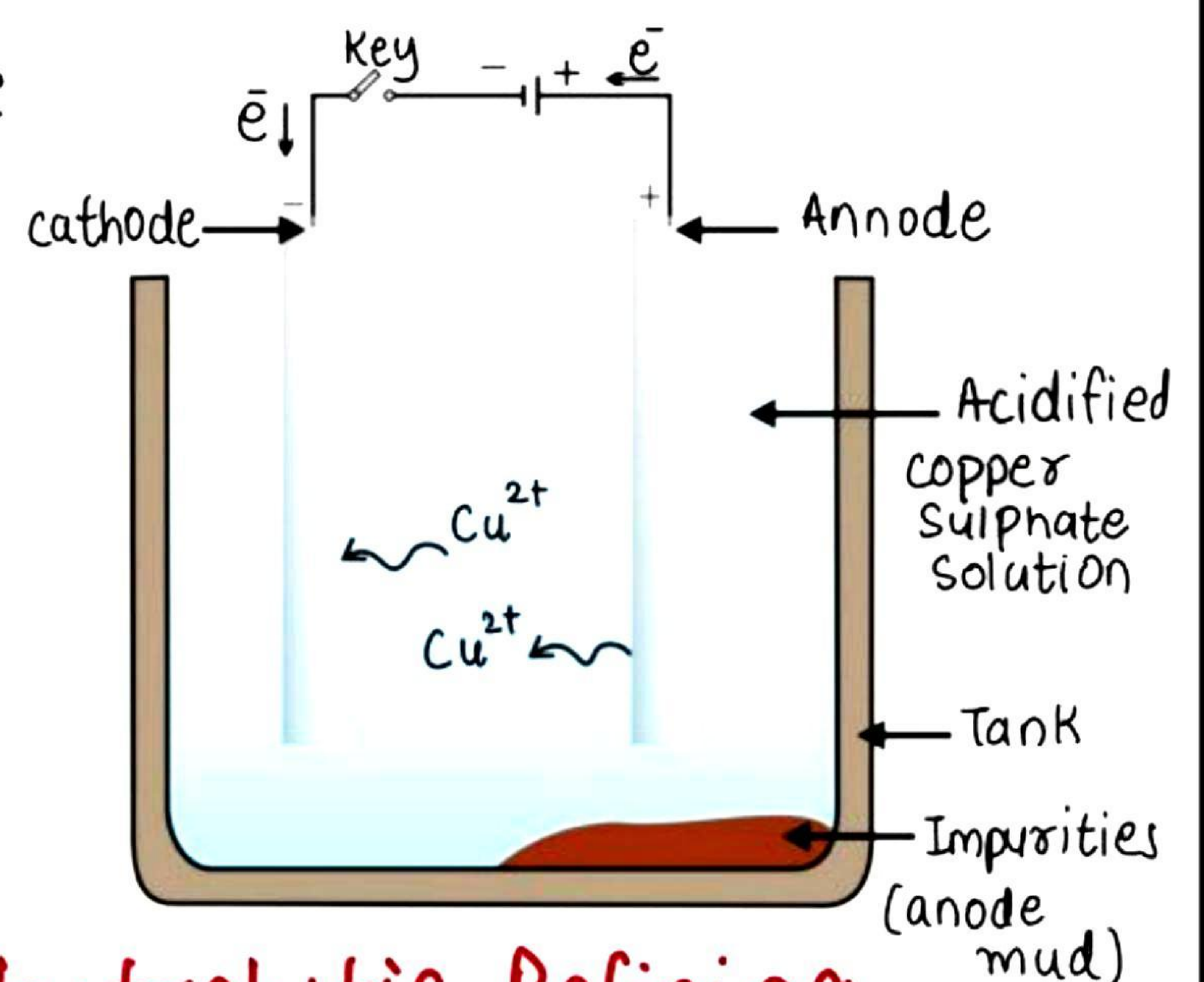
#### 💡 Galena (PbS)



- **Roasting**: Heating with oxygen below boiling point, for sulphide ores to convert them into oxides or sulphates.
- **Calcination**: Heating without oxygen below melting point, for carbonate ores to remove carbon dioxide, leaving oxides behind.

➔ **Refining** - Refining transforms impure metals into pure forms through various methods tailored to their properties. This purification process eliminates impurities, enhancing the metal's quality and utility. Techniques like electrolysis, distillation and fractional crystallization are employed, ensuring the final product meets specific standards for industrial and commercial applications.

➔ **Electrolytic Refining** - During this electrolytic refining process, the impure metal serves as the anode, while a slender strip of pure metal acts as the cathode. Current flowing



Electrolytic Refining

through the electrolyte causes the impure metal at the anode to dissolve into the solution. Simultaneously, an equivalent amount of pure metal is deposited into the cathode. Soluble impurities dissolve into the electrolyte, while insoluble impurities settle as "anode mud" at the bottom of the anode.

➔ **Corrosion** - Corrosion is the gradual decay of materials often metals due to environmental factors like moisture or chemicals. Example - Iron rusts in the presence of oxygen and water.

### Preventive Measures:

- **Protective coatings**: Applications of paints, oils or grease forms a barrier, preventing air and moisture contact.
- **Alloying**: Mixing metals enhance corrosion resistance, stainless steel is a prime example.
- **Galvanization**: Coating iron with molten zinc forms a protective layer preventing corrosion.
- **Electroplating**: Coating with one metal via electric current prevents corrosion and improves appearance. Example - silver or nickel plating.
- **Sacrificial Protection**: Using more reactive metals like magnesium sacrificially corrodes to shield iron or steel from corrosion.

### Prevention of corrosion

- Rusting of iron is prevented by painting, oiling, greasing, galvanizing, chrome plating, anodising and making alloys.
- In galvanization, iron or steel is coated with a layer of zinc because zinc is preferably oxidized than iron.

➔ **Alloy** - Alloys are uniform mixtures of metals with either other metals or non metals. The formation of alloys results in improved properties, including increased hardness, tensile strength and corrosion resistance. Example - Brass (an alloy composed of copper and zinc) Bronze (an alloy formed by combining copper and tin).

