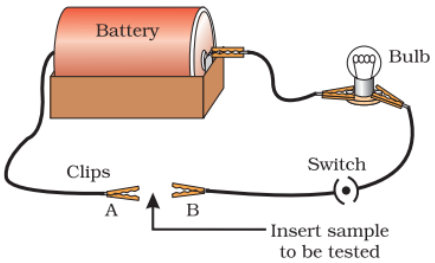
Properties	Metal	Non-Metal
Appearance	Shiny	Dull Except Iodine
State at room temperature	Solid (except mercury - liquid)	About half are solids, about half are gases, and one (bromine) is a liquid
Density	High (they feel heavy for their size)	Low (they feel light for their size)
Strength	Strong	Weak
Malleable or brittle	Malleable (they bend without breaking) Except Sodium, Potassium	Brittle (they break or shatter when hammered)
Conduction of heat	Good Except Lead	Poor (they are insulators)
Conduction of electricity	Good	Poor (EXCEPT **graphite)**
Magnetic material	Only iron, cobalt, and nickel	None
Sound when hit	They make a ringing sound (they are sonorous)	They make a dull sound
Melting and boiling points	Metals generally have high MP and BP except **gallium and caesium.**	Non-metals have low MP and BP except **diamond and graphite**.
Type of oxide	Basic or alkaline	Acidic

❖ **Chemical properties of Metals and Non-metals: -**

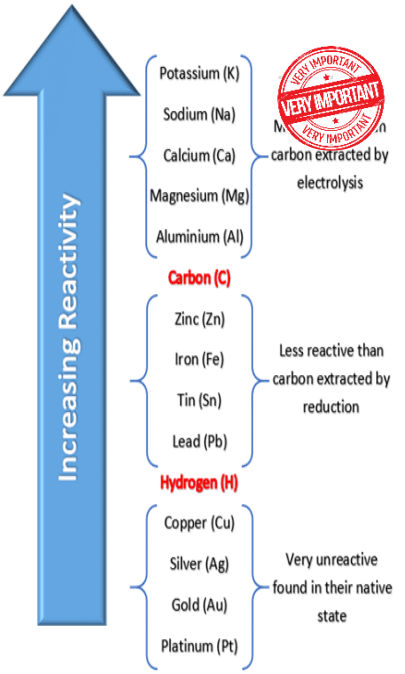
METAL	NON-METAL
REACTION WITH OXYGEN	
Metals form **basic oxides**	Non-metals form **acidic oxides**
Metal + Oxygen → Metal Oxide	Non-metal+Oxygen →Non-metal oxide
$4Na_{(s)} + O_{2(g)} \rightarrow 2Na_2O_{(s)}$	$C + O_2 \rightarrow CO_2$
$4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$	$S + O_2 \rightarrow SO_2$
• Zn and Al form **amphoteric oxides** (they show the properties of both acidic and basic oxides)	• CO and H2O are neutral oxides (they are neither acidic nor basic in nature)
• Most of the metal oxides are insoluble in water.	• Non-metal oxides are soluble in water.
• Some of them dissolve to form **Alkali**	• They dissolve in water to form acids.
• $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$	• $SO_2 + H_2O \rightarrow H_2SO_3$
REACTION WITH WATER	
Metals react with water to form metal oxides or metal hydroxide and H_2 gas is released.	Non-metals do not react with water, steam to evolve hydrogen gas.
$2Na_{(s)}+2H_2O_{(l)} \rightarrow 2NaOH_{(s)}+H_{2(g)}+Heat$	
REACTION WITH DILUTE ACIDS	
Metal + Acid → Metal salt + Hydrogen	Non-metals do not react with acids to release H_2 gas
• With HCl	
$Mg(s)+2HCl(aq) \rightarrow MgCl_2(aq)+H_2(g)$	
• With H_2SO_4	
$2Na(s)+H_2SO_4 \rightarrow Na_2SO_4(aq)+H_2(g)$	
• With HNO_3	
Metal + HNO_3 → H_2 gas is not evolved.	
Reason- HNO_3 is strong oxidizing agent.	
REACTION WITH SALT SOLUTIONS	
Metals react with salt solution and more reactive metal will displace a less reactive metal from its salt solution – **Single displacement reaction.**	When non-metals react with salt solution, more reactive non-metal will displace a less reactive non-metal from its salt solution.
$CuSO_{4(aq)} + Zn_{(s)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)}$	$2NaBr_{(aq)}+Cl_{2(g)} \rightarrow 2NaCl_{(aq)}+Br_{2(aq)}$



THERMITE REACTION

$Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(l) + Al_2O_3(s)$

Iron (III) oxide — Aluminium — Molten iron — Aluminium oxide



IONIC COMPOUNDS:

- Metals tend to lose electrons to form cations (+).
- Non-metals gain electrons to form anions (-).
- Ionic compounds are formed through the transfer of electrons from metals to non-metals (e.g., NaCl)

Properties of ionic Compounds:

- **Physical nature**: solid and hard due to strong force of attraction. (generally brittle)
- **Melting point and boiling point**: have high M.P and B.P, as large amount of heat energy is required to break strong ionic attraction.
- **Solubility**: soluble in water and insoluble in kerosene and petrol.
- Conduction of electricity: ionic compounds in solid state do not conduct electricity. (Reason—**Ions cannot move due to rigid solid structure**.)

Note: Ionic compounds conduct electricity in molten state. (Reason-- Ions can move freely since the electrostatic forces of attraction between the oppositely charged ions are overcome due to heat.)

$Na \rightarrow Na^+ + e^-$
2,8,1 2,8
(Sodium cation)

$Cl + e^- \rightarrow Cl^-$
2,8,7 2,8,8
(Chloride anion)

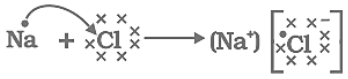


***Figure 3.5** Formation of sodium chloride*

$Mg \longrightarrow Mg^{2+} + 2e^-$
2,8,2 2,8
(Magnesium cation)

$Cl + e^- \longrightarrow Cl^-$
2,8,7 2,8,8
(Chloride anion)

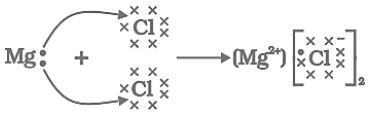


***Figure 3.6** Formation of magnesium chloride*

EXTRACTION OF METALS

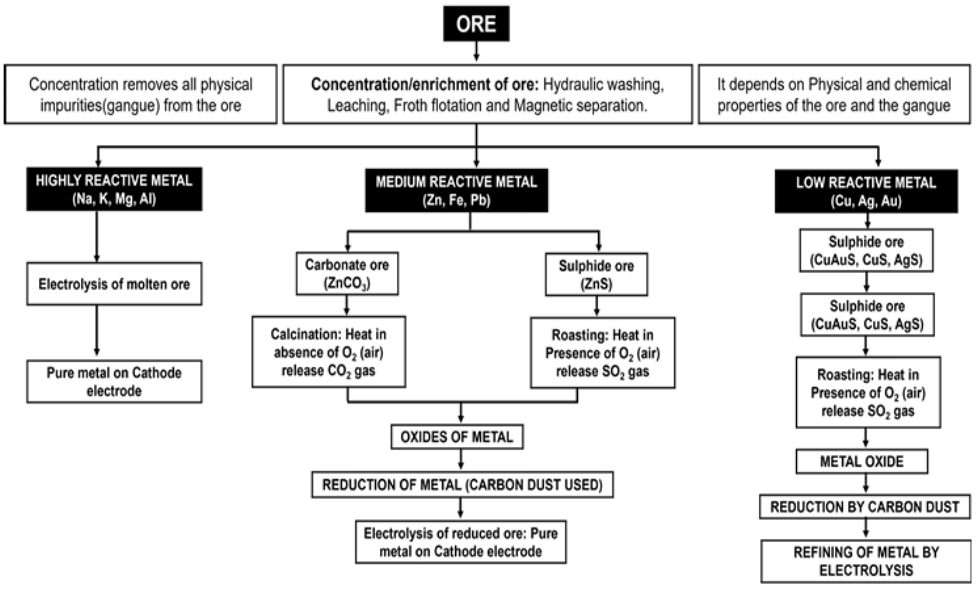
Ores: Minerals that contain a very high percentage of a particular metal and these metals can be extracted economically on a large scale.

Example:

- **Bauxite ore → Aluminium**
- **Haematite ore → Iron**
- **Magnetite ore → Iron**
- **Limestone → Calcium**
- **Gypsum → Calcium**
- **Bauxite → Aluminium**
- **Calamine → Zinc**

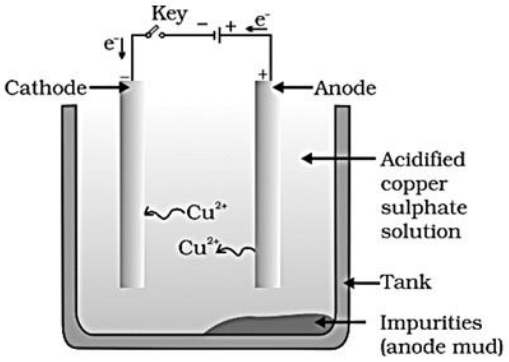
Reactivity	Metal	Method of Extraction
Most reactive	Potassium	Extracted by electrolysis of molten compounds
	Sodium	
	Lithium	
	Calcium	
	Magnesium	
	Aluminium	
	Carbon	
	Zinc	Extracted by reduction, by heating with carbon
	Iron	
	Copper	
	Silver	Found as pure elements in nature
Least reactive	Gold	

Calcination	Roasting
Calcination is carried out in absence of oxygen.	Roasting is carried out in presence of excess of oxygen.
As a result of calcination, carbonate ore is converted to the oxide. $ZnCO_3 \xrightarrow{heat} ZnO + CO_2$	As a result of roasting the sulphide ore is converted to the oxide. $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$



Electrolysis:

This is the final process to find purest form of metal. In a jar/container electrolysis performed here impure metal(anode) and a strip of pure metal (cathode) are used as electrodes. They are dipped in an electrolytic bath which contains the soluble salt of the same metal. As **electricity is passed through the solution, the less basic metal moves towards the anode** mud leaving the more basic metal in the solution.



For example, copper is purified using this method.

Corrosion: Corrosion is oxidation of metals.

Example of corrosion are as follows

- **Blacking of silver** (Silver sulphide) $4Ag + 2H_2S + O_2 \rightarrow 2Ag_2S + 2H_2O$
- **Green layer on copper** (Copper carbonate) $2Cu+O_2+CO_2+H_2O \rightarrow CuCO_3.Cu(OH)_2$
- **brown flaky substance on iron** $4Fe + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3$ $2Fe(OH) \rightarrow Fe_2O_3.3H_2O$

Note: Corrosion of iron also known as Rusting.

- **Prevention methods:**

✓ **Galvanization** ✓ **Painting** ✓ **Using alloys** (Metals are combined to form alloys to enhance properties) (e.g., brass is an alloy of copper and zinc).