



Chapter - 3

Metals And Non-Metals

- Elements can be classified as metals and non-metals on the basis of their properties.
- Example of some metals are :
Iron (Fe), Aluminium (Al), Silver (Ag), Copper (Cu)
- Examples of some non-metals are :
Hydrogen (H), Nitrogen (N), Sulphur (S), Oxygen (O)

I. PHYSICAL PROPERTIES

PROPERTY	METALS	NON-METALS
1. Lustre	Metals have shining surface.	They do not have shining surface. • Except Iodine.
2. Hardness	They are generally hard. • Except Sodium, Lithium and Potassium which are soft and can be cut with knife.	Generally soft. • Except Diamond, a form of carbon which is the hardest natural substance.
3. State	Exist as solids. • Except Mercury.	Exist as solids or gaseous. • Except Bromine.
4. Malleability	Metals can be beaten into thin sheets. • Gold and Silver are the most malleable metals.	Non-metals are non-malleable.

5. Ductility	Metals can be drawn into thin wires.	They are non-ductile.
6. Conductor of heat & electricity	Metals are good conductors of heat and electricity. • Silver (Ag) and Copper (Cu) : Best conductors of heat. • Lead (Pb), Mercury (Hg) poor conductor of heat.	Non-metals are poor conductor of heat and electricity. • Except Graphite.
7. Density	Generally have high density and high melting point. • Except Sodium and Potassium.	Have low density and low melting point.
8. Sonorous	Metals produce a sound on striking a hard surface.	They are not sonorous.
9. Oxides	Metallic oxides are basic in nature.	Non-metallic oxides are acidic in nature.

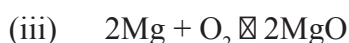
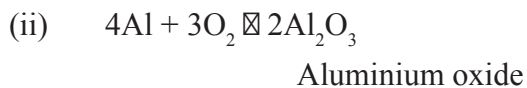
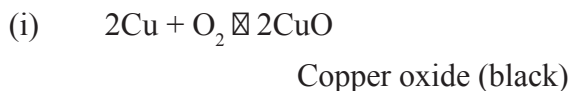
II. CHEMICAL PROPERTIES OF METALS

(A) Reaction with Air :

Metals combine with oxygen to form metal oxide.



Examples :



Different metals show different reactivities towards O_2 .

- Na and K react so vigorously that they catch fire if kept in open so they are kept immersed in kerosene.
- Surfaces of Mg, Al, Zn, Pb are covered with a thin layer of oxide which prevent them from further oxidation.
- Fe does not burn on heating but iron fillings burn vigorously.
- Cu does not burn but is coated with black copper oxide.

- Au and Ag does not react with oxygen.

Amphoteric Oxides : Metal oxides which react with both acids as well as bases to produce salts and water are called amphoteric oxides.

Examples : $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$

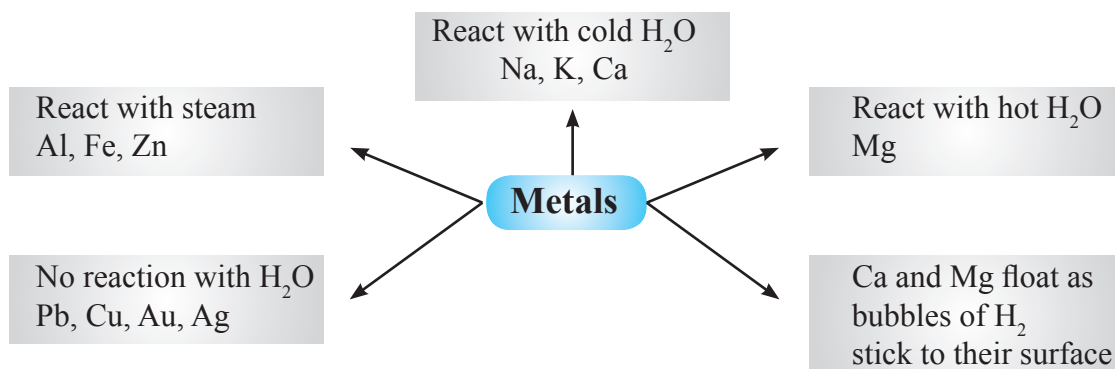


Sodium Aluminate

(B) Reaction of Metals with Water :

Metal + Water $\rightarrow$ Metal oxide + Hydrogen

Metal oxide + Water $\rightarrow$ Metal hydroxide



Examples :



(C) Reaction of Metals with Acids (Dilute) :

Metal + Dilute acid $\rightarrow$ Salt + H_2

Cu, Ag, Hg do not react with dil. acids.

Examples :



(D) Reaction of Metals with Solutions of other Metal Salts :



- Reactive metals can displace less reactive metals from their compounds in solution form.



REACTIVITY SERIES

The reactivity series is a list of metals arranged in the order of their decreasing activities.

K	Most reactive
Na	
Ca	
Mg	
Al	
Zn	Reactivity decreases
Fe	
Pb	
H	
Cu	
Hg	
Ag	
Au	Least reactive

Reaction of Metals with Non-metals

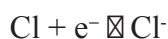
- Reactivity of elements is the tendency to attain a completely filled valence shell.
- Atoms of the metals lose electrons from their valence shell to form cation. Atom of the non-metals gain electrons in the valence shell to form anion.

E.g., Formation of NaCl



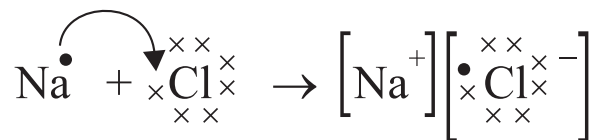
2, 8, 1 2, 8

Sodium cation



2, 8, 7 2, 8, 8

Chloride anion



Ionic Compounds

The compounds formed by the transfer of electrons from a metal to a non-metal are called ionic compounds or electrovalent compounds.

Properties of Ionic Compounds

1. **Physical nature** : They are solid and hard, generally brittle.
2. **Melting and Boiling Point** : They have high melting and boiling point.
3. **Solubility** : Generally soluble in water and insoluble in solvents such as kerosene, petrol etc.
4. **Conduction of electricity** : Ionic compounds conduct electricity in molten and solution form but not in solid state.

Occurrence of Metals

Minerals : The elements or compounds which occur naturally in the earth's crust are called minerals.

Ores : Minerals that contain very high percentage of particular metal and the metal can be profitably extracted from it, such minerals are called ores.

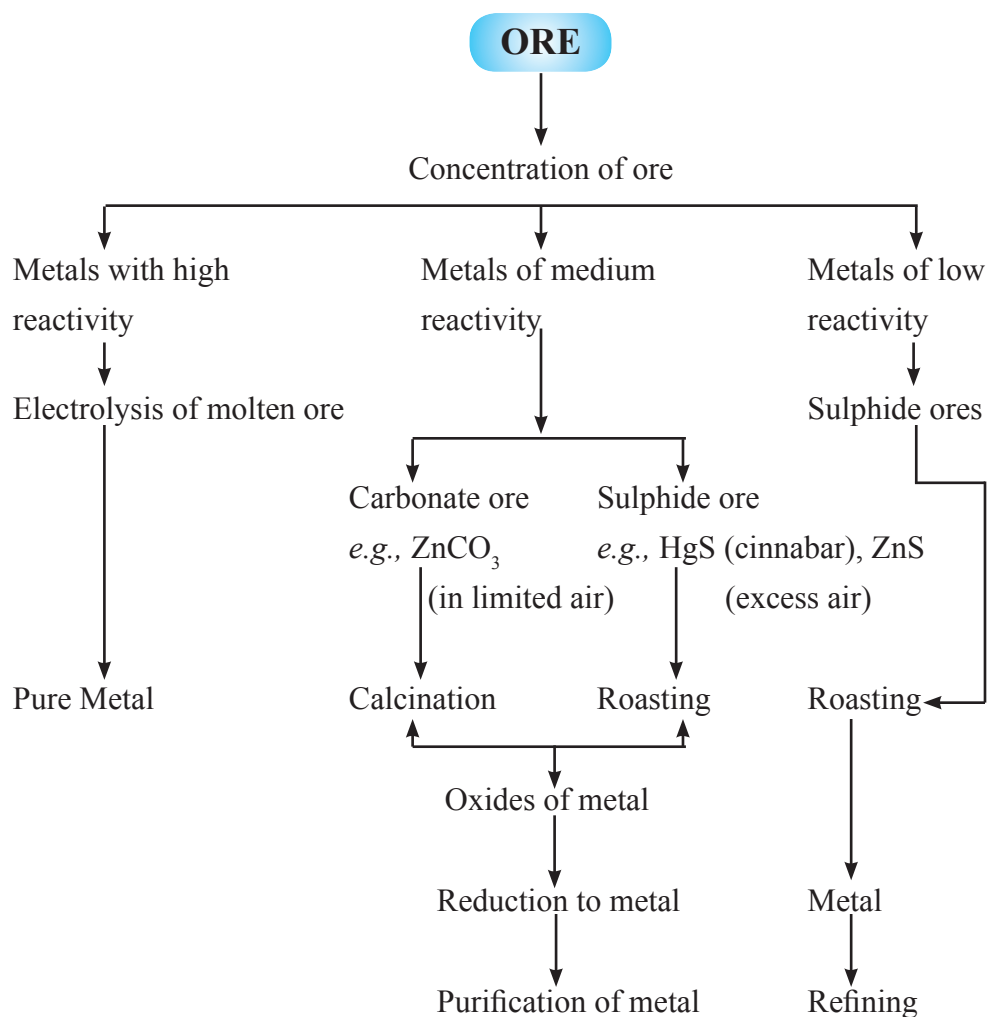
Very reactive metals	K	Not found in free state Extraction by electrolysis
	Na	
	Ca	
	Mg	
	Al	
Moderately reactive	Zn	Occur as sulphides, oxides, carbonates Reduction by using carbon
	Fe	
	Pb	
	Cu	
	Hg	
Least reactive	Ag	Occur in native/free state
	Au	

Extraction of Metals from Ores

Step 1. Enrichment of ores.

Step 2. Extraction of metals.

Step 3. Refining of metals.



Steps Involved in Extraction of Metals from Ores

Some Important Terms

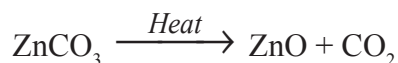
(a) Gangue : Ores are usually contaminated with large amount of impurities such as soil, sand etc. called gangue.

(b) Roasting : The sulphide ores are converted into oxides by heating strongly in the

presence of excess air. This process is called roasting.



(c) Calcination : The carbonate ores are changed into oxides by heating strongly in limited air. This process is called calcination.

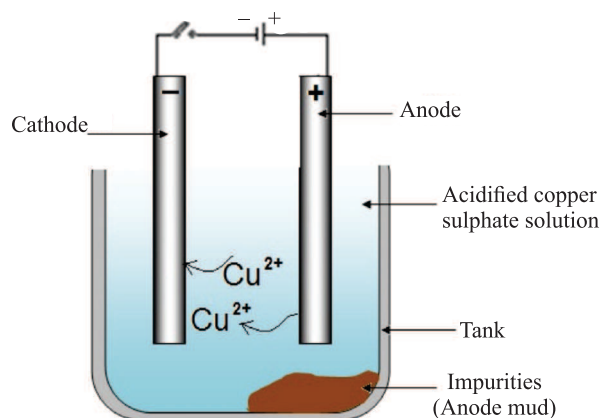


(d) Reduction : Metal oxides are reduced to corresponding metals by using reducing agent like carbon.



Refining of Metals

The most widely used method for refining impure metal is electrolytic refining.



- Anode : Impure copper
 - Cathode : Strip of pure copper
 - Electrolyte : Solution of acidified copper sulphate
- (a) On passing the current through electrolyte, the impure metal from anode dissolves into the electrolyte.
 - (b) An equivalent amount of pure metal from the electrolyte is deposited at the cathode.
 - (c) The insoluble impurities settle down at the bottom of the anode and is called anode mud.

Corrosion

The surface of some metals such as iron is corroded when they are exposed to moist air

for a long period of time. This is called corrosion.

- (i) Silver becomes black when exposed to air as it reacts with air to form a coating of silver sulphide.
- (ii) Copper reacts with moist carbon dioxide in the air and gains a green coat of copper carbonate.
- (iii) Iron when exposed to moist air acquires a coating of a brown flaky substance called rust.

Prevention of Corrosion

The rusting of iron can be prevented by painting, oiling, greasing, galvanizing, chrome plating, anodizing or making alloys.

Galvanization : It is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc.

Alloy : An alloy is a homogenous mixture of two or more metals or a metal and a non-metal.

Iron : Mixed with small amount of carbon becomes hard and strong.

Steel : Iron + Nickel and chromium

Brass : Copper + Zinc

Bronze : Copper + Tin (Sn)

Solder : Lead + tin

Amalgam : If one of the metal is mercury (Hg).