

METALS AND NON METALS PART 3

EDUCATION FOR LIFE

AIS



ASIAN
INTERNATIONAL
SCHOOL

EXTRACTION OF METALS AND NON-METALS

Applications of Displacement Reaction

Uses of displacement reaction

Extraction of metals

Manufacturing of steel

Thermite reaction: $\text{Al(s)} + \text{Fe}_2\text{O}_3\text{(s)} \rightarrow \text{Al}_2\text{O}_3 + \text{Fe(molten)}$

The thermite reaction is used in welding of railway tracks, cracked machine parts, etc.

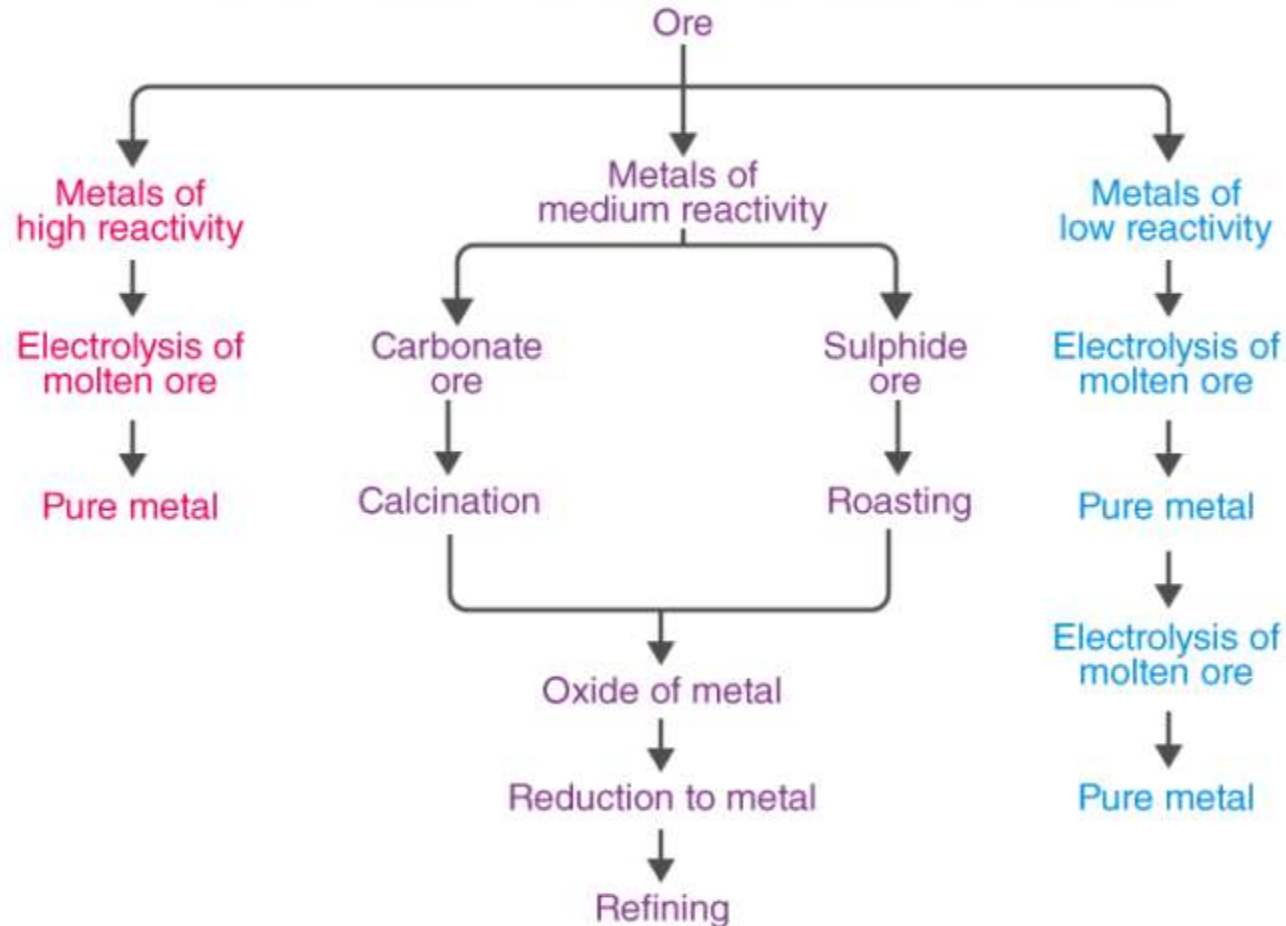
Occurrence of Metals

Most of the elements especially metals occur in nature in the combined state with other elements. All these compounds of metals are known as **minerals**. But out of them, only a few are viable sources of that metal. Such sources are called **ores**.

Au, Pt - exist in the native or free state.

EXTRACTION OF METALS

Steps involved in the extraction of metals from their ores



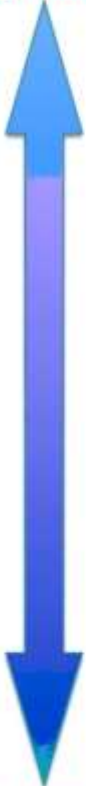
Metals of high reactivity - Na, K, Mg, Al.

Metals of medium reactivity - Fe, Zn, Pb, Sn.

Metals of low reactivity - Cu, Ag, Hg

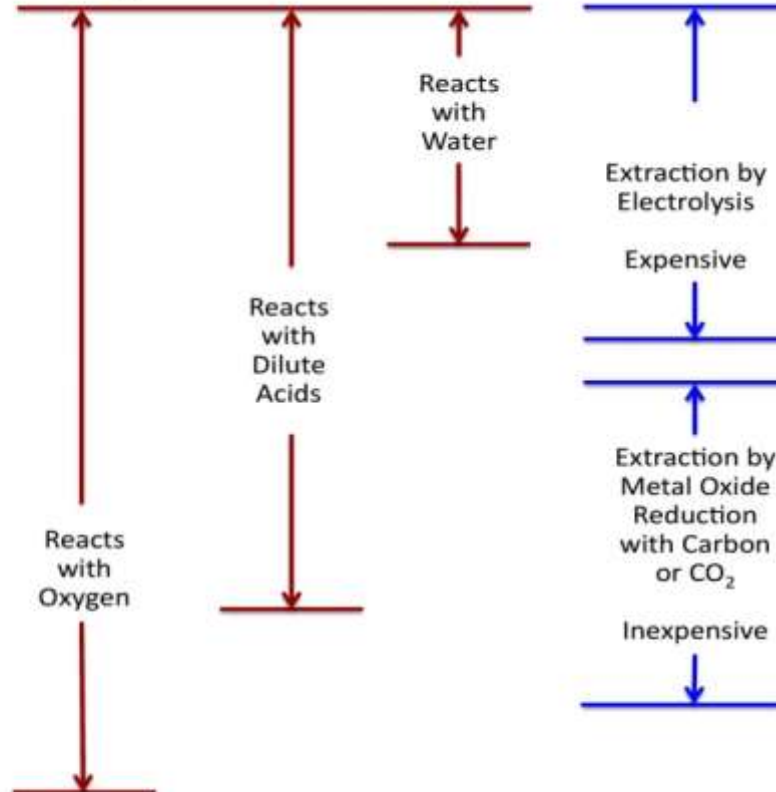
Metals Activity Series

Very Reactive



Very Unreactive

Li	Lithium
K	Potassium
Ba	Barium
Ca	Calcium
Na	Sodium
Mg	Magnesium
Al	Aluminum
C	Carbon
Zn	Zinc
Fe	Iron
Ni	Nickel
Sn	Tin
Pb	Lead
H	Hydrogen
Cu	Copper
Hg	Mercury
Ag	Silver
Au	Gold
Pt	Platinum



Carbon and Hydrogen are not metals but are included for reference.

ROASTING

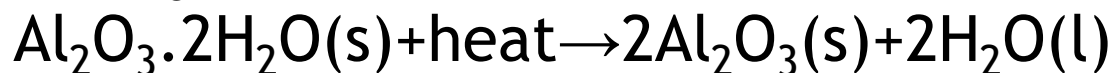
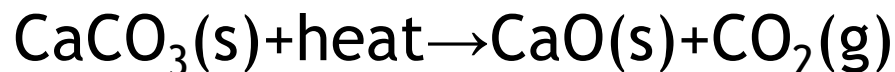
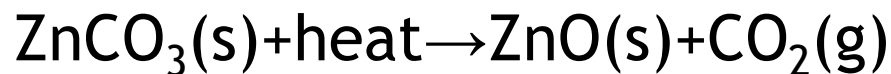
Converts sulphide ores into oxides on heating strongly in the presence of excess air.

It also removes volatile impurities.



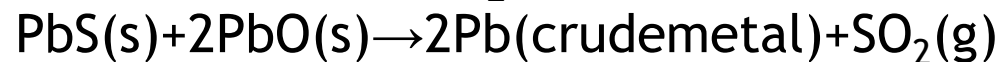
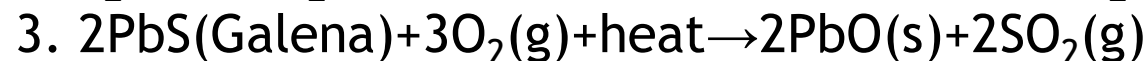
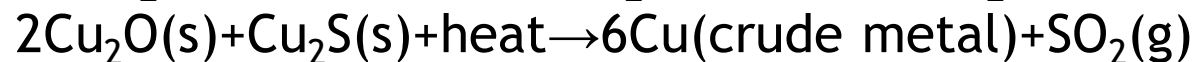
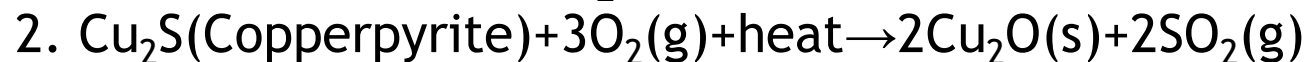
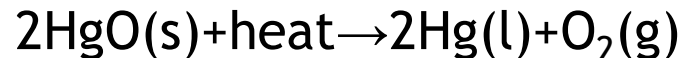
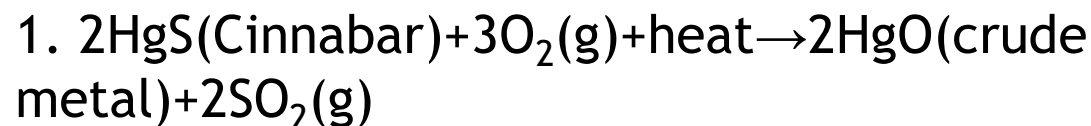
CALCINATION

Converts carbonate and hydrated ores into oxides on heating strongly in the presence of limited air. It also removes volatile impurities.



EXTRACTING METALS LOW IN REACTIVITY SERIES

By self-reduction- when the sulphide ores of less electropositive metals like Hg, Pb, Cu etc., are heated in air, a part of the ore gets converted to oxide which then reacts with the remaining sulphide ore to give the crude metal and sulphur dioxide. In this process, no external reducing agent is used.



EXTRACTING METALS IN THE MIDDLE OF REACTIVITY SERIES

Smelting - it involves heating the roasted or calcined ore(metal oxide) to a high temperature with a suitable reducing agent. The crude metal is obtained in its molten state.



Aluminothermic reaction - also known as the Goldschmidt reaction is a highly exothermic reaction in which metal oxides usually of Fe and Cr are heated to a high temperature with aluminium.

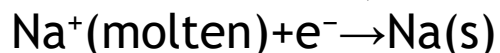


EXTRACTION OF METALS TOWARDS THE TOP OF THE REACTIVITY SERIES

Electrolytic reduction:

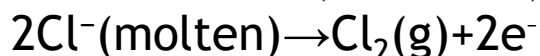
1. Down's process: Molten NaCl is electrolysed in a special apparatus.

At the **cathode** (reduction) -



Metal is deposited.

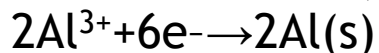
At the **anode** (oxidation) -



Chlorine gas is liberated.

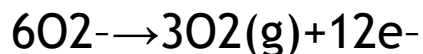
2. Hall's process: Mixture of molten alumina and a fluoride solvent usually cryolite, (Na_3AlF_6) is electrolysed.

At the **cathode** (reduction) -



Metal is deposited.

At the **anode** (oxidation) -



Oxygen gas is liberated.

ENRICHMENT OF ORES

It means the removal of impurities or gangue from ore, through various physical and chemical processes. The technique used for a particular ore depends on the difference in the properties of the ore and the gangue.

REFINING OF METALS

Refining of metals - removing impurities or gangue from crude metal. It is the last step in metallurgy and is based on the difference between the properties of metal and the gangue.

Electrolytic Refining

Metals like copper, zinc, nickel, silver, tin, gold etc., are refined electrolytically.

Anode - impure or crude metal

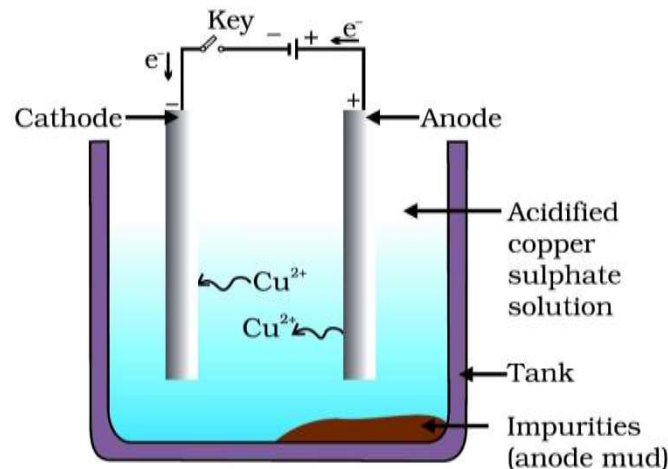
Cathode - a thin strip of pure metal

Electrolyte - aqueous solution of metal salt

From anode (oxidation) - metal ions are released into the solution

At cathode (reduction) - the equivalent amount of metal from solution is deposited

Impurities deposit at the bottom of the anode.



The reactions are:

Anode: $M \rightarrow M^{n+} + ne^{-}$

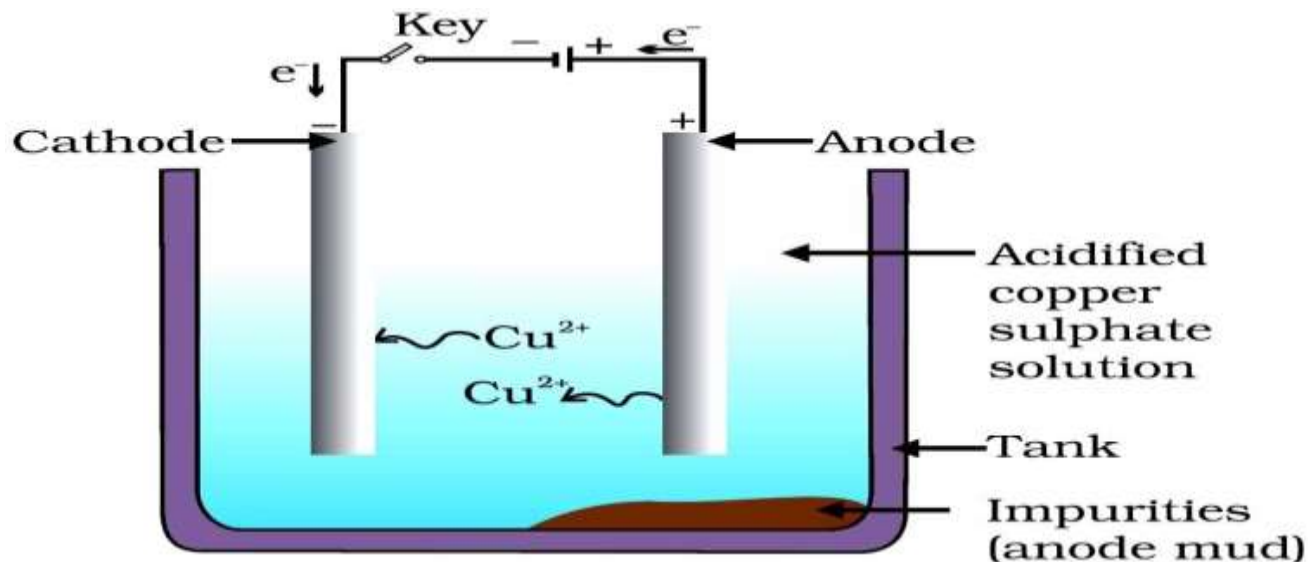
Cathode: $M^{n+} + ne^{-} \rightarrow M$ (M = pure metal) Where $n = 1, 2, 3, \dots$

We use this electrolytic method to refine copper.

For this an impure copper is taken as anode and pure copper strips are taken as cathode. The electrolyte is a acidified solution of copper sulphate. As a result of electrolysis copper in pure form is transferred from the anode to the cathode.

Anode: $Cu \rightarrow Cu^{2+} + 2e^{-}$

Cathode: $Cu^{2+} + 2e^{-} \rightarrow Cu$



CORROSION:

- The eating up of metal by the action of gases, moisture or acids present in air.
- Corrosion of Iron:

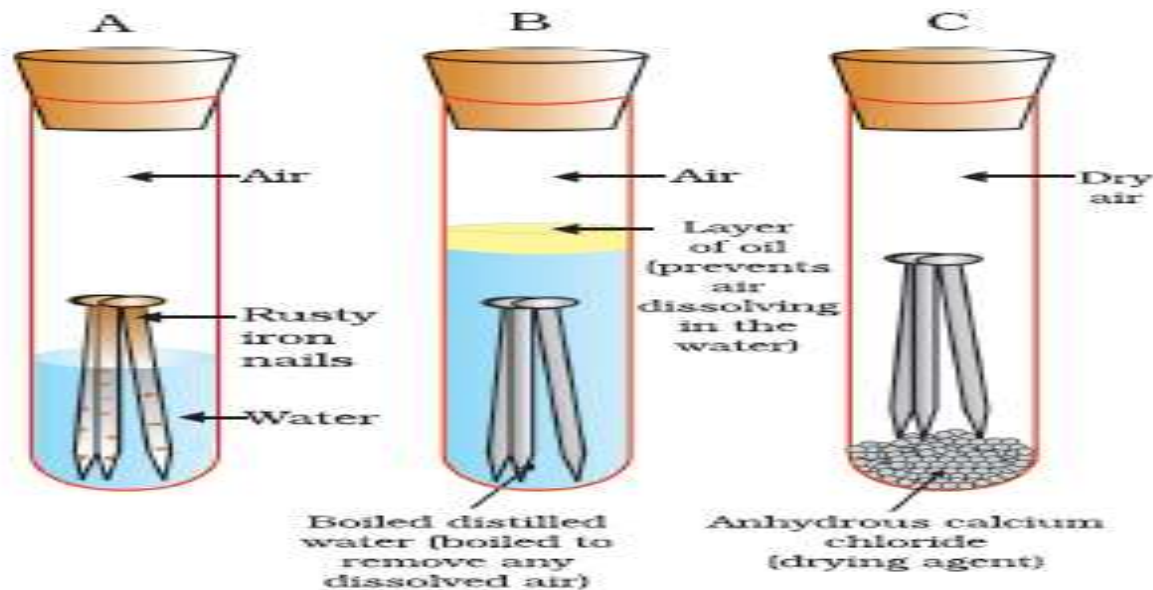


Figure 4 : *Investigating the conditions under which iron rusts. In tube A, both air and water are present. In tube B, there is no air dissolved in the water. In tube C, the air is dry.*

PREVENTION OF CORROSION OF IRON:

- ❖ Painting
- ❖ Applying grease
- ❖ **Galvanisation** : Process of protecting steel and iron from rusting by coating them with thin layer of zinc.
- ❖ Chromium plating/ tin plating
- ❖ Alloying: Improve the properties of a metal.

Alloy is a homogeneous mixture of a metal and two or more other metals or non-metals.

It has better properties than metals like in case of **strength, corrosion and lower electrical conductivity& melting points.**

It is prepared by melting primary metal first and then dissolving other in definite proportion and then cooling to room temperature.

Some common alloys:

Stainless Steel - Alloy of Fe, Ni and Cr

Brass - Alloy of Cu and Zn

Bronze - Alloy of Cu and Sn

Solder - Alloy of Pb and Sn

Amalgam - Any alloy containing mercury

Alloy of Gold - Contains gold and silver/copper.

