Metals and Non Metals

Property	Metals	Non-Metals
State	Solid at room temperature (except Mercury - liquid)	Can exist in all three states: solids (e.g., Sulfur, Phosphorus), liquid (Bromine - only liquid), gases (e.g., Oxygen, Nitrogen)
Lustre	Shiny (metallic lustre)	Dull (except Iodine - lustrous)
Hardness	Generally hard (except Sodium, Potassium - soft)	Generally soft (Diamond - exception, hardest natural substance)
Malleability	Can be beaten into sheets	Brittle, cannot be beaten into sheets
Ductility	Can be drawn into wires	Non-ductile, cannot be drawn into wires
Conductivity (Heat & Electricity)	Good conductors (except Lead, Mercury - poor conductors of heat)	Poor conductors (except Graphite - conducts electricity but not heat efficiently)
Melting & Boiling Point	Generally high (except Gallium, Caesium - low melting points)	Generally low (Diamond - exception, extremely high melting point)
Sonority	Produces sound when struck	Does not produce sound

PRASHANT KIRAD

Reactions of Metals and Non Metals

Oxygen - Non - metals

Non-Metal + Oxygen → Non-Metal Oxide (Acidic/Neutral)

Example: $C + O_2 \rightarrow CO_2$

$S + O_2 \rightarrow SO_2$

Oxygen - Metals

Metal + Oxygen → Metal Oxide (Basic)

Example: $2Mg + O_2 \rightarrow 2MgO$

Amphoteric Metals: Beryllium (Be), Zinc (Zn), Tin (Sn), Lead (Pb), Aluminium (Al), (Antimony (Sb)

Aluminium with Oxygen: $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

Zinc with Oxygen: $2Zn(s) + O_2(g) \rightarrow 2ZnO(s)$

Aluminium Oxide Reactions:

- $Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$
- $Al_2O_3(s) + 2NaOH(aq) \rightarrow 2NaAlO_2(aq) + H_2O(l)$

Water- Non - metals

Non metals don't react with water

Non-Metal Oxide + Water → Acid

- $SO_2 + H_2O \rightarrow H_2SO_3$
- $SO_3 + H_2O \rightarrow H_2SO_4$
- $CO_2 + H_2O \rightarrow H_2CO_3$
- $NO_2 + H_2O \rightarrow HNO_3 + HNO_2$

Water- Metal

Metal + Water → Metal Hydroxide + H_2

Na_2O, K_2O, CaO, and MgO dissolve in water to form metal hydroxides

Example: $2Na + 2H_2O \rightarrow 2NaOH + H_2$

K, Na react violently with water; Ca reacts mildly;

$Ca+2H2O \rightarrow Ca(OH)2+H2$

Mg reacts with hot water. Al, Fe, Zn react with steam;

$2Al+3H2O$ (steam) $\rightarrow Al2O3+3H2$

$3Fe+4H2O$ (steam) $\rightarrow Fe3O4+4H2$

Pb, Cu, Ag, Au do not react with water.

Acids- Non - metals No Reaction

Acids- Metal

Metal + dil. Acid → Salt + H_2

Example: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

Hydrogen gas isn't produced when metals react with HNO_3 because it oxidizes H_2 to water and reduces to nitrogen oxides.

Only Mg and Mn with very dilute HNO_3 release H_2 gas.

Metal (Mg and Mn) + Dilute nitric acid → Salt + Hydrogen gas

- $2Mg + 4HNO_3 \rightarrow 2Mg(NO_3)_2 + H_2$
- $Mn + 2HNO_3 \rightarrow Mn(NO_3)_2 + H_2$

Other Metals + Dilute nitric acid → Salt + Water + $NO_2/N_2O/NO$

Aqua regia is a mix of concentrated hydrochloric and nitric acids in a 3:1 ratio. It's highly corrosive and can dissolve gold and platinum.

Metal Salts Non - metals

No Reaction

Metal Salts Metal

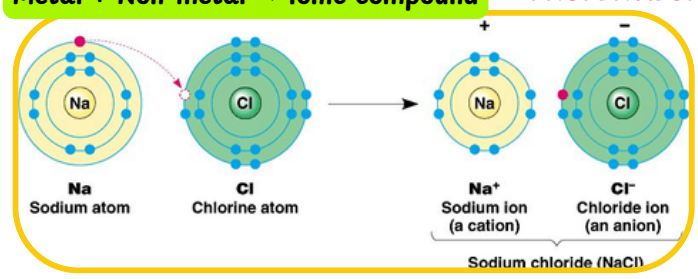
More reactive metals displace less reactive metals from their salt solutions (displacement reaction).

Metal A + Salt solution of B → Salt solution of A + Metal B

Example: $Pb + CuCl_2 \rightarrow PbCl_2 + Cu$

When metals react with non-metals, electrons transfer from metals to non-metals, forming ions. The compound formed is ionic.

Metal + Non-metal → Ionic compound PROPERTIES?



Property	*Description*
Physical nature	Solid, hard, brittle due to strong ionic bonds.
Melting & Boiling points	High, due to strong inter-ionic attractions requiring more energy to break.
Solubility	Soluble in water, insoluble in organic solvents like kerosene and petrol.
Electrical conductivity	Conducts in molten and aqueous states, not in solid due to immobile ions.

Metallurgy: Science & tech of metals' properties, production, purification

↓

Minerals: Naturally occurring elements/compounds in Earth's crust

↓

Ores: Minerals from which metals can be extracted economically and conveniently

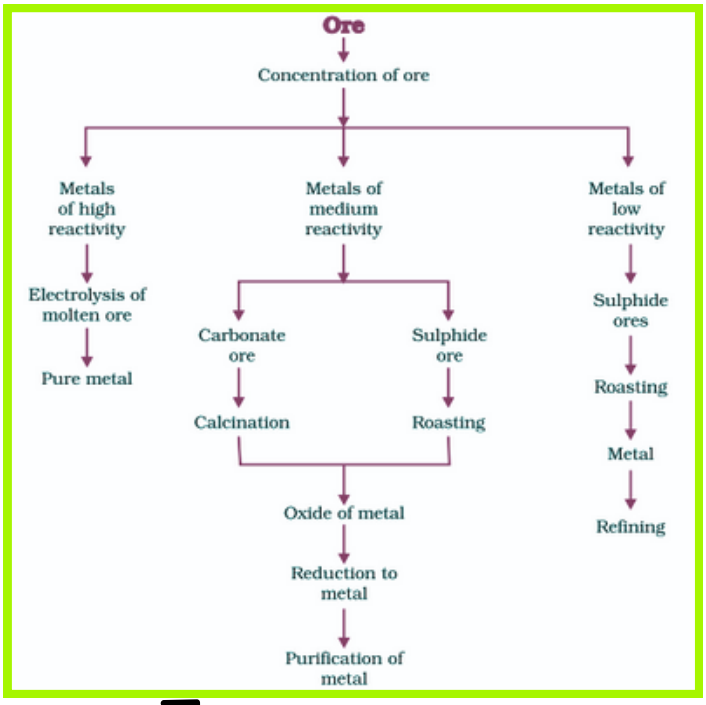
↓

Gangue Particles: Impurities in ores (sand, oil, etc.)

↓

Enrichment of Ore/Concentration: Process of removing gangue particles from ore

Zinc (Zn) - Zinc Blende (Sphalerite) : ZnS
- Calamine : $ZnCO_3$
Mercury (Hg) - Cinnabar : HgS
Copper (Cu) - Copper Glance : Cu_2S
Aluminium (Al)- Bauxite : $Al_2O_3 \cdot xH_2O$



K (Potassium)
Na (Sodium)
Ca (Calcium)
Mg (Magnesium)
Al (Aluminum)
— *Electrolysis*: Highly reactive metals (K, Na, Ca, Mg, Al) are extracted using electrolysis.

Zn (Zinc)
Fe (Iron)
Pb (Lead)
— *Reduction using carbon*: Moderately reactive metals (Zn, Fe, Pb) are usually extracted through carbon reduction.

Cu (Copper)
Ag (Silver)
Au (Gold)
— *Found in native state*: Metals like gold and silver are found in a free state due to low reactivity.

Roasting	*Calcination*
Heating of a metal ore in the presence of excess air or oxygen.	Heating of a metal ore in the presence of limited air or oxygen.
Requires an excess amount of air or oxygen.	Done with limited air or oxygen.
Mainly done for sulphide ores.	Done for carbonate ores.
Releases toxic gases and substances (e.g., SO_2).	Releases volatile compounds, often less toxic than in roasting.

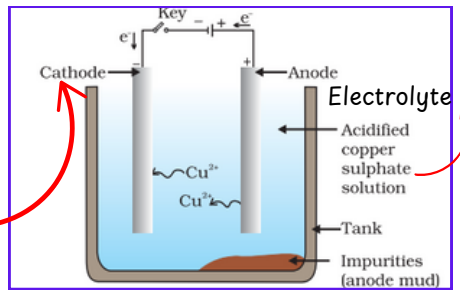
Electrolysis Highly reactive metals (K, Na, Ca, Mg, Al) are extracted using electrolysis.

Reduction using carbon Moderately reactive metals (Zn, Fe, Pb) are usually extracted through carbon reduction.

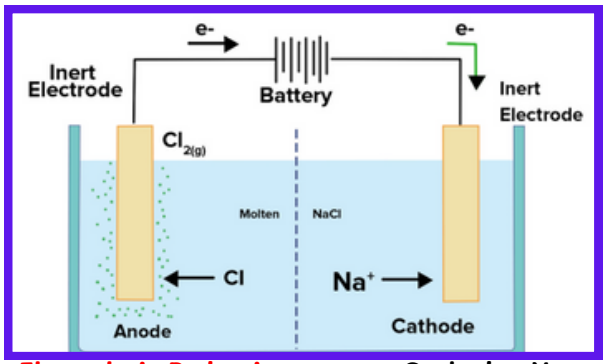
Found in native state Metals like gold and silver are found in a free state due to low reactivity.

Refining of Metals

Electrolytic refining is widely used for purification.
Metals like copper, zinc, tin, nickel, silver, gold are refined using this method



Insoluble impurities form anode mud, while soluble ones stay in the solution.



Electrolytic Reduction

Cathode : $Na^+ + e^- \rightarrow Na$
Anode : $2Cl^- \rightarrow Cl_2 + 2e^-$

Alloying

- An alloy is a mixture of metals or a metal with a non-metal, altering properties like conductivity and melting point.
  Examples :
- Brass (Copper + Zinc) and Bronze (Copper + Tin) are poor conductors, unlike Copper, which powers electrical circuits.
- Solder (Lead + Tin) melts easily, making it perfect for welding electrical wires.
- Pure gold is soft, so it is alloyed with silver or copper to make jewelry, typically in 22 carat form in India.
- The Iron Pillar near Qutub Minar in Delhi, over 1600 years old, resists rust due to ancient Indian metallurgy techniques

Chapter ka KAZAANA:
- **Chemical Properties of Metal**
- **Reactivity Series (Give reasons type of questions)**
- **Exceptional Cases (HNO_3 reaction with metals)**
- **Metallurgy**
- **Calcination/Roasting**
- **Electrolytic Refining**