METALS AND NON-METALS

Metals: The elements, which have the properties of luster, malleability and ductility, high thermal and electrical conductivities. The metals have a good tendency to loose electrons.

Non-metals: The elements, which do not have the above, mentioned properties. These have a good tendency to gain electrons.

Metalloids: The elements having the properties of metals as well as non-metals.

Difference between metals and non-metals

Properties	Metals	Non-metals
Physical Properties		
1. State	Metals are **solids** at ordinary temperature. (except mercury, which is a liquid.)	Non-metals exist in all the three states, that is, **solid, liquid and gas**.
2. Lustre	They possess **lustre or shine**.	They possess **no lustre**. (except Iodine and graphite.)
3. Malleability and Ductility	Metals are generally **malleable and ductile**.	Non-metals are **neither malleable nor ductile**.
4. Hardness	Metals are generally **hard**. Alkali metals are exception.	Non-metals possess **varying hardness**. Diamond is an exception. It is the hardest substance known to occur in nature.
5. Density	They have **high** densities.	They generally possess **low** densities.
6. Conductivity (Heat & Electricity)	Metals are **good conductors** of heat and electricity.	Non-metals are **poor conductors** of heat and electricity. The only exception is graphite which is a good conductor of electricity.
7. Melting and boiling point	They usually have **high** melting and boiling point.	Their melting and boiling point are usually **low**. The exceptions are boron, carbon and silicon.

Chemical Properties of Metals and Non-Metals

Properties	Metals	Non-Metals
1. Reaction with oxygen	Metal + oxygen →Metal oxide Example: $4Na + O_2 \rightarrow 2Na_2O$ Metal oxides are basic (Na_2O, CaO, K_2O, etc.) or Amphoteric (Zno and Al_2O_3)	Non-metal + oxygen → non-metallic oxide Example: $S+O_2 \rightarrow SO_2$ Non-metallic oxides are acidic (SO_2, CO_2, etc) or neutral (H_2O, CO, N_2O).
2. Reaction with water	Metal + oxygen →Metal oxide (Al, Zn, Fe) or Metal hydroxide (K, Na, Ca, Mg) Example : (i) $2K + 2H_2O \rightarrow 2KOH + H_2$ (ii) $2Al + 2H_2O \rightarrow Al_2O_3 + 3H_2$ Active metals (K, Na, Ca) react with coldwater, moderate metals (Mg react with warm water and reactive metals (Al, Zn, Fe) react with steam.	Non-metals do not react with water. Non-metals are electronegative hence do not lose electrons Non–metal + H_2O → No reaction
3. Reaction with acids	Metal + Dilute acid → Salt + Hydrogen Example : (i) $Mg + HCl\ (dil) \rightarrow 2NaCl + H_2$ (ii) $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$ Nitric acid (oxidizing agent) oxidizes H_2 to H_2O and it self gets reduced to NO, N_2O, or NO_2 Except for Mg and Mn where nitric acid forms metal nitrate and liberates H_2	Non-metal + Acid → No reaction Non-metals do not displace hydrogen from acids.
4. Reaction with salt solutions	More active Metal A + Salt solution of less active metal of B →Salt solution of metal A + metal B. Example : (i) $Zn\ (s) + CuSO_4(aq) \rightarrow ZnSO_4\ (aq) + Cu(s)$	More reactive non metal A + Salt solution of less reactive non-metal B→Salt solution of non-metal A + non-metal B Example :I) $2\ NaBr + Cl_2 \rightarrow 2NaCl + Br_2$
5. Reaction with chlorine	Metal + chlorine → Metal Chloride Example : i) $Mg + Cl_2 \rightarrow MgCl_2$ ii) $2Fe + 3Cl_2 \rightarrow 2FeCl_3$	Non-metal+ Chlorine → Non-metallic chloride Example: i) $H_2+Cl_2 \xrightarrow[\text{sunlight}]{\text{diffused}} 2HCl$ ii) $P_4+6Cl_2 \longrightarrow 4PCl_3$
6. Reaction with Hydrogen	Metal + Hydrogen→ metal Hydride Example : i) $2Na + H_2 \rightarrow 2NaH$ Only active metals like Na, K and Ca reacts with hydrogen	Non-metal+ Hydrogen→ Non-metallic hydride Example: i) $2H_2+O_2 \rightarrow 2H_2O$ ii) $N_2+3H_2 \rightarrow 2NH_3$
7. Oxides	Oxides of metals are either basic or amphoteric. i) Basic oxides turn red litmus blue and show neutralization reaction with acids or acidic oxides. Example :	Oxides of non-metals are either acidic or neutral. i) Acidic oxides turn blue litmus red and show neutralization reaction

	i) $\underset{\text{Basic}}{Na_2O} + \underset{\text{Acid}}{2HCl} \rightarrow \underset{\text{salt}}{2NaCl} + \underset{\text{water}}{H_2O}$ ii) Amphoteric oxide show neutralization reaction with acids as well as base $Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$ $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + H_2O$	with base or basic oxides. Example: i) $SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$ ii) Neutral oxides do not show neutralization reaction with either acids or bases Example: N_2O, CO, H_2O
8. Electrochemical behaviour	Metals are electropositive in character. They form cations in solution and are deposited on the cathode when electricity is passed through their solution.	Non-metals are electronegative in character. They form anions in solution and are liberated at the anode when their salt solutions are subjected to electrolysis. Hydrogen in an exception. It usually forms positive ions and is liberated at cathode.
9. Oxidising or reducing behaviour	Metals behave as reducing agents. This is because of their tendency to lose electrons. $Na \longrightarrow Na^+ + e^-$	Non-metals generally behave as oxidising agents since they have the tendency to gain electrons. $\frac{1}{2}Cl_2 + e^- \rightarrow Cl^-$

- Metal + Metal → No reaction
- Metal + Non-metal → Electrovalent or Ionic compound by complete transfer of electrons from metallic atom to non-metallic and forming corresponding positive and negative ions.
- Nonmetal + Non-metal → Covalent compound by sharing of electrons

Reactivity series of metals :

Element	Symbol	
Potassium	K	← Most Reactive
Sodium	Na	
Barium	Ba	
Calcium	Ca	
Magnesium	Mg	
Aluminium	Al	
Zinc	Zn	
Iron	Fe	
Nickel	Ni	
Tin	Sn	
Lead	Pb	
Hydrogen	H	
Copper	Cu	
Mercury	Hg	
Silver	Ag	
Gold	Au	
Platinum	Pt	← Least Reactive

Metals More Reactive than Hydrogen

Metals less Reactive than Hydrogen

Reactivity decreases downward

Activity series of non-metals (Halogens)

F > Cl > Br > I

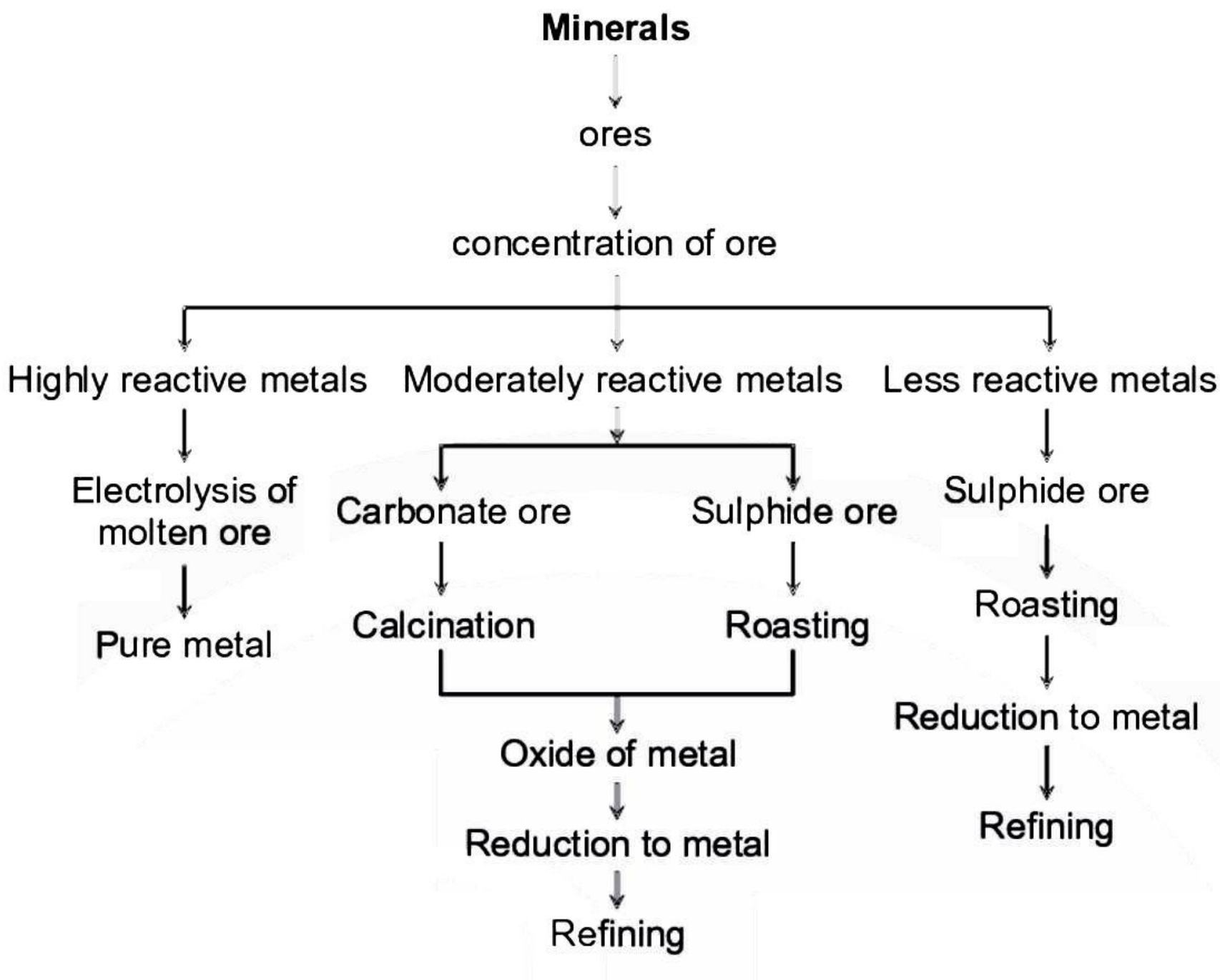
Occurrence of metals

- Free state → Least reactive metals
- Combined or compound state → Reactive metals

Mineral : Metals occurring naturally in the earth's crust in their inorganic elemental or compound form are called Minerals.

Gangue: The earthy, sandy and rock impurities associated with minerals are called gangue or matrix.

Ores: The minerals from which the metals can be extracted conveniently and profitably are called an ore:


Minerals
ores
concentration of ore
Highly reactive metals
Moderately reactive metals
Less reactive metals
Electrolysis of molten ore
Pure metal
Carbonate ore
Sulphide ore
Calcination
Roasting
Oxide of metal
Reduction to metal
Refining
Sulphide ore
Roasting
Reduction to metal
Refining