

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: $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$ Metal oxides are basic (Na_2O, CaO, K_2O, etc.) or Amphoteric (ZnO and Al_2O_3)	Non-metal + oxygen → non-metallic oxide Example: $\text{S} + \text{O}_2 \rightarrow \text{SO}_2$ 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) $2\text{K} + 2\text{H}_2\text{O} \rightarrow 2\text{KOH} + \text{H}_2$ (ii) $2\text{Al} + 2\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2$ 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 + $\text{H}_2\text{O} \rightarrow$ No reaction
3. Reaction with acids	Metal + Dilute acid → Salt + Hydrogen Example : (i) $\text{Mg} + \text{HCl (dil)} \rightarrow \text{MgCl}_2 + \text{H}_2$ (ii) $\text{Mg} + \text{H}_2\text{SO}_4 \rightarrow \text{MgSO}_4 + \text{H}_2$ 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) $\text{Zn (s)} + \text{CuSO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{Cu(s)}$	More reactive non metal A + Salt solution of less reactive non-metal B → Salt solution of non-metal A + non-metal B Example : i) $2\text{NaBr} + \text{Cl}_2 \rightarrow 2\text{NaCl} + \text{Br}_2$
5. Reaction with chlorine	Metal + chlorine → Metal Chloride Example : i) $\text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2$ ii) $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$	Non-metal + Chlorine → Non-metallic chloride Example: i) $\text{H}_2 + \text{Cl}_2 \xrightarrow[\text{sunlight}]{\text{diffused}} 2\text{HCl}$ ii) $\text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3$
6. Reaction with Hydrogen	Metal + Hydrogen → metal Hydride Example : i) $2\text{Na} + \text{H}_2 \rightarrow 2\text{NaH}$ Only active metals like Na, K and Ca reacts with hydrogen	Non-metal + Hydrogen → Non-metallic hydride Example: i) $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ ii) $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
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) $\text{Na}_2\text{O} + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O}$ Basic Acid salt water ii) Amphoteric oxide show neutralization reaction with acids as well as base $\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$ $\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + \text{H}_2\text{O}$	with base or basic oxides. Example: i) $\text{SO}_2 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_3 + \text{H}_2\text{O}$ 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 is 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. $\text{Na} \longrightarrow \text{Na}^+ + \text{e}^-$	Non-metals generally behave as oxidising agents since they have the tendency to gain electrons. $\frac{1}{2}\text{Cl}_2 + \text{e}^- \rightarrow \text{Cl}^-$

- 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

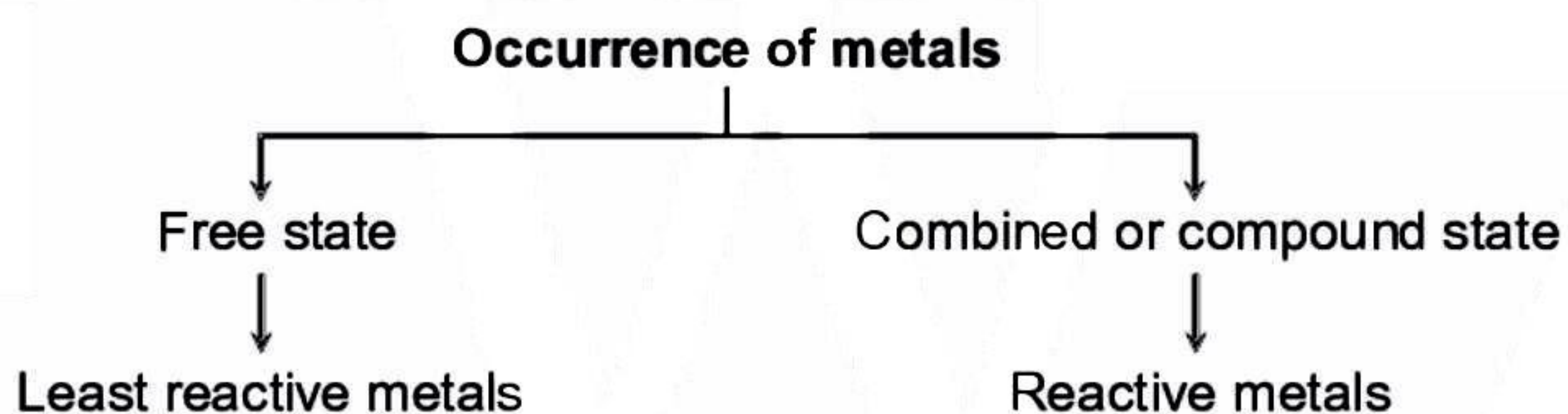
Reactivity series of metals :



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

Activity series of non-metals (Halogens)

$F > Cl > Br > I$



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:

