



METALS AND NON METALS

PART -1

METALS AND NON-METALS

Elements are generally classified into metals and non-metals based on their properties.

Physical properties of metals and non-metals:

Malleability: Property of a substance due to which it can be beaten into thin sheet. Metals are malleable while non-metals are not.

Ductility: Property of a substance by which it can be drawn into thin wires. Metals are ductile while non-metals are not.

Conduction of heat: Metals are good conductors of heat. Silver and copper are best conductors while lead and mercury are the poor conductors of heat. Non-metals are bad conductors of heat.

Conduction of electricity: Metals are good conductors of electricity while non-metals are bad conductors of electricity with an exception of graphite(an allotrope of carbon)

Appearance of surface: Metals, in their pure state, have a shining surface also called metallic lustre. Non-metals are generally non-lustrous with an exception of iodine. Metals on reacting with gases in atmosphere lose its shiny appearance when kept in air for a long time.

Hardness: Metals are generally hard with the exceptions of sodium and potassium that can be cut by knife.

Density: Metals have high density except sodium and potassium.

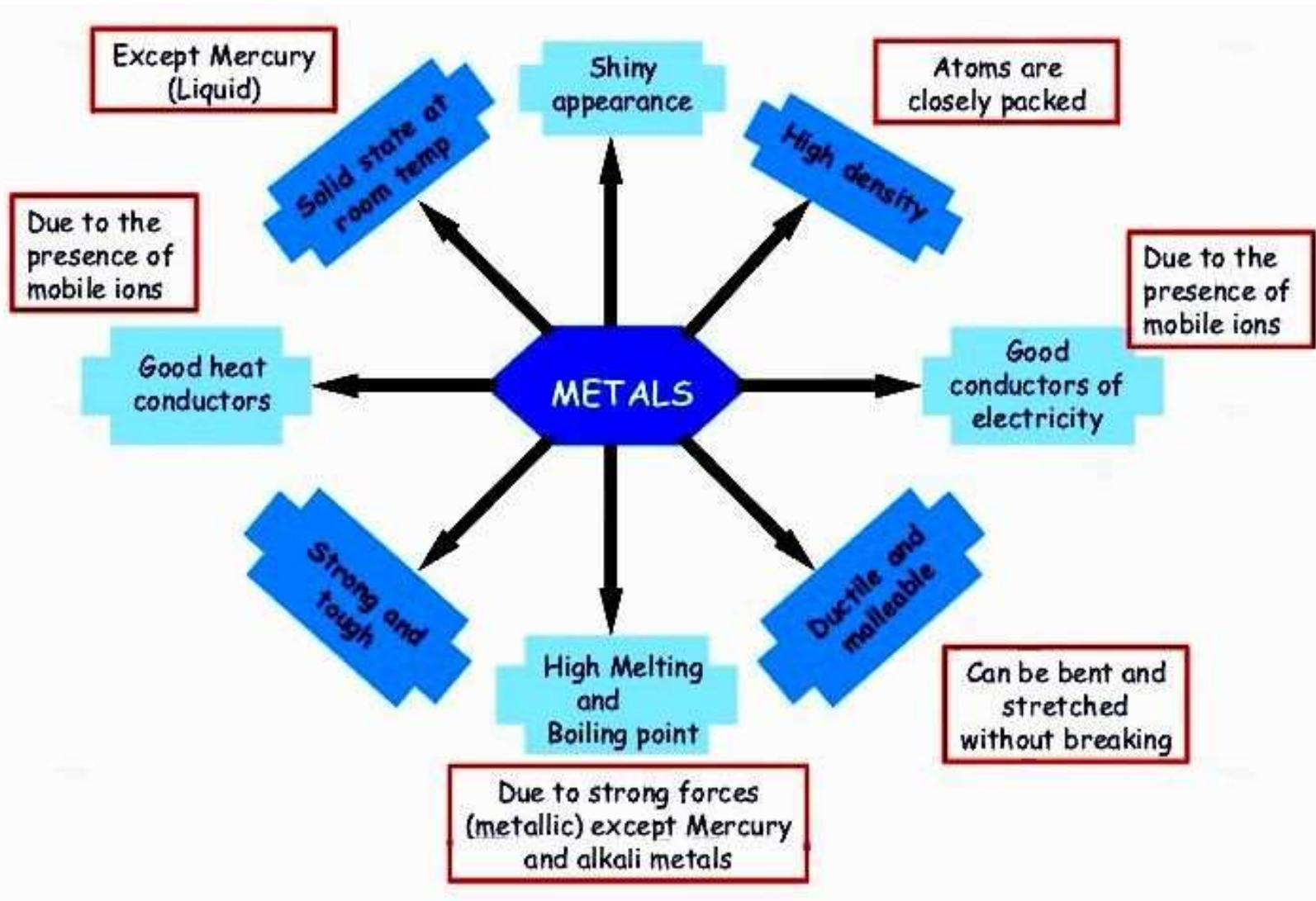
Melting and boiling points: Generally metals have melting and boiling points except for sodium, potassium, mercury, cesium, gallium.

State at room temperature: Metals are generally solid at room temperature with an exception of mercury which is liquid. Non-metals are present in all three states, solids, liquids and gaseous, at room temperature.

Sonority: Property of producing sound on striking a hard surface. Metals are sonorous while non-metals are not.

EXCEPTIONS IN PHYSICAL PROPERTIES

- ❖ Graphite, a non-metal, is a good conductor of electricity.
- ❖ Iodine is a lustrous non-metal.
- ❖ Diamond, an allotrope of carbon, which is a non-metal is the hardest substance while sodium and potassium, being metals are soft enough to be cut by knife.
- ❖ Mercury, which is a metal, is liquid at room temperature while rest are solids.
- ❖ Sodium, potassium, mercury, cesium and gallium are metals with low melting and boiling points.
- ❖ Diamond is the non-metal with high melting and boiling point.
- ❖ Sodium, potassium and lithium are metals with low density.



CHEMICAL PROPERTIES OF METALS

Reaction with oxygen:

Almost all metals combine with oxygen to form metal oxides.

Metal + Oxygen → Metal oxide

For e.g. **$2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$**

Metal oxides are basic in nature. Some metal oxides, such as aluminium oxide, zinc oxide, etc., which react with both acids as well as bases to produce salts and water are known as **amphoteric oxides**.

For e.g. **$\text{Al}_2\text{O}_3 + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2\text{O}$**

$\text{Al}_2\text{O}_3 + 2\text{NaOH} \rightarrow 2\text{NaAlO}_2 + \text{H}_2\text{O}$

Most metal oxides are insoluble in water but some dissolve to form alkalis like sodium and potassium oxides.

Metals such as potassium and sodium react so vigorously with oxygen that they catch fire if kept in the open. So to protect them they are kept immersed in kerosene oil.

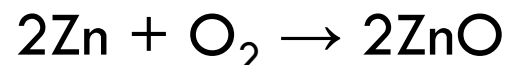
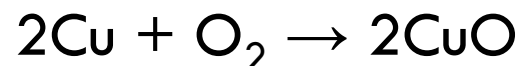
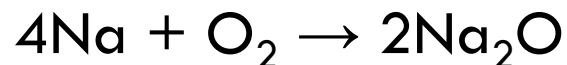
For e.g. **$\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq})$**

Anodising: Process of forming a thick oxide layer of aluminium that makes it resistant to further corrosion.

REACTION WITH WATER:

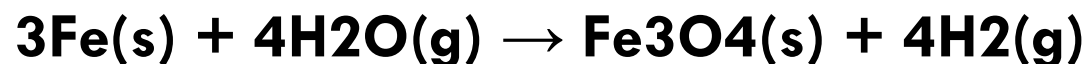
All metals do not react with water. Those which react form metal oxide and hydrogen gas. Metal oxides that are soluble in water further form metal hydroxide.

Metal + Water $\rightarrow$ Metal oxide + Hydrogen



Metal oxide + Water $\rightarrow$ Metal hydroxide

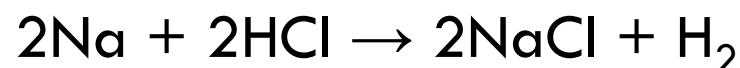
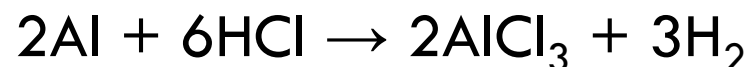
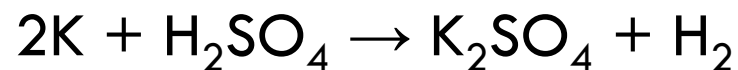
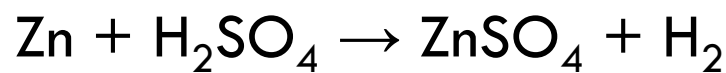
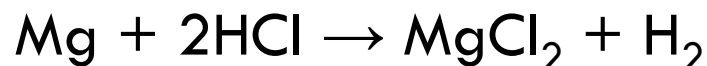
Metals like sodium & potassium react with cold water vigorously; metals like magnesium react with hot water. Iron, zinc reacts with steam while lead, silver and gold do not react with water at all.



REACTION WITH DILUTE ACID:

Most metals react with acids to give a salt and hydrogen gas.

Metal + Dilute acid $\rightarrow$ Salt + Hydrogen



Hydrogen gas is not evolved when a metal reacts with nitric acid. It's a strong oxidizing agent and oxidizes hydrogen produced to water and itself gets reduced to any of the nitrogen oxides (N_2O , NO , NO_2).

But magnesium (Mg) and manganese (Mn) react with very dilute

HNO_3 to evolve H_2 gas.

• **AQUAREGLA:**

- Freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1.
- Is a highly corrosive, fuming liquid and one of the few reagents able to dissolve gold and platinum.
- **Reactivity of metals / Reactivity Series:**

Figure 1: Activity Series : Relative reactivities of metals

K	Potassium	Most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
Zn	Zinc	Reactivity decreases
Fe	Iron	
Pb	Lead	
H	Hydrogen	
Cu	Copper	
Hg	Mercury	
Ag	Silver	
Au	Gold	Least reactive

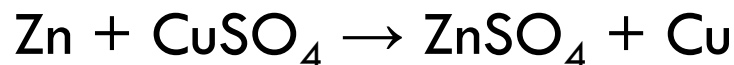
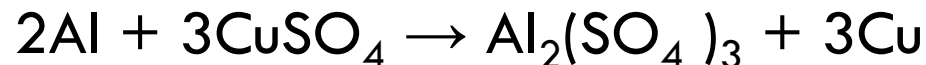
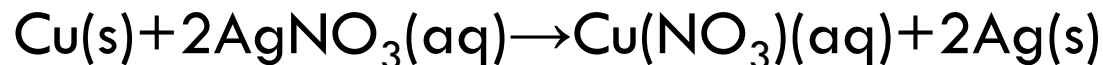
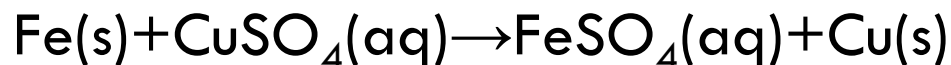
		Metal		Reaction with AIR	Reaction with WATER	Reaction with ACIDS
WEIGHT (Light) (Heavy)		Potassium	K	Burn vigorously to form metal oxides	React with cold water $\text{H}_2\text{O (l)}$ to form $\text{H}_2\text{(g)}$ and $\text{(metal)OH}_{\text{(aq)}}$	Strong reaction with diluted acid (aq) to form $\text{H}_2\text{(g)}$. Metal replaces H in compound to form a salt.
		Sodium	Na			
		Calcium	Ca	Burn with decreasing vigour down the series to form metal oxides	Only reacts with steam $\text{H}_2\text{O(g)}$ to form $\text{H}_2\text{(g)}$ and metal oxide	
		Magnesium	Mg			
		Aluminium	Al			
		Zinc	Zn			
		Iron	Fe			
		Lead	Pb	React slowly (when heated) to form an oxide layer	No reaction	React with concentrated acid (l) . Metal replaces H to make a salt. Some of the acid decomposes into $\text{NO}_2\text{(g)}$ and $\text{H}_2\text{O (l)}$.
		Copper	Cu			
		Mercury	Hg			
		Silver	Ag	No reaction		No reaction
		Gold	Au			

DISPLACEMENT REACTION

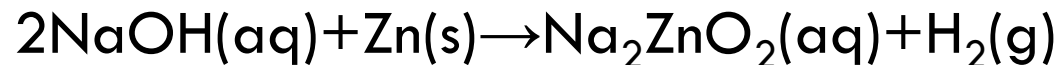
A more reactive element displaces a less reactive element from its compound or solution.

HOW DO METAL REACT WITH SOLUTION OF OTHER METAL SALTS

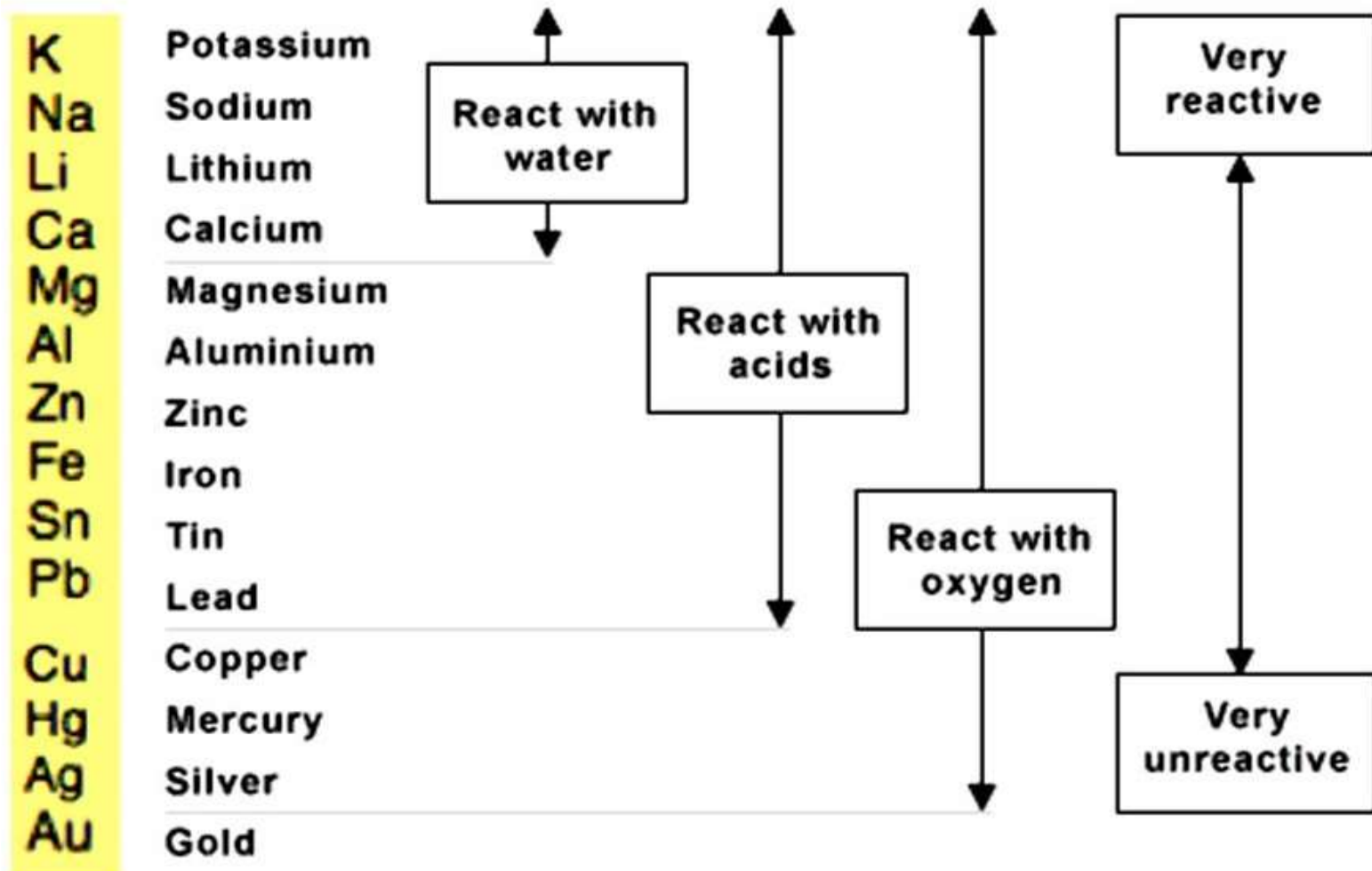
Metal A + Salt of metal B → Salt of metal A + Metal B



REACTION OF METALS WITH BASES



Reactivity Series of Metals



Following points become evident from the activity series of metals.

- The higher the metal in the series, the more reactive it is i.e., its reaction is fast and more exothermic.
- This also implies that the reverse reaction becomes more difficult i.e., the more reactive a metal, the more difficult it is to extract it from its ore. The metal is also more susceptible to corrosion with oxygen and water.
- The reactivity series can be established by observation of the reaction of metals with water, oxygen or acids.
- Within the general reactivity or activity series, there are some periodic table trends:
 - (i)Down Group 1(I) the "Alkali Metals", the activity increases $\text{Cs} > \text{Rb} > \text{K} > \text{Na} > \text{Li}$.
 - (ii)Down Group 2(II) the activity increases e.g., $\text{Ca} > \text{Mg}$.
 - (iii)In the same period, the Group 1 metal is more reactive than the group II metal and the group II metal is more reactive than the Group III metal and all three are more reactive than the "Transition Metals".
e.g., $\text{Na} > \text{Mg} > \text{Al}$ (in Period 3) and $\text{K} > \text{Ca} > \text{Ga} > \text{Fe/Cu / Zn}$ etc. (in Period 4)

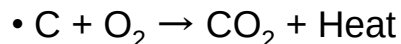
CHEMICAL PROPERTIES OF NON-METALS

REACTION OF NON-METALS WITH OXYGEN:

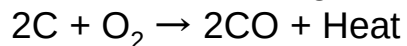
Non-metals form respective oxide when react with oxygen.

Non-metal + Oxygen $\rightarrow$ Non-metal oxide

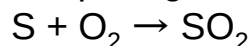
•When carbon reacts with oxygen, carbon dioxide is formed along with production of heat.



•When carbon is burnt in insufficient supply of air, it forms carbon monoxide. Carbon monoxide is a toxic substance. Inhaling of carbon monoxide may prove fatal.



•Sulphur gives sulphur dioxide when react with oxygen. Sulphur caught fire when exposed to air.



•When hydrogen reacts with oxygen it gives water. $2H_2 + O_2 \rightarrow 2H_2O$

NON-METAL OXIDE:

Non-metal oxides are acidic in nature. Solution of non-metal oxides turns blue litmus red.

Examples:

•Carbon dioxide gives carbonic acid when dissolved in water. $CO_2 + H_2O \rightarrow H_2CO_3$

•Sulphur dioxide gives sulphurous acid when dissolved in water. $SO_2 + H_2O \rightarrow H_2SO_3$

•Sulphur dioxide gives sulphur trioxide when it reacts with oxygen. $2SO_2 + O_2 \rightarrow 2SO_3$

•Sulphur trioxide gives sulphuric acid when dissolved in water. $SO_3 + H_2O \rightarrow H_2SO_4$

REACTION OF NON-METAL WITH CHLORINE:

Non metals give respective chloride when they react with chlorine gas.

Non-metal + Chlorine $\rightarrow$ Non-metal chloride

Examples:

•Hydrogen gives hydrogen chloride and phosphorous gives phosphorous trichloride when react with chlorine.



Thank
you

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