

Class 10th

CHEMISTRY

METALS AND NON-METALS

Elements can be classified as metals and non-metals on the basis of their properties.

Examples of some metals are:

Iron (Fe), Aluminium (Al), Silver (Ag), Copper (Cu)

Examples of some non-metals are:

Hydrogen (H), Nitrogen (N), Sulphur (S), Oxygen (O)

Physical properties of metals:

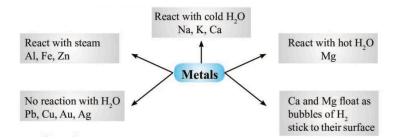
Metals are generally hard, malleable, lustrous, sonorous and have high melting points.

They are good conductors of heat and electricity.

Mercury is a liquid metal at room temperature.

Chemical properties of metals:

- 1. Metal + Oxygen \rightarrow Metal oxide, example: $2Cu(s) + O_2(g) \rightarrow 2CuO(s)$
- 2. Metal + Water \rightarrow Metal hydroxide + Hydrogen, example: $2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g) + heat energy$



- 3. Metal oxide + Water \rightarrow Metal hydroxide, example: CaO(s) + H₂O(l) \rightarrow Ca(OH)₂(aq)
- 4. Metal + Dilute acid \rightarrow Salt + Hydrogen, example: Fe(s) +dil.H₂SO₄(aq) \rightarrow FeSO₄(aq) + H₂(g)

Hydrogen gas is not evolved when a metal reacts with nitric acid. This is because HNO_3 is a strong oxidising agent. It oxidises the H_2 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.

$$Mg(s) + 2HNO_3(aq) \rightarrow Mg(NO_3)_2(aq) + H_2O(g)$$

Amphoteric Oxides: Metal oxides which react with both acids as well as bases to produce salts and water are called amphoteric oxides.

Examples: $Al_2O_3(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2O(l)$

$$Al_2O_3(s) + 2NaOH(aq) \rightarrow 2NaAlO_2(aq) + H_2O(l)$$

Sodium Aluminate



Aqua regia: (Latin for 'royal water') is a freshly prepared mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio of 3:1. It can dissolve gold and platinum, even though neither of these acid can do so alone. Aqua regia is a highly corrosive, fuming liquid. It is one of the few reagents that is able to dissolve gold and platinum.

5. Metal A + Salt solution of B \rightarrow Salt solution of A + Metal B, example: Fe(s) + CuSO₄(aq) \rightarrow Cu(s) + FeSO₄(aq)

The Reactivity Series: The reactivity series is a list of metals arranged in the order of their decreasing activities.

K Na	Potassium Sodium	Most reactive
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

Activity series: Relative reactivities of metals

Reaction of Metals with Non-metals

Reactivity of elements is the tendency to attain a completely filled valence shell.

Atoms of the metals lose electrons from their valence shell to form cations.

Atoms of the non-metals gain electrons in the valence shell to form an anions.

For example: Formation of NaCl

$$Na \rightarrow Na^{+} + e^{-}$$

2,8,1 2,8 (Sodium cation)

$$\begin{array}{c} \text{Cl} & +\text{e}^{\text{-}} \rightarrow \text{Cl}^{\text{-}} \\ \text{2,8,7} & \text{2,8,8} \\ & \text{(Chloride anion)} \end{array}$$

Properties of Ionic Compounds

- 1. Physical nature: They are solid and hard, and brittle.
- 2. Melting and Boiling Point: They have high melting and boiling point.
- 3. Solubility: Generally soluble in water and insoluble in solvents such as kerosene, petrol etc.
- 4. Conductivity: Ionic compounds conduct electricity in molten and aqueous solution but not in solid state.

Occurrence of Metals

Minerals: The elements or compounds which occur naturally in the earth's crust are called minerals.

Ores: Minerals that contain a very high percentage of a particular metal and the metal can be profitably extracted from it, such minerals are called ores.

Gangue: Ores mined from the earth are usually contaminated with large amounts of impurities such as soil, sand, etc., called gangue.



	$\Gamma^{\mathbf{K}}$	
	Na	Not found in free state
Very reactive	Ca	Extraction by electrolysis
	Mg	
	L_{Al} I	
	ΓZn	
	Fe	Occur as sulphides, oxides, carbonates
Moderately reactive	Fe Pb	
	Cu	Reduction by using carbon
	$L_{Hg}I$	
Least reactive	[Ag	Occur in native/free state
	L_{Au}	

Extraction of Metals

(i) Metals of low reactivity:

(ii) Metals of medium reactivity:

Roasting: The sulphide ores are converted into oxides by heating strongly in the presence of excess air. This process is known as roasting. Example:

$$2ZnS(s) + 3O_2(g)$$
 Roasting $\rightarrow 2ZnO(s) + 2SO_2(g)$ Zinc blende

Calcination: The carbonate ores are changed into oxides by heating strongly in limited air or the absence of air. This process is known as calcination.

$$ZnCO_3(s)$$
 Calcination $\rightarrow ZnO(s) + CO_2(g)$

(iii) Metals of high reactivity.

Sodium, magnesium and calcium are obtained by the electrolysis of their molten chlorides and oxides. The metals are deposited at the cathode (the negatively charged electrode), whereas, chlorine or oxygen is liberated at the anode (the positively charged electrode).

$$2NaCl(l)$$
 Electrolysis $\rightarrow 2Na(s) + Cl_2$

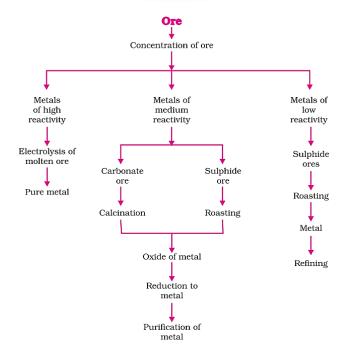
Molten

At Cathode: $2Na^+ + 2e^- \rightarrow 2Na$

At Anode: $2Cl^{-} \rightarrow Cl_2 + 2e^{-}$

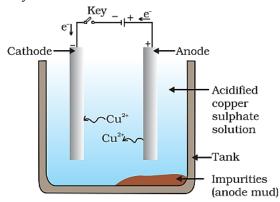
A summary of these steps:





Refining of Metals:

Electrolytic Refining: Many metals, such as copper, zinc, tin, nickel, silver, gold, etc., are refined electrolytically. In this process, the impure metal is made the anode and a thin strip of pure metal is made the cathode. A solution of the metal salt is used as an electrolyte.



Corrosion:

The surface of some metals such as iron, copper etc is corroded when they are exposed to moist air for a long period of time. This is called corrosion.

- (i) Silver becomes black when exposed to air as it reacts with air to form a coating of silver sulphide(Ag₂S).
- (ii) Copper reacts with moist carbon dioxide in the air and gains a green coat of basic copper carbonate (Cu(OH)₂.CuCO₃).
- (iii) Iron when exposed to moist air acquires a coating of a brown flaky substance called rust(Fe₂O₃.xH₂O)

Prevention of Corrosion:

The rusting of metals can be prevented by painting, oiling, greasing, galvanising, chrome plating, anodising or making alloys.

Galvanisation is a method of protecting steel and iron from rusting by coating them with a thin layer of zinc. The galvanised article is protected against rusting even if the zinc coating is broken.



Alloy: An alloy is a homogenous mixture of two or more metals or a metal and a non-metal.

Steel: Iron + Carbon **Brass:** Copper + Zinc **Bronze:** Copper + Tin **Solder:** Lead + Tin

Amalgam: If one of the metals is mercury (Hg)